Site Inspection Report
Mayflower - Ochoco Mine Complex
Ochoco National Forest

November 2005

Natural Solutions for Water

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SITE INSPECTION
Mayflower - Ochoco Mine Complex
Ochoco National Forest

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Prepared for: USDA Forest Service
Ochoco National Forest

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Ochoco National Forest
Crook County, Oregon

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Cover Photos: Informational sign near the Mayflower Mine (upper left), and Mayflower Adit and drainage (lower right).

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LIST OF ACRONYMS AND ABBREVIATIONS

90UCL	90th percentile upper confidence limit on the arithmetic mean
ABA	Acid Based Accounting
ABP	Acid Base Potential
AGP	Acid Generating Potential
amsl	above mean sea level
ANP	Acid Neutralization Potential
ARD	Acid Rock Drainage
bgs	below ground surface
CERCLA	Comprehensive Environmental Response and Liability Act
CES	Cascade Earth Sciences
COI	Containments of Interest
COPC	Containments of Potential Concern
COPEC	Containments of Potential Ecological Concern
CTE	Central Tendency Exposure
ECR	Excess Cancer Risk
EECA	Engineering Evaluation / Cost Analysis
ERA	Ecological Risk Assessment
HHRA	Human Health Risk Assessment
MDL	Method Detection Limit
ODEQ	Oregon Department of Environmental Quality
PQL	Practical Quantification Limit
PRG	Preliminary Remediation Goals
QA/QC	Quality Assurance / Quality Control
RCRA	Resource Conservation Recovery Act
RME	Reasonable Maximum Exposure
RTE	Rare, Threatened, and Endangered
SI	Site Inspection
SPLP	Synthetic Precipitation Leaching Procedure
TCLP	Toxicity Characterization Leaching Procedure
USEPA	United States Environmental Protection Agency
USFS	United States Department of Agriculture, Forest Service

EXECUTIVE SUMMARY

A Site Inspection (SI) was performed at the Mayflower - Ochoco Mine Complex (Site), abandoned gold and silver mines, located in the Ochoco National Forest. The SI was conducted to assess if the Site poses an immediate and potential threat to human health and the environment, and to collect sufficient information to support a decision regarding the need for further action. Based on the information presented in this report, the results indicate the following:

Groundwater Pathway

- The groundwater pathway does not appear to be complete; further assessment is not recommended.

Surface Water Pathway

- The surface water pathway is complete because metal concentrations in surface water, pore water, and sediment are elevated near the Site. Arsenic is the primary metal of concern.
- The Human Health Risk Assessment (HHRA) determined that no unacceptable human health risks were expected for exposure to metals in surface water, pore water, and sediments.
- The Ecological Risk Assessment (ERA) suggests a potential ecological impact in Scissors Creek and Ochoco Creek related to arsenic V and total arsenic.
  - This is supported by the benthic invertebrate enumeration results at SC-SS-2 (Scissors Creek) and OC-SS-05 (Ochoco Creek) adjacent to the Mayflower Mine.
  - This suggests that the mine workings in the Scissors Creek watershed are likely affecting Scissors Creek, and the Mayflower Mine is likely affecting Ochoco Creek.

Soil Pathway

- The soil exposure pathway is complete for both human and ecological receptors, and a release of hazardous substances has been documented in this SI. Arsenic is the main metal of concern.
- The HHRA suggests a potential exists for unacceptable carcinogenic risk to the reasonable maximum exposure (RME) individual from dermal contact and ingestion of arsenic impacted soil, wasterock, and tailings at the Mayflower Mine and Scissors Creek workings.
- The ERA suggests that ecological impacts are expected by metals in soil, wasterock, and tailings.
  - The most significant risk would be posed to plants and invertebrates that inhabit the soil, wasterock, and tailings in the immediate vicinity of the Mayflower Mine and the Scissors Creek workings.
  - Mobile and wide-ranging wildlife species are unlikely to spend large amounts of time on or around the Site, and thus, are less likely to be impacted.

Air Pathway

- The air pathway is complete for both human and ecological receptors.
- Further assessment is not recommended; the air pathway will be addressed under the soil pathway.

Recommendations

- Based on the SI, CES recommends performing an Engineering Evaluation / Cost Analysis (EECA) because unacceptable risks have been identified for human and ecological receptors, mainly from the Mayflower Mine and Scissors Creek workings.
- CES recommends additional background samples (~six) be collected from around the Site to further quantify background concentrations.
- The EECA will establish removal cleanup standards, and assess removal action alternatives.
- Physical dangers (i.e., opened adits, stopes, steep waste piles, etc.) should also be included as part of the EECA.

SITE INSPECTION DATA SUMMARY SHEET

Project Name: Mayflower-Ochoco Mine Complex Site Inspection
Project Location: Sections 20 and 30, Township 13 South, Range 20 East
Latitude (Ochoco): 44° 25' 38" N **Longitude:** 120° 21' 44" W
Latitude (Mayflower): 44° 25' 01" N **Longitude:** 122° 22' 22" W
Nearest Surface Water Body: Ochoco Creek
Area of Disturbance: ~0.5 acres at Ochoco Mine; 4 acres at Mayflower Mine

SUMMARY OF ANALYTICAL/DOCUMENTED CONTAMINATION

Media	Sample Location	Rate of Discharge/Volume (cfs, gpm, or CY)	Contaminant	Highest Concentration	Lowest Criteria Eco – Ecological HH – Human Health	Background Concentration
Surface Water	OC-SW-6	4.12 cfs	Arsenic, TR	0.71 µg/L	0.018 µg/L – Eco	<0.43 µg/L
	SC-SW-2	0.28 cfs	Arsenic, TR	2.78 µg/L	0.018 µg/L – Eco	<0.43 µg/L
	SMM-AD1	0.005 cfs	Arsenic V, TR	3.312 µg/L	3.1 µg/L – Eco	<0.43 µg/L
			Arsenic, TR	3.33 µg/L	0.018 µg/L – HH	<0.43 µg/L
			Cadmium, TR	0.42 µg/L	0.21 µg/L – Eco	<0.12 µg/L
			Manganese, TR	4,870 µg/L	50 µg/L – HH	10.2 µg/L
Pore water	OC-PW-4	Not Applicable (NA)	Barium, Diss	22.1 µg/L	4 µg/L – Eco	12.5 µg/L
			Iron, Diss	7,860 µg/L	1,000 µg/L – Eco	65 µg/L
Sediment	OC-SS-5	NA	Arsenic	55.6 mg/kg	5.9 mg/kg – Eco	3.4 mg/kg
			Chromium	51.3 mg/kg	37 mg/kg – Eco	33.2 mg/kg
	OC-SS-6	NA	Arsenic	13.7 mg/kg	5.9 mg/kg – Eco	3.4 mg/kg
			Copper	70.5 mg/kg	36 mg/kg – Eco	36.3 mg/kg
			Mercury	0.50 mg/kg	0.17 mg/kg – Eco	<0.03 mg/kg
	SC-SS-2	NA	Arsenic	69.2 mg/kg	5.9 mg/kg – Eco	<2.5 mg/kg
Wasterock	Ochoco Mine	660 cubic yards (cy)	Aluminum	31,600 mg/kg	50 mg/kg – Eco	22,360, mg/kg
			Copper	98.3 mg/kg	50 mg/kg – Eco	55.1 mg/kg
			Mercury	3.12 mg/kg	0.00051 mg/kg – Eco	0.079 mg/kg
			Selenium	5.27 mg/kg	0.21 mg/kg – Eco	0.50 mg/kg
			Vanadium	165 mg/kg	2 mg/kg – Eco	89.2 mg/kg
	Mayflower Mine	12,000 cy	Arsenic	577 mg/kg	1.6 mg/kg – HH	209.8 mg/kg
			Copper	127 mg/kg	50 mg/kg – Eco	55.1 mg/kg
			Lead	348 mg/kg	16 mg/kg – Eco	20.8 mg/kg
			Manganese	10,400 mg/kg	100 mg/kg – Eco	1,513 mg/kg
			Mercury	1.35 mg/kg	0.00051 mg/kg – Eco	0.079 mg/kg
			Nickel	81.7 mg/kg	30 mg/kg – Eco	27.3 mg/kg
			Silver	17.8 mg/kg	2 mg/kg – Eco	1.0 mg/kg
			Zinc	730 mg/kg	8.5 mg/kg – Eco	87 mg/kg

SUMMARY OF ANALYTICAL/DOCUMENTED CONTAMINATION (cont.)

Media	Sample Location	Rate of Discharge/Volume (cfs, gpm, or CY)	Contaminant	Highest Concentration	Lowest Criteria Eco – Ecological HH – Human Health	Background Concentration
Soil	Mayflower Mine	Soil = 420 cy Vat Residue = 90 cy	Antimony	1,720 mg/kg	5 mg/kg – Eco	4.9 mg/kg
			Arsenic	5,140 mg/kg	1.6 mg/kg – HH	209.8 mg/kg
			Cadmium	9.16 mg/kg	4 mg/kg – Eco	<0.2 mg/kg
			Copper	240 mg/kg	50 mg/kg – Eco	55.1 mg/kg
			Lead	5,440 mg/kg	16 mg/kg – Eco	20.8 mg/kg
			Mercury	5.61 mg/kg	0.00051 mg/kg – Eco	0.079 mg/kg
			Silver	445 mg/kg	2 mg/kg – Eco	1.0 mg/kg
			Zinc	4,190 mg/kg	8.5 mg/kg – Eco	87 mg/kg
Tailings	Mayflower Mine	600 cy	Antimony	3,190 mg/kg	5 mg/kg – Eco	4.9 mg/kg
			Arsenic	5,350 mg/kg	1.6 mg/kg – HH	209.8 mg/kg
			Chromium	119 mg/kg	0.4 mg/kg – Eco	62 mg/kg
			Copper	270 mg/kg	50 mg/kg – Eco	55.1 mg/kg
			Lead	9,460 mg/kg	16 mg/kg – Eco	20.8 mg/kg
			Manganese	31,700 mg/kg	100 mg/kg – Eco	1,513 mg/kg
			Mercury	2.5 mg/kg	0.00051 mg/kg – Eco	0.079 mg/kg
			Selenium	5.35 mg/kg	0.21 mg/kg – Eco	0.50 mg/kg
			Silver	265 mg/kg	2 mg/kg – Eco	1.0 mg/kg
			Zinc	5,740 mg/kg	8.5 mg/kg – Eco	87 mg/kg
Wasterock Scissor Creek Workings	Brian O'Lynn Adit	450 cy	Arsenic	357 mg/kg	1.6 mg/kg – HH	209.8 mg/kg
			Lead	719 mg/kg	16 mg/kg – Eco	20.8 mg/kg
			Mercury	0.81 mg/kg	0.00051 mg/kg – Eco	0.079 mg/kg
			Silver	5.58 mg/kg	2 mg/kg – Eco	1.0 mg/kg
			Zinc	541 mg/kg	8.5 mg/kg – Eco	87 mg/kg
	Street Adit	1,400 cy	Lead	7,558mg/kg	16 mg/kg – Eco	20.8 mg/kg
			Manganese	2,330 mg/kg	100 mg/kg – Eco	1,513 mg/kg
			Mercury	0.91 mg/kg	0.00051 mg/kg – Eco	0.079 mg/kg
			Silver	6.09 mg/kg	2 mg/kg – Eco	1.0 mg/kg
			Zinc	560 mg/kg	8.5 mg/kg – Eco	87 mg/kg
	Little Giant Adit	110 cy	Lead	748 mg/kg	16 mg/kg – Eco	20.8 mg/kg
			Manganese	2,770 mg/kg	100 mg/kg – Eco	1,513 mg/kg
			Mercury	2.76 mg/kg	0.00051 mg/kg – Eco	0.079 mg/kg
			Silver	5.23 mg/kg	2 mg/kg – Eco	1.0 mg/kg
			Zinc	300 mg/kg	8.5 mg/kg – Eco	87 mg/kg

Notes: This table only lists sample concentrations that are at least 1.5 times higher than the lowest criteria and/or background concentration. These exceedances are considered the major contaminants of concern (COCs) and not a complete list of all COCs.
Highest background concentration in waters and sediments used since only two samples were collected; background soil concentrations listed are the 90UCLof the mean.
TR = Total Recoverable Metals; Diss. = Dissolved Metals; µg/L = micrograms per liter; mg/kg = milligrams per kilogram; B=analyte detected between the method detection limit (MDL) and the practical quantification limit (PQL)

1.0 INTRODUCTION AND OBJECTIVES

The United States Department of Agriculture, Forest Service (USFS) retained Cascade Earth Sciences (CES) to perform a Site Inspection (SI) at the Mayflower and Ochoco Mine Complex (Site).

- The purpose is to determine the potential threat to human health and the environment from issues identified during the Abbreviated Preliminary Assessments (APAs) conducted by the USFS in 2004.
- The objectives were to:
  - assess the immediate or potential threat that mining wastes pose to human health and/or the environment, and
  - collect sufficient information to support a decision regarding the need for further action.
- The SI was performed following the USFS approved Field Operation Plan (FOP) (CES, 2005), which was developed based on the APAs and USFS Statement of Work (SOW).

2.0 SITE DESCRIPTION, OPERATIONAL HISTORY, AND WASTE CHARACTERISTICS

The following sections give a description of the location and operational history of the Site.

- Photographs of the Site and sampling locations are included in Appendix A.
- No regulatory removal actions have been undertaken at the Site.
- No permits, violations, and/or regulatory inspections have been documented at the Site.

2.1 Location

The Site is located in the Ochoco National Forest (ONF) in Crook County, 26 aerial miles east of Prineville, Oregon, (Figure 1). According to the USGS 7 ½ Minute Quadrangle Map – Ochoco Butte (USGS, 1992), the Site location is described as Sections 20, 29, and 30, Township 13 South, Range 20 East of the Willamette Meridian. Specific latitude and longitude coordinates and elevations are listed below.

- Mayflower Mine - Mayflower Adit portal
  - Latitude – 44° 25’ 01”N
  - Longitude – 120° 22’ 22”W
  - Elevation – 4,480 feet above mean sea level (amsl)
- Ochoco Mine – Ochoco Adit portal
  - Latitude – 44° 25’ 38”N
  - Longitude – 120° 21’ 44”W
  - Elevation – 4,400 to 4,600 feet amsl
- Brian O’Lynn Adit
  - Latitude – 44° 24’ 50”N
  - Longitude – 120° 21’ 58”W
  - Elevation – 4,720 feet amsl
- Street Tunnel
  - Latitude – 44° 24’ 41”N
  - Longitude – 120° 22’ 9”W
  - Elevation – 4,680 feet amsl
- Little Giant Adit
  - Latitude – 44° 24’ 43”N
  - Longitude – 120° 22’ 6”W
  - Elevation – 4,710 feet amsl

2.2 Operational History

The following information was gleaned from *History and Geologist's Report of the Mayflower Group of Mines* (Kimberlin, 1926), *Geology and Mineralization of the Ochoco Gold Prospect, Crook County, Oregon* (Willis, 1992), *Some Mining Districts of Eastern Oregon* (Gilully et al, 1933), *The Mineral Resources of Oregon, Handbook of the Mining Industry of Oregon* (Parks and Swartley, 1916), and an interview with A.J. Champion reprinted in a Crook County Historical Society Field Trip (1991). The following information is a chronological summary of the operational history of the Site and the estimated gold and silver production mainly at the Mayflower Mine. Historic information on the Ochoco Mine and other workings in the area was limited and/or not available.

Mayflower Mine

- 1871 Discovery of gold in the area of the Mayflower Mine by three men (Howard, Evans, and Belcher) hauling grain from Mitchell to Prineville.
- 1872 First placer claims (by Belcher and Howard) and prospects were located in the area. First of five water supply ditches were hand dug to supply water to placer operations. First lode gold was discovered while digging the Middle Line ditch bringing water from Ochoco Creek 200 feet above the creek onto gold bearing ground.
- 1873 Mineralized area was organized into the Howard Mining District, centered on the town of Howard, located along Ochoco Creek north of the Mayflower Mine.
- 1873-1883 Placer mining occurred in Scissors Creek and in gulches on the hillsides surrounding the Site.
- 1884 Mr. Williams purchased Belcher claim which crossed the Mayflower vein.
- 1884 The Mayflower vein was discovered during construction of the Highland Ditch and associated hydraulic mining.
- 1885 McAllister brothers purchase the Mayflower claim from Williams and started work on the main adit. Drifts were developed along the Mayflower vein with minor, continuous production.
- 1885 First record of production reported an output of about $10,000 in 1885 from carload of ore shipped to the Tacoma smelter.
- 1892 Cave-in after blasting revealed high-grade ore (Mayflower vein).
- 1886-1896 Small but continuous shipments made to the Tacoma smelter from 1885-1896.
- 1896 Ladd Estate secured an option from Lewis McAllister on the Mayflower claim. The adit is driven further into the hillside. A small smelter was erected and 40 tons of ore smelted when the smelter caught fire and melted down.
- 1896-1898 Small shipments continue to the Tacoma smelter until lode mines shut down. However, placer mining continued in gulches and on Scissors Creek.
- 1903 Lode production resumed in the Howard District. Thronson brothers acquire an option on the Mayflower claim and proceed to mine and ship ore until 1903.
- 1904 Mr. Blodgett purchased and consolidated all placer ground on Scissors Creek. King's Reservoir (Walton Lake) was constructed to supply water for the hydraulic "giants". Placer mining vigorously renewed through 1907.
- 1905 Bruce Gatewood, obtains option to purchase from Thronson brothers, organizes Gatewood Mining and Trading Company, and sells stock to raise money for equipment.
- 1906 A 10 ton per day (tpd), 5-stamp mill, with Wilfey table and amalgamating plates, and a cyanide plant were constructed near the Mayflower Adit. Approximately 2,000 tons of ore were treated from the mill. The attempt to cyanide the concentrates was unsuccessful due to the metallurgical problems with base metals. Only lower grades were concentrated at the mill and shipments were sent to the Tacoma smelter. The mine shut down in august 1906 due to expenditure of funds.
- 1908 Al Nichols secured a labor lien for the Mayflower claim and sold the mine to Lewis McAllister and W.T. Davenport.
- 1912 A.J. Champion purchased McAllister's interest and began prospecting with Davenport.

- 1912 -1918 Annual production (Mayflower Mine) ranged from 24 to 919 tons of crude ore, with most of the ore averaging 1 ounce of gold and 5 ounces of silver per ton.
- 1917 The Mayflower Mine sold to Stockman and Ownes and considerable development occurred.
- 1918-1925 The mines were worked intermittently.
- 1920 Stockman and Ownes relinquished their option and Champion and Davenport commence shipping ore.
- 1923 The Mayflower Mine sold to F.B. Chapin. He sunk the Chapin winze. Six carloads of ore were shipped to the smelter.
- 1925 A.J. Champion sold his interest to W.P. Marvin Davenport.
- 1926 Most of the Mayflower workings collapsed and were no longer accessible.
- 1933 A few ounces of gold were produced from the Howard District.
- 1948 The owner was identified as L.A. Houston of Prineville. Houston requested examination of ore samples from the Site from the Oregon Department of Geology and Mineral Industries (DOGAMI), which he believed contained cobalt. Assays of the samples revealed the mineralization in question was actually arsenopyrite.
- Late 1970's Inspiration Mining conducted extensive sampling of the Mayflower Adit.
- Early 1980's Freeport-McMoRan Gold Company sampled the area during a regional reconnaissance program, which yielded poor results.
- 1983 Ocelot optioned T.J. Hoffman's claims and conducted an extensive exploration of the area around the Mayflower Mine. However, the claims were released to Toby Hoffman.
- 1982-1983 Utah International staked 128 lode claims and optioned the original claim blocks.
- 1987 Orvanna Resources secured management of the property from BHP-Utah (Utah International).
- 1990 Orvanna Resources allowed the BHP-Utah claims to lapse, reverting the core group of claims to the original claim holder (T.J. Hoffman).

Total estimated production from the Howard Mining District from 1885 to 1923, including placer and lode production, amounted to 3,595 ounces of gold, 521 ounces of silver, and 2,662 pounds of lead (Willis, 1992). The majority of the lode production from the District was primarily from the Ophir Mayflower Mine (Brooks and Ramp, 1968). A summary of the estimated lode production from the District by Willis (1992), modified from Gilluy et al. (1933), is provided in the table below:

Year	Crude ore (tons)	Gold (ounces)	Silver (ounces)	Lead (pounds)	Value*
1885	?	~500	?	-	$10,340
1886-1896	?	~80	?	-	$1,650
1897-1902	-	-	-	-	-
1902-1923	2,225	2,478	442	2,662	$51,680
Total	**2,225**	**~3,058**	**442**	**2,662**	**$63,670**

Notes: "–" No data reported.
? Production records are unverified.
~ Estimated production.
*Values were estimated by Willis (1992) assuming gold at $20.67/oz, silver at $0.67/oz, and lead at $0.06/lb.

Ochoco Mine

- The Gilluly et al. report (1933) contains a 1914 map of the area which shows three prospects located in the gulch above the (present) adit portal, indicating the adit was most likely driven after the prospects were located. The report also states that the gulch was placer mined.
- The Crook County Historical Society (1991) apparently refers to this mine as the Sunshine Mine. In addition, it was reported that Louis Beirl bored a 400 foot tunnel in search for gold. The length of the tunnel correlates well with the size of the current wasterock pile.

2.3 Site Description

The Site is accessed from Crook County Road 22, and situated on steep side slopes adjacent to Ochoco Creek (Figure 2). The following were identified as major features at the Site. Photographs of pertinent features are included in Appendix A.

Mayflower Mine

- Two adits are located at the mine. The adits were referred to as the Upper and Lower in the Gilluly et al. report (1933).
  - The Lower Adit is commonly referred to the Mayflower Adit.
  - The Mayflower Adit portal is located at 4,540 feet amsl and extends 1,475 feet into the hillside (underground working map is included in Appendix B).
  - Water drains from the Mayflower Adit portal and flows across the wasterock before infiltrating into forest soils adjacent to the access road.
  - The Upper Adit is located at 4,655 feet amsl and 250 feet east the Mayflower Adit.
- A short prospect was observed at 4,785 feet amsl, above the Upper Adit.
- The remains of the 10 tpd, 5-stamp mill are located below the Mayflower Adit.
- The remains of an apparent cyanide vat was observed adjacent to the former mill building.
- According to a former owner, Toby Hoffman (Hoffman, 2005), the collapsed timber structure south of the cyanide vat is a recent attempted adit excavated to drain the Mayflower Adit. The excavation went approximately 30 feet into the hillside below the Mayflower Adit but does not appear to have been driven into hard rock, rather only through wasterock.
- Tailings (600 cy) were deposited downgradient from the mill and adjacent to Ochoco Creek.
- A large wasterock pile (12,000 cy) is located below the Mayflower Adit. A small wasterock pile (70 cy) is also located below the Upper Adit.
- Based on field observations, there is 420 cy of impacted soil near the former mill, with approximately 90 cy of residue in and near the cyanide vat.
- Numerous other shallow workings are located in the area (Kimblerlin, 1926). More recent logging efforts in the area likely used wasterock piles for landings in logging operations, thus covering up many of these workings (Hoffman, 2005).

Ochoco Mine

- Ochoco Adit is located at approximately 4,500 feet amsl.
- One wasterock pile (~660 cy) is located adjacent to Ochoco Creek.

Scissors Creek Workings

- Numerous workings, adits, and wasterock piles are scattered on the south side of Gold Hill and adjacent to Scissor Creek. The following workings and adits are considered the main workings (Gilluly, et al., 1933).
- Street Adit - one adit 360 feet long trending N 6° W with 55 feet of drifts, wasterock pile = 1,400 cy.
- Brian O'Lynn - one adit 360 feet long trending N 70° W, wasterock pile = 450 cy.
- Little Giant - one adit 15 feet long trending N 70° W, wasterock pile = 60 cy.

3.0 PATHWAYS AND ENVIRONMENTAL HAZARD ASSESSMENT

3.1 Groundwater Exposure Pathway

3.1.1 Targets

For the groundwater pathway, the target distance is 4-miles. Example targets are drinking water wells, wellhead protection areas, etc., which are summarized below:

- No wellhead protection areas are located within the target distance.
- According to the Oregon Water Resource Department (OWRD, 2005) a total of 12 drinking water wells are located within the target distance (Figure 1).
  - Three wells are located approximately 3.3 miles downstream from the Site along Ochoco Creek, in the vicinity of the Ochoco Ranger Station. These are the only wells that have potential to be impacted by Site activities.
  - Nine wells are located upgradient or outside of the Ochoco Creek drainage and are not likely to be impacted by Site activities. These include:
    - Six wells located approximately four miles northwest of the Site in the Marks Creek drainage,
    - One well located north of the Site in the Crystal Creek drainage, and
    - Two wells located upstream of the Site near Walton Lake.
- None of the wells were observed or sampled during the SI field activities.

3.1.2 Geologic Setting

Site-specific geology was compiled from Willis, (1992); Kimberlin (1926); Gilluly et al. (1933); Brooks and Ramp (1968); and a Site-specific reconnaissance performed by a CES Oregon Registered Geologist.

- Country rock in the vicinity of the Site consists primarily of dense to porphorytic andesite cut by andesitic and basaltic dikes and carbonate-quartz-sulfide veinlets.
- Veinlets at the Site enlarge into three main ore shoots at narrow intersections.
- Ochoco Creek follows a main fault line, striking at N40-60E. Secondary faults in Scissors Creek strike at N40E and N60E.
- Faults exposed in the underground workings, which usually host veins, generally strike at N40E-60E. Normally, these faults dip at 70 to 90 degree angles.
- Ore minerals at the Site consist of pyrite and lesser amounts of sphalerite, galena, chalcopyrite, tetrahedrite, pyrrhotite, marcasite, stibnite, cinnabar, realgar, argentite, and supergene minerals (jamesonite, valentinite).
- Mineralization consists of pyrite occurring as disseminations and veinlets; and calcite veinlets with subordinate pyrite, sphalerite, galena, chalcopyrite, tetrahedrite, and rhodochrosite.
- The heaviest mineralization occurs along dacite dikes, which intrude the country rock.
- Hydrothermal alteration assemblages in the vicinity of the Site are propylitic, intermediate argillic, and advanced argillic.
- The main underground working is the 1,475 foot-long Mayflower Adit, which cuts the Mayflower vein at a distance of 335 feet. Three additional veins (Mary Davenport, Center, and Pett veins) cross the adit.
- Commodities included gold and silver with minor amounts of manganese and lead.

3.1.3 Hydrogeology

The hydrogeology of the area surrounding the Site is based on field observations and a review of the logs of the 12 wells previously noted in Section 3.1.1 (copies of well logs are available in the USFS Project File).

- The Site is located within the Ochoco Creek watershed.
- The depth at which water was first encountered in wells, located downstream of the Site along Ochoco Creek, ranged from 145 feet to 240 feet below ground surface (bgs). Static water levels ranged from 2 to 8 feet bgs indicating confined aquifer conditions (artesian) in the area of the wells.
- The shallow geology of the Ochoco Creek drainage primarily consists of glacial deposits consisting of clay with boulders to depths of 0 to 14 feet bgs.
- Fractured and hard basalt, graystone, quartzite, and granite are reportedly encountered below the unconsolidated sediments at depths ranging from 15 to 270 feet bgs.
- During the field activities the seep from the Mayflower Adit infiltrated into native soils approximately 200 feet downslope from the portal. The seep likely infiltrates into the shallow groundwater.
- The hydrogeology in the vicinity of the Site is likely dominated by heterogeneous fracture flow within the basalt aquifer. Evidence of this is the fact that water emanates from the Mayflower Adit indicating a water bearing fracture(s) was encountered.
- The connection between the unconsolidated alluvial aquifer with the hard rock aquifer at the Site is unknown. However, groundwater within the fractures likely discharges to the alluvial aquifer and ultimately to Ochoco and Scissors Creeks. This is also indicated by the increase in flow rate between the upstream and downstream stations, without the addition of surface water inputs (see Section 3.2.2).

3.1.4 Groundwater Exposure Pathway Summary

- Groundwater is used for drinking water within four miles of the Site.
  - A total of three domestic wells are listed on the OWRD database within the 4-mile radius, and are located approximately 3.3 miles downstream from the Mayflower Mine along Ochoco Creek.
  - One well located at the Ochoco Ranger Station is identified in the well log as a community supply well under artesian pressure.
- Drainage from the Mayflower Adit infiltrates into native soil and may impact the shallow groundwater quality.
  - A soil sample collected in the infiltration area (MM-SA-S1) exhibited metals concentrations that were slightly above background concentrations, this is most likely a combination of the adit seep and the adjacent wasterock pile.
  - Groundwater sampling was not performed as part of the SI; therefore, this could not be confirmed.
- Shallow groundwater at the Site likely provides base flow to Ochoco Creek; therefore, it is addressed in the surface water pathway.
- The bedrock hydrogeology in the vicinity of the Site is likely dominated by heterogeneous fracture flow. The contribution from the area of the Site is a small fraction of the total capture zone for the nearest downgradient wells and therefore any impact on these wells from the Site would be negligible.
- Based on known information, the groundwater pathway does not appear complete and further assessment is not recommended.

3.2 Surface Water Exposure Pathway

3.2.1 Targets

The target distance has been defined as 15-miles, and example targets are surface water intakes supplying drinking water, sensitive environments (e.g., wetlands), and rare, threatened, and endangered (RTE) species.

3.2.1.1 Local Surface Water Use

- A total of two active surface water rights exist between the Site and 15-miles downstream along Ochoco Creek.
  - The first active surface water right is located 10 miles downstream from the Site along Ochoco Creek (Figure 1). The water right of 0.69 cubic feet per second (cfs) is used for irrigation.
  - The other active surface water right, also for irrigation at 0.45 cfs, is located along Ochoco Creek 15 miles downstream of the Site.
- A total of three active surface water rights are located upstream from the Site in the vicinity of Walton Lake (Figure 1). These active rights are for recreation and campsite use.
- One surface water right is located 2 miles southeast of the Site, in the Scissors Creek drainage. This water right, for 0.06 cfs, is for livestock water.
- Surface water uses were not field verified as part of the SI. Since Ochoco Creek flows through USFS administered lands, public access is not restricted. Surface water use may also be used for swimming, camping (washing dishes, cooking), and fishing.

3.2.1.2 Wetlands

The National Wetlands Inventory (NWI) utilizes maps as a preliminary tool for determining the location of potential wetlands, although the map alone is not sufficient for ascertaining the presence of jurisdictional wetlands. The following area is "listed" on the NWI map (USF&W, 1995) that could be affected by the Site.

- The stretch of Ochoco Creek located adjacent to the Site, is identified as Riverine, Upper Perennial, Unconsolidated Bottom, Permanently Flooded (R3UBH);
- An unnamed tributary entering Ochoco Creek between Stations OC-2 and OC-3 is designated a PSSC wetland;
- McAllister Creek, which enters Ochoco Creek immediately downstream of the Ochoco Mine, is classified as a palustrine, emergent, temporarily flooded (PEMA) wetland;
- An unnamed tributary entering Ochoco Creek approximately 0.10 miles upstream of the Mayflower Mine is designated a riverine, intermittent, streambed, temporarily flooded (R4SBA) wetland; and
- Scissors and Judy Creeks, which flow into Ochoco Creek downstream of the Mayflower Mine, are classified as riverine, intermittent, streambed, seasonally flooded (R4SBC) wetlands.

The NWI map does not clearly outline the boundaries of riverine wetland systems. Therefore, the exact lateral boundaries adjacent to the stream cannot be determined without a jurisdictional wetland delineation conducted in accordance with the U.S. Army Corps of Engineers (USACE) Technical Report/Y-87-1.

According to the Comprehensive Environmental Response and Liability Act (CERCLA) (40 CFR 230.5) and USACE Technical Report/Y-87-1, "wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." A jurisdictional wetland delineation in accordance with USACE standards was not conducted during this investigation. As such, the exact boundaries and areas of potential wetlands were not defined. However, based on field observations (i.e., plant types, etc.) and measurements, potential wetlands that could be impacted by the Site are listed below:

- Areas adjacent to Ochoco Creek and Mayflower Adit drainage, ~ 0.3 acres.
- Areas adjacent to Scissors Creek, ~ 0.1 acres.
- Total area of potential wetlands that could be affected by the Site, ~ 0.4 acres.

3.2.1.3 Aquatic Ecological Survey

Aquatic surveys were conducted within six Ochoco Creek reaches and two Scissors Creek reaches (Figure 2) to assess the potential impacts of the Site on instream habitat, benthic macroinvertebrate community, and presence of fish species due to the potential for site-related physical impacts or chemical contamination (Appendix C). The RTE species known or expected to inhabit the area surrounding the Site are also listed in Appendix C. The results of the aquatic ecological survey suggest:

- Riparian habitat was consistent across all stations, except SC-02, where channel straightening has apparently impacted the creek and riparian corridor.
- Overall instream physical habitat conditions (sum of 10 habitat parameters; Barbour 1999) were optimal or suboptimal, but some individual habitat parameters were rated as marginal or poor.
- Substrate within the upstream reaches of both Ochoco Creek (OC-01 and 02) and Scissors Creek (SC-01) was predominantly organic muck, compared to gravel in the lower reaches.
- Both pool and riffle habitats were available at all Ochoco Creek reaches. No pools were present within Scissors Creek reaches. Pool habitat (primarily the amount of fine versus coarse grained material) varied somewhat between the pools and was predominantly instream behind large woody debris piles or other obstacles.
- Differences in the distribution of the benthic macroinvertebrate community in pool habitats at OC-04 and -05 suggests impacts. At OC-04, the pool impacts appear to be related to instream physical differences in the pool conditions (e.g., pool instream position and related substrate differences) which could not be directly related to mining activities. However, at OC-05, the pool impacts do not appear to be physical, which indicates the differences might be chemical.
- The numbers and types of benthic macroinvertebrate species present in riffle habitats were quite similar among stations with similar instream conditions. Species diversity was lower within the riffle habitat at SC-02, likely due to past physical alteration of the stream channel and the low volume of water in the channel. In addition, metals loading from instream and/or upslope mining activities appear to be contributing to the lower diversity of species in this reach.
- Inland Columbia red-band trout, a state listed “vulnerable” and USFS “sensitive” species, were noted in Ochoco Creek. No anadromous fish reside in this portion of Ochoco Creek because the Ochoco Reservoir dam blocks passage.

3.2.2 Hydrologic Setting

- The Site is located adjacent (southeast) to Ochoco Creek (Figure 1).
- The Ochoco Creek watershed above the Ochoco Mine is 3,780 acres (Figure 1).
- Water emanates from the Mayflower Adit and appears to flow year round.
  - The adit drainage flows across the large wasterock pile, follows the road, and infiltrates into forest soils on the downslope side of the road.
- Overland water flows down the slope and across the Ochoco and Mayflower wasterock piles and Mayflower tailings and into Ochoco Creek.
- No evidence (i.e., erosion gullies, channels, etc.) was observed that indicates that overland flow or the adit drainage reaches Ochoco Creek during normal precipitation events.
- Ochoco Creek discharges into the Ochoco Reservoir 22 river miles downstream from the Site.
- Numerous creeks and unnamed drainages enter Ochoco Creek on its path to the Ochoco Reservoir.
  - McAllister Creek at 0.05 miles downstream from the Ochoco Mine.
  - Scissors Creek at 0.5 miles downstream from the Mayflower Mine.
  - Judy Creek at 0.62 miles downstream from the Mayflower Mine.
  - Fisher Creek at 1.7 miles downstream from the Mayflower Mine
  - Canyon Creek at 3.5 miles downstream from the Mayflower Mine.
  - Coyle Creek at 3.8 miles below the Mayflower Mine, near the Ochoco Ranger Station.

- Flow rates were measured in Ochoco and Scissors Creeks on June 14 and 15, 2005.
  - Flow in Scissors Creek ranged from 0.017 cfs at SC-01 to 0.28 cfs at SC-02.
  - Flow in Ochoco Creek ranged from 0.44 cfs at OC-01 to 4.12 cfs at OC-06.
  - The flow rate of the adit drainage was estimated to be approximately 0.005 cfs.
  - The increase of flow rate between the upstream and downstream stations in each creek is a result of groundwater discharging to surface water and indicates the creeks were gaining streams.

3.2.3 Previous Investigations

In 1982, the DOGAMI completed a geochemical investigation of the western part of the ONF (Ferns and Brooks, 1983). Sediment samples were collected from Ochoco and Scissors Creeks and analyzed for gold, silver, arsenic, copper, mercury, lead, and zinc. Results, tabulated below, show arsenic and mercury concentrations in both Scissors and Ochoco Creeks exceeded regulatory criteria. The numbers in parenthesis refer to the map numbers in the DOGAMI report and are also shown on Figure 2.

Summary of DOGAMI Geochemical Investigation

Sample Location	Arsenic	Copper	Lead	Mercury	Silver	Zinc
Ochoco Creek	mg/kg					
Above confluence with Ahalt Creek (221)	2	33	5.7	0.08	0.04	36
Below Ochoco Mine (92)	1	23	5.4	**0.300**	0.04	37
Between Ochoco and Mayflower Mines (301)	**18**	**49**	6.8	**0.205**	0.03	71
Between Ochoco and Mayflower Mines (302)	2	25	7.5	0.04	<	43
Up from Mayflower (219)	**53**	34	32	**0.26**	1.49	76
Adjacent to Mayflower (194)	1	30	14.8	0.155	0.68	63
Scissors Creek						
Near Davis Spring (196)	**32**	31	9.3	0.125	0.23	50
Near Davis Spring (197)	**22**	29	33.2	0.065	0.32	57
Above confluence with Ochoco Creek (88)	**15**	32	22.9	**1.65**	0.23	58
Regulatory Screening Criteria						
OR – Freshwater [1]	NS	36	35	0.2	4.5	123
USEPA – Freshwater TEL [2]	5.9	35.7	35	0.174	NS	123.1
USEPA – Freshwater PEL [3]	17	197	91.3	NS	NS	315
ORNL – Freshwater [4]	42	77.7	110	0.7	1.8	270

Notes: < = less than the detection limit (not reported)
1 - State of Oregon, Level II Screening Level Values for Freshwater Sediment
2 - USEPA Threshold Effects Level
3 - USEPA Probable Effects Level
4 - ORNL ecological screening level values for freshwater, lowest chronic value used
NS = No Standard

3.2.4 Site Inspection Analytical Results

This section presents the surface water, pore water, and stream sediment analytical results for the SI conducted at the Site. Aquatic sampling locations are shown on Figure 2; analytical results are tabulated in Tables 1, 2 and 3. Original laboratory reports and a complete report of the quality assurance - quality control (QA/QC) procedures and results are available in the USFS Project File. Photographs of selected sampling locations are included in Appendix A. Field activities were conducted from June 14 through June 16, 2005; the reader is referred to the FOP (CES, 2005) for sampling procedure, protocols, and analyses.

A total of 17 water samples (9 surface water and 8 pore water) and 9 sediment samples were collected from pool substations in Ochoco Creek and the adit drainage at Mayflower Mine during the SI field activities. Results of the metals analyses are summarized and discussed in the following table.

Summary of Surface Water, Pore Water, and Sediment Metals Results

SAMPLE TYPE	TABLE / SAMPLE ID	METALS EXCEEDING ONE OR MORE COMPARISON CRITERIA	TRENDS OBSERVED AND COMMENTS
Surface Water	**Table 1**	**Total Recoverable metals (µg/L)**	
Near headwaters of Ochoco Creek (background)	OC-SW-1	Aluminum (150) and Barium (4.6)	
Along Ochoco Creek, upstream from Ochoco Mine (background)	OC-SW-2	Aluminum (215) and barium (7.8)	
Along Ochoco Creek, immediately downstream of the Ochoco Mine	OC-SW-3	Aluminum (221) and Barium (9.4)	Aluminum concentration similar to background, barium slightly above background.
Midpoint between Ochoco and Mayflower Mines	OC-SW-4	Aluminum (116) and barium (9.3)	
Along Ochoco Creek, immediately downstream from Mayflower Mine	OC-SW-5	Aluminum (124), arsenic (0.46), and barium (10.6)	
Along Ochoco Creek, downstream from Site and confluence with Scissors Creek	OC-SW-6	Arsenic (0.71) and barium (10)	Barium concentration slightly above background, arsenic concentration approximately 40 times higher than the lowest regulatory screening level
Near headwaters of Scissors Creek (background)	SC-SW-1	Barium (10.8)	Highest barium concentration detected in surface water.
Scissors Creek, upstream of confluence with Ochoco Creek	SC-SW-2	Arsenic (2.78) and Barium (7.7)	Arsenic concentration is about 150 times higher than lowest regulatory screening level. Barium concentration is below background.
Mayflower Mine adit seep	SMM-AD1	Arsenic V (3.312), total arsenic (3.33), cadmium (0.42), calcium (119,000), manganese (4,870) and zinc (395)	Highest concentrations of arsenic V, total arsenic, cadmium, calcium, manganese and zinc at the Site. Manganese and arsenic exceed human health criteria.
Pore Water	**Table 2**	**Dissolved metals (µg/L)**	
Near headwaters of Ochoco Creek (background)	OC-PW-1	Barium (12.5) and manganese (716)	
Along Ochoco Creek, upstream from the Ochoco Mine (background)	OC-PW-2	Barium (10.6)	
Along Ochoco Creek, immediately downstream of the Ochoco Mine	OC-PW-3	Barium (9.3)	Barium concentration exceeds lowest regulatory screening level, but was less than background.
Midpoint between Ochoco and Mayflower Mines	OC-PW-4	Barium (22.1), Iron (7,860), and manganese (894)	Barium, iron, and manganese in excess of highest background concentrations and lowest regulatory screening level.
Along Ochoco Creek, immediately downstream from Mayflower Mine	OC-PW-5	Barium (11.6)	Barium concentration slightly lower than highest background concentration.
Along Ochoco Creek, downstream from Site and confluence with Scissors Creek	OC-PW-6	Barium (10.2)	
Near headwaters of Scissors Creek (background)	SC-PW-1	Barium (14.7) and manganese (124)	Barium and manganese detected above lowest regulatory screening level
Along Scissors Creek, upstream of confluence with Ochoco Creek	SC-PW-2	Barium (8.9)	Barium concentration is below background concentration.

Summary of Surface Water, Pore Water, and Sediment Metals Results (cont.)

SAMPLE TYPE	TABLE / SAMPLE ID	METALS EXCEEDING ONE OR MORE COMPARISON CRITERIA	TRENDS OBSERVED AND COMMENTS
Sediment	**Table 3**	**Total Metals (mg/kg)**	
Near headwaters of Ochoco Creek (background)	OC-SS-1	Copper (36.3)	
Along Ochoco Creek, upstream from Site (background)	OC-SS-2	None	
Along Ochoco Creek, immediately downstream of the Ochoco Mine	OC-SS-3	Nickel (22.2)	Nickel concentration slightly above background (17.7 mg/kg).
Midpoint between Ochoco and mayflower Mines	OC-SS-4	Nickel (25.2)	
Along Ochoco Creek, immediately downstream from Mayflower Mine	OC-SS-5	Arsenic (55.6), chromium (51.3), copper (47.9), nickel 33.2)	Arsenic concentration is 16 times higher than background, 10 times higher than lowest comparison criteria. Chromium, copper, and nickel slightly higher than background concentrations.
Along Ochoco Creek, downstream from Site and confluence with Scissors Creek	OC-SS-6	Arsenic (13.7), chromium (49.4), copper (70.5), mercury (0.50), nickel (36.8)	Highest concentration of mercury, copper, and nickel in sediment (discussed in Section 3.2.5).
Ochoco Creek below confluence with Judy Creek	OC-SS-7	Copper (50.1), Nickel (27.8)	Copper and nickel above background and lowest regulatory screening criteria
Near headwaters of Scissors Creek (background)	SC-SS-1	Chromium (47.9), copper (40.4), nickel (23.9)	Chromium, copper, and nickel in excess lowest regulatory screening level.
Along Scissors Creek, upstream of confluence with Ochoco Creek	SC-SS2	Arsenic (69.2), chromium (56), copper (48.7), lead 38.9), manganese (1,260), nickel (30.9), zinc (124)	Highest concentrations of arsenic, chromium, lead, manganese, and zinc in sediment at the Site.

3.2.5 Surface Water Exposure Pathway Summary

- The surface water pathway is complete because metal concentrations in surface water, pore water, and sediment are elevated near the Site.
  - Aluminum and arsenic are the metals of concern in Ochoco Creek surface water.
  - Arsenic, cadmium, manganese, and zinc are the metals of concern in the Mayflower Adit seep.
  - Barium is the metal of concern in pore water. Iron and manganese exceeded criteria in pore water samples OC-PW-1, OC-PW-4, and SC-PW-1. Because gravel/sand substrate was not presented at these stations, samples were drawn from an organic rich substrate and are likely not representative of actual pore water.
  - Arsenic, chromium, copper, and nickel are the metals of concern in sediment.
  - Sample OC-SS-6 had the highest mercury concentration detected at 0.50 milligrams per kilogram (mg/kg). The source of the mercury is unknown because mercury was not detected above 0.03 mg/kg in sediment samples collected in the vicinity of the Site. However, Ochoco Creek and the area has been heavily placer and hydraulic mined in the past and amalgamation (using elemental mercury to recover gold) was a common practice.
  - The highest arsenic concentration of onsite water was detected at 3.33 micrograms per liter (μg/L) (Mayflower Adit).
  - The highest concentration of arsenic in surface water was detected in Scissors Creek, above the confluence with Ochoco Creek at 2.78 μg/L.
- The Mayflower Adit seep infiltrates into native soils prior to reaching Ochoco Creek; no evidence of channeling was observed from the Site to Ochoco Creek.
- The aquatic survey results suggest only a slight difference in benthic macroinvertebrate populations between pools and riffles upstream, adjacent to and downstream of the Site in Ochoco Creek.
  - Physical differences were noticed between pools at OC-04 and OC-05 from other pools in Ochoco Creek; the cause is not known, but may be related to impacts from the Mayflower Mine.
- Species diversity was lower within the riffle habitat at SC-02 in Scissors Creek than all other riffles in Ochoco and Scissors Creeks; this is most likely due to physical differences at that Station.
- Inland Columbia red-band trout, a state listed "vulnerable" and USFS "sensitive" species were observed in Ochoco Creek. No anadromous fish reside in this portion of Ochoco Creek.

3.3 Soil Exposure Pathway

3.3.1 Targets

3.3.1.1 Local Use

- No onsite workers or persons living within 200 feet of the Site.
- Public use of the Site appears to be moderate, although public access records are not maintained**.**
- Access is not restricted by fencing, nor were any "No Trespassing" signs noted during the SI.
- A large sign, posted north of Ochoco Creek across from the Mayflower Mine, announces the Mayflower Claim and Scissorsville historic site.
- Land uses in this area are limited to timber harvesting, firewood cutting, recreation (hiking, fishing, camping, hunting, etc.), and some minerals prospecting.

3.3.1.2 Terrestrial Ecological Survey

- Terrestrial habitats and animals that are present or likely at and surrounding the Site were documented during the ecological survey and via examination of previous ecological study results for the Site vicinity (Appendix C).
  - Four 30-minute bird surveys were conducted.
  - A majority of plants were identified across each identified major vegetative community.
  - Qualitative surveys were conducted at and surrounding the Site for mammal and terrestrial invertebrate presence and use.
  - Lists of RTE plants and animals likely or known to be present in the vicinity of the Site were obtained from the USFS and the Oregon Natural Heritage Program (USFS Project File).
- Results of the terrestrial ecological surveys showed:
  - The Site is primarily within an open ponderosa pine forest community and adjacent to the Ochoco Creek riparian plant community.
  - The disturbed areas are primarily wasterock or excavated gravelly soil with patchy colonizing and weedy herbaceous and shrub species, and no significant canopy layer.
    - The vegetation within the disturbed plant communities is clearly different from the other communities surrounding the Site.
  - Other than within the disturbed areas, there was no clear evidence of mine-related impacts to the forest and wetland/riparian communities.
  - Terrestrial invertebrate noted on and near the Site included black carpenter ants, butterflies, moths, black flies, and bees. None of these or any other invertebrates around the Site are known RTE species.
  - Game trails were not clearly present, but evidence of deer and elk was noted in the vicinity of the Site. No RTE mammal species are expected to inhabit the Site.
  - The birds identified at the Site represent an assemblage common among eastern Oregon pine forests.
    - Of these, only the black-backed woodpecker and mountain quail are possible long term inhabitants of the Site.
    - Other RTE bird species may inhabit the forest surrounding the Site, but are unlikely to forage in the disturbed mine area.
  - A garter snake was noted in the vicinity of the Mayflower Mine. No RTE herpetile species were identified as inhabiting the Site.
  - Of the terrestrial invertebrates and wildlife documented or likely to inhabit the Site, plants and ground-dwelling invertebrates such as ants are the species most likely to be exposed to mine-related contamination.

3.3.2 Previous Investigations

- In 1982, the DOGAMI completed a geochemical investigation of the western part of the ONF (Ferns and Brooks, 1983).
- Samples were collected from the wasterock dumps at the Site as well as the Street and Brian O'Lynn Adits in the Scissors Creek drainage.
  - Analytical results are shown in the table below. The numbers in parenthesis refer to the map numbers in the DOGAMI report and are also shown on Figure 2.

Summary of DOGAMI Geochemical Investigation

Sample Location	Arsenic	Copper	Lead	Mercury	Silver	Zinc
	Results in mg/kg					
Mayflower Mine (91)	**500**	**113**	**1,630**	**0.900**	**34**	**4,365**
Ochoco Mine (93)	**12**	**80**	6.8	**0.34**	0.13	**105**
Brian O'Lynn Adit (198)	**50**	39	5.6	**0.80**	0.45	**72**
Street Adit (199)	**13**	38	8.4	**0.205**	0.46	**98**
Regulatory Criteria						
OR - Ecological Receptors[1]	NS	50i	16b	0.1i	2p	50p
USEPA Industrial PRGs - Human[2]	1.6	41,000	800	310	5,100	100,000
USEPA - Ecological Receptors[3]	37p	61i	NS	NS	NS	120i
ORNL - Ecological Receptors[4]	9.9	60	40.5	0.00051	2	8.5

Notes: 1 - State of Oregon, Level II Ecological Screening Level Values for Soil
2 - USEPA Region 9 Industrial Preliminary Remediation Goals
3 - USEPA Ecological Soil Screening Levels - Lowest Criteria Listed
4 - ORNL = Oak Ridge National Laboratory Preliminary Remediation Goals for Ecological Endpoints
b = bird, i = invertebrate, p = plant; NS = No standard; Values in **bold** exceed a standard

- As the table above shows, all samples exceeded the Region IX Preliminary Remediation Goals (PRGs) for arsenic and the lowest regulatory screening level for mercury.
- In November of 2004, the USFS performed an APA of the Site, which consisted of field screening of wasterock and tailings piles at the Site with a Niton XL-722S x-ray fluorescent (XRF) unit.
  - Antimony, arsenic, cobalt, iron, lead, manganese, and nickel were detected at elevated concentrations at the Mayflower Mine.
  - Arsenic, iron, and nickel were detected at elevated concentrations at the Ochoco Mine.

3.3.3 Site Inspection Analytical Results

- The following sections present the background soil, wasterock, soil, and tailings analytical results.
  - A total of 8 background soil samples, 22 wasterock samples, 11 soil, and 9 tailings were collected around the Site and Scissors Creek drainage.
  - Background sampling locations for soils are shown on Figure 2.
  - The wasterock, soil, and tailings sample locations for the Mayflower Mine and Ochoco Mine are shown on Figures 3 and 4, respectively.
  - Four wasterock samples were collected in the Scissors Creek drainage: two from the wasterock at the Brian O'Lynn Adit, and one each at the Street Adit and Little Giant Adit (Figure 2).
  - Analytical results for background soils are tabulated in Table 4; soil, wasterock, and tailings in Table 5; and toxicity characterization leaching procedure (TCLP) and synthetic precipitation leaching procedure (SPLP) results for wasterock and tailings in Table 6.
  - The reader is referred to the FOP (CES, 2005) for sampling procedure, protocols, and analyses.
  - The complete laboratory analytical results and a discussion of QA/QC procedures and results are available in the USFS Project File.

3.3.3.1 Background Soil, Wasterock and Tailings Metals/pH Results

- Laboratory pHs:
  - Background soil pH ranged from 5.37 to 6.18 standard units (su);
  - Ochoco Mine wasterock pH ranged from 5.83 to 8.08 su;
  - Mayflower Mine wasterock pH ranged from 3.75 to 7.10 su;
  - Mayflower Mine tailings pH ranged from 3.74 to 5.53 su;
  - Mayflower Mine soil pH ranged from 3.44 to 6.76 su; and
  - Scissors Creek drainage wasterock pH ranged from 7.06 to 7.80 su.
- The following table summarizes the metals results for background soil and waste sample at the Site.
  - The table presents metals that exceeded at least one comparison criteria and the 90th percentile upper confidence limit on the arithmetic mean (90UCL) of the eight background samples.
  - The 90UCL for arsenic in background samples includes one sample that had arsenic detected at 609 mg/kg. This sample was included in the 90UCL calculations because 1) the sample was collected in an undisturbed area topographically upgradient from the Site, and 2) the Gold Hill area is a highly mineralized zone, and the sample is representative of soils derived from the localized geologic unit.

Summary of Background Soil, Site Soil, and Waste Source Metals Results

SAMPLE TYPE	TABLE / SAMPLE ID	METALS EXCEEDING AT LEAST ONE CRITERIA	METALS EXCEEDING ONE CRITERIA AND THE 90UCL MEAN BACKGROUND	TRENDS OBSERVED AND COMMENTS
Background Soil	**Table 4**	**Total metals (units in mg/kg)**		
Background Soil	BGS-1 to BGS-8	Aluminum, antimony, arsenic, barium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, vanadium, and zinc.	Not Applicable (NA)	NA
Ochoco Mine	**Table 5**	**Total metals (units in mg/kg) / Criteria: Eco = Ecological, HH = Human Health**		
Wasterock Pile	OM-WR-1 to OM-WR-8	Aluminum, arsenic, barium, cobalt, copper, lead, manganese, mercury, nickel, selenium, vanadium, and zinc.	Aluminum (31,600), chromium (71.6), cobalt (21.2), copper (98.3), mercury (3.12), nickel (38.3), selenium (5.27), and vanadium (165).	Mercury, selenium and vanadium are the metals of concern when compared to the lowest regulatory screening criteria and the 90UCL mean background. Other metals were slightly above the 90UCL mean background and/or lowest regulatory screening level.
Mayflower Mine	**Table 5**	**Total metals (units in mg/kg) / Criteria: Eco = Ecological, HH = Human Health**		
Wasterock Piles	MM-WR1-2 MM-WR1-4 MM-WR1-5 MM-WR1-7 MM-WR2-1 MM-WR2-2	Aluminum, antimony, arsenic, barium, chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, vanadium, and zinc.	Antimony (70.4), arsenic (577), chromium (95.8), copper (127), lead (348), manganese (10,400), mercury (1.35), nickel (81.7), silver (17.8), vanadium (94.4) and zinc (730).	Antimony, arsenic, lead, mercury, and silver are the metals of concern when compared to the lowest regulatory screening criteria and the 90UCL mean background concentrations. All other metals were slightly above the 90UCL mean background concentrations and/or the lowest regulatory screening level.
Soil (includes vat material)	MM-S1 through MM-S5	Aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, silver, vanadium, and zinc.	Aluminum (22,800), antimony (1,770), arsenic (5,140), chromium (70.3), cobalt (32.8), copper (240), lead (5,440), mercury (5.61), nickel (44.3), silver (445), vanadium (105), and zinc (4,190).	
Tailings	MM-TP1-1 through MM-TP1-8	Aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc.	Aluminum (30,200), antimony (3,190), arsenic (5,350), chromium (119), cobalt (34.7), copper (270), lead (9,460), manganese (31,700), mercury (2.5), nickel (71.3), selenium (5.35), silver (265), vanadium (111), and zinc (120).	
Wasterock Scissors Creek Workings	MM-WRSC-1, MM-WRSC-2, MM-WRB-1, & MM-WRB-2.	Aluminum, antimony, arsenic, barium, chromium, copper, lead, manganese, mercury, silver, vanadium, and zinc.	Antimony (7), arsenic (357), copper (66.7), lead (748), manganese (2,770), mercury (2.76), silver (6.09), and zinc (560).	Antimony, arsenic, lead, manganese, mercury, silver, and zinc are the metals of concern when compared to the lowest regulatory screening criteria, and the 90UCL mean background. Other metals exceed lowest regulatory screening level but are below the 90UCL.

Notes: For multiple samples, the concentration listed is the highest detected concentration in the sample set. Concentrations listed are "total" concentrations, unless indicated (i.e., chromium III)

3.3.3.2 Acid Based Accounting / Sulfur Results

- Acid Base Accounting (ABA) was analyzed on ten wasterock samples and five tailings samples.
  - The acid base potential (ABP) of wasterock ranged from -34.2 to 57.5 t $CaCO_3$/Kt (ABP units are presented as tons of calcium carbonate needed to neutralize a kiloton of waste [$CaCO_3$/Kt]).
  - The ABP of tailings ranged from -12.8 to +12.6t $CaCO_3$/Kt.
    - ABP is the result of the acid neutralizing potential (ANP) minus the acid generating potential (AGP).
    - A negative ABP indicates that the AGP is greater than the ANP, and thus the material has the potential to produce acid rock drainage (ARD).
  - Based on this, wasterock at the Ochoco Mine, and wasterock and tailings at the Mayflower Mine, have the potential to produce ARD.
- Total sulfur in the ten wasterock samples analyzed ranged from 0.06% to 4.03%; total sulfur ranged from 0.03% to 2.38% in the five tailings samples.

3.3.3.3 Wasterock and Tailings SPLP / TCLP Results

- Five wasterock samples and five tailings samples from Mayflower Mine, two wasterock samples from Ochoco Mine, and two wasterock from Scissors Creek workings were submitted for Toxicity Characterization Leaching Procedure (TCLP) and Synthetic Precipitation Leaching Procedure (SPLP) analyses for the eight Resource Conservation Recovery Act (RCRA) metals.
- There are no applicable standards for SPLP; however, the results can be compared to RCRA TCLP disposal limits.
- None of the samples had SPLP or TCLP results in excess of the TCLP standard.

3.3.3.4 Volumes

- The volumes were estimated by field measurements and test pit depths and with the use of AutoCAD and the prismoidal formula. The following list the volumes at the Site.

Mayflower Mine large wasterock pile	=	12,000 cy
Mayflower Mine small wasterock pile	=	70 cy
Mayflower Mine tailings pile	=	600 cy
Mayflower Mine impacted mill soils	=	420 cy
Mayflower Mine vat residue	=	90 cy
Ochoco Mine wasterock pile	=	660 cy
Brian O'Lynn Adit wasterock pile	=	450 cy
Street Adit wasterock pile	=	1,400 cy
Little Giant Adit wasterock pile	=	60 cy
Total volume of waste material	**=**	**15,750 cy**

3.3.4 Soil Exposure Pathway Summary

- The soil exposure pathway is complete for both human and ecological receptors, and a release of hazardous substances has been documented in this SI.
- Metals of concern in wasterock, tailings, and Site soils at the Mayflower Mine are antimony, arsenic, cadmium, copper, lead, manganese, mercury, selenium, silver, and zinc; all were significantly above background concentrations and the lowest regulatory screening level.
- Metals of concern in wasterock at the Ochoco Mine are mercury and selenium; both were significantly above the lowest comparison criteria and background concentrations. Arsenic, chromium, and vanadium exceed the lowest comparison criteria but are similar to background concentrations.

- Metals of concern in wasterock in Scissors Creek workings are antimony, arsenic, lead, manganese, mercury, silver, and zinc; all were significantly above background concentrations and the lowest comparison criteria.
- Elevated metals were also detected in the soil where Mayflower Adit seep infiltrates; however, these concentrations are lower than the wasterock concentrations.
- Arsenic, highest detection at 5,350 mg/kg, is the primary metal of concern for the Site.

3.4 Air Exposure Pathway

3.4.1 Targets

- The target distance has been defined as 1 and 4 miles from the Site.
- There is no dominant wind direction in this area.
- Based on a review of well logs in the area, there are up to five residences located between 3.5 and 4 miles from the Ochoco Mine (Figure 1).
  - It is not known if these are year round residences or seasonal homes.
  - Based on the distance from the Site and location outside of the watershed they are unlikely to be affected by Site activities.

3.4.2 Air Exposure Pathway Summary

- Air samples were not collected as part of the field activities.
- Arsenic and other metals were likely released to the air during the mining and milling processes as dust and particulate matter.
- The air pathway is complete because metal impacted soil and waste material is concentrated at the surface where human and ecological receptors could be exposed to particulate matter by inhalation.
- Further assessment of the air pathway is not recommended because addressing and/or eliminating the soil exposure pathway will render the air exposure pathway incomplete.

4.0 STREAMLINED HUMAN AND ECOLOGICAL RISK ASSESSMENTS

4.1 Streamlined Human Health Risk Assessment

- A human health risk assessment (HHRA) is an analysis of the potential adverse health effects that could result from current or future exposures to hazardous substances released from a facility, in the absence of any action to control or mitigate these releases.
- The HHRA evaluated potential impacts to human health resulting from exposure to Site-related contaminants of potential concern (COPCs) in surface and subsurface soils, sediment, and surface water at the Site.
- Determining the COPCs is the first step in the HHRA.
  - COPCs are determined by screening the Site analytical data against applicable PRGs and background concentrations.
  - COPCs are listed in Table 10.
- The conceptual human exposure model (CHHM) is presented in Appendix B, Figure 3-1.
- For the purposes of this HHRA, both reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios were evaluated.
  - The RME scenario is a conservative estimate of potential exposure.
  - The CTE scenario is typically more realistic.
- The HHRA was completed in accordance with Oregon Administrative Rules [OAR] 340-122-084, Oregon Department of Environmental Quality (ODEQ) Guidance for Deterministic Human Health

Risk Assessment (ODEQ, 1998), and United States Environmental Protection Agency (USEPA) Risk Assessment Guidance for Superfund (RAGS), Volumes 1 and 2 (USEPA, 1991).

- The following sections briefly summarize the estimated human health risks and hazards. A more detailed discussion of the HHRA is provided in Appendix B.

4.1.1 Risk and Hazard Estimates for the Recreational Receptor

- The results of the quantitative risk assessment are summarized in this section.
- The Site is not currently occupied, nor is it expected to be occupied or developed in the near future. Therefore, the only likely current and future receptors identified for the Site are recreational users (i.e., hikers, campers, and hunters).
- Calculations, assumptions, and exposure inputs are available in the USFS Project File.
- The Hazard Quotient (HQ) is defined as a comparison of the estimated intake dose of a metal with the reference dose or concentration, expressed as a ratio.
  - An HQ of less than 1.0 indicates that the exposure is unlikely to cause adverse non-carcinogenic risks.
- The excess cancer risk (ECR) is defined as the incidence of cancer over and above known background (1 case for every three people).
  - The standard of one in one million (1×10^{-6}) sets the allowable "excess" cancer cases at one case in a population of one million people. The following sections providing a brief summary of the non-carcinogenic, carcinogenic, and lead risks.

4.1.1.1 Non-Carcinogenic Risks Results

- Soils, Wasterock, and Tailings: Antimony, arsenic, chromium, iron, lead, and manganese were identified as the COPCs. The HQs for these metals did not exceed 1.0 for both the CTE and RME exposure scenarios; therefore, a non-carcinogenic risk is not expected.
- Surface Water: Arsenic and manganese were identified as COPCs in surface water. The HQs for these metals did not exceed 1.0 for both the CTE and RME exposure scenarios; therefore, a non-carcinogenic risk is not expected.
- Sediments: Antimony, arsenic, chromium, iron, lead, and manganese were identified as COPCs in sediment. The HQs for these metals did not exceed 1.0 for both the CTE and RME exposure scenarios; therefore, a non-carcinogenic risk is not expected.
- Air: Inhalation of particulates potentially contaminated with manganese was quantified. The HQ did not exceed 1.0; therefore, a non-carcinogenic risk is not expected from air.

4.1.1.2 Carcinogenic Risks Results

- Soils, Wasterock, and Tailings: The only carcinogenic constituent identified in soil, wasterock, and tailings was arsenic. The ECR did not exceed the regulatory standard of 1×10^{-6} for exposure to soils under CTE exposure conditions. However, there are exceedances of the regulatory standard for ingestion (1×10^{-5}) and dermal contact (9×10^{-6}) from arsenic in soil under RME exposure conditions Therefore, a carcinogenic risk is possible for exposure to soil, wasterock, and tailings under the RME exposure scenario.
- Sediments: The only carcinogenic constituent identified in sediment is arsenic. The ECRs for arsenic in sediment ranged from 6×10^{-7} (RME) to 2×10^{-8} (CTE). Therefore, no carcinogenic risk is expected from exposure to sediment.
- Surface Water and Air: No carcinogenic constituent were identified in surface water or air.
- The risk characterization determined no unacceptable ECR from exposure to sediment. However, there is a potential for unacceptable cancer risk from ingestion and dermal contact with arsenic in soil, wasterock, and tailings under RME conditions.

4.1.1.3 Lead Risk Results

Meaningful ingestion and inhalation critical toxicity values have not been developed for lead. Many of the noncarcinogenic effects associated with lead may not exhibit a threshold, especially in young children. In lieu of a reference dose or slope factor, the USEPA has developed two models which correlate dose with blood lead levels. The results of the lead screening are summarized in the following bullets:

- Soil, Wasterock, and Tailings: Using an exposure point concentration (EPC) of 922 mg/kg (CTE – arithmetic mean) and 1,340 mg/kg (RME = 90UCL) the predicted intake was calculated to be 0.62 µg/day (CTE) and 3.6 µg/day (RME). The USEPA provisional ingestion intake value for men (most likely receptor) is 75 µg/day and children under six (least likely receptor) is 6 µg/day. If you assume that the total intake from dermal exposure and inhalation is equal to the intake from ingestion, no risk is expected for exposure to lead in soil, wasterock, and tailings.

- Sediment: Using an EPC of 11 mg/kg (CTE – arithmetic mean) and 38.9 mg/kg (RME = maximum concentration) the predicted intake was calculated to be 0.003 µg/day (CTE) and 0.08 µg/day (RME). Using the USEPA provisional ingestion intake listed above, no risk is expected for exposure to lead in sediment.

- Surface Water: The USEPA maximum containment level (MCL) for lead is 15 µg/L. No lead was detected above the method detection limit of 0.6 µg/L in any water sample from the Site. Therefore, exposure to lead in drinking water is not expected to be a risk.

4.1.2 Determination of Hotspots

- The assessment of hotspots is performed by comparing the concentration of each constituent that exceeded the risk criteria (HQ = 1.0 and ECR = 1×10^{-6}); arsenic in surface soil, wasterock, and tailings was the only metal that exceeded risk criteria.
- The hotspot levels correspond to a lifetime ECR of 1×10^{-4} for carcinogens and a HQ of 10.0 for non-carcinogens.
- Using an ECR of 1×10^{-4} a hotspot concentration for arsenic in soil, wasterock, and tailings was calculated to be 8,664 mg/kg. This concentration was compared with the sampling results at the Site; none of the samples in soil or sediment exceeded the hotspot concentration.

4.1.3 Human Health Risk Assessment Summary

The following summarized the HHRA:

- Of the contaminants of interest (COIs) identified, the following were identified as COPCs:
  - Wasterock, Tailings, and Soil: Antimony, arsenic, chromium, iron, lead, and manganese
  - Sediment: Antimony, arsenic, chromium, iron, lead, and manganese
  - Surface Water: arsenic and manganese
  - Air: manganese
- Based on current and future land use, individuals who might come in contact with Site related contaminants through recreational activities such as hunting, hiking, and camping were the only potential receptors identified.
- The risk assessment determined no unacceptable non-carcinogenic health risks associated with metals.
- Arsenic was the only carcinogenic COPC identified at the Site.
  - The risk assessment determined that concentrations of arsenic in surface water did not result in unacceptable risks.
  - Risks from ingestion and dermal contact with arsenic in soil, wasterock, and tailings exceeded the regulatory standard of 1×10^{-6} for the RME exposure scenario. Therefore, a carcinogenic health risk was predicted for human exposure to arsenic in soil, wasterock, and tailings.

- Calculating the risk associated with lead is done using two USEPA models because ingestion and inhalation toxicity values have not been developed.
  - Lead exposure from soil, wasterock, tailings, and sediment is not expected to be a risk because the predicted intake values were lower then the USEPA provisional intake values.
  - Lead exposure from surface water was not determined to be a risk because concentrations (<0.6 µg/L in all samples) did not exceed the USEPA MCL of 15 µg/L.
- A risk-based cleanup concentration for soil, wasterock, and tailings was calculated to be 53 mg/kg (total arsenic); however, this is below the average background arsenic concentration of 96.2 mg/kg. Therefore, the cleanup goal was adjusted to 96.2 mg/kg, to be no more stringent than that average background concentration expected around the Site.
- Hotspots are only calculated for constituents that exceed risk criteria (HQ = 1.0 and ECR = 1×10^{-6}).
  - For this Site, arsenic is the only metal that exceeded the risk criteria.
  - Arsenic hotspot concentrations were calculated to be 8,664 mg/kg for soil, wasterock, and tailings.
  - None of the samples exceeded these concentrations; therefore, no hotspots were identified.

4.2 Streamlined Ecological Risk Assessment

- In accordance with ODEQ guidance (ODEQ, 2001), a Screening Level Ecological Risk Assessment (ERA) was completed for the Site. The ERA is also consistent with national and regional guidance (USEPA 1992, 1997, 1998).
- The goal of the ERA is to provide an understanding of the potential for ecological risks due to Site related contamination and to determine whether there is a need for more detailed ERA.
- The ERA includes the following:
  - A description of the COI-based Site uses and data gathered during the SI;
  - A description of the ecology of the Site and potential ecological receptors (including RTE species);
  - Presentation of the conceptual ecological exposure model (CEEM) which provides a summary of potential and likely exposure media and pathways;
  - Assessment and measurement endpoints;
  - An assessment of the analytical data used in the ERA;
  - An ecological risk-based screening; and
  - A risk characterization to assess the potential for significant ecological effects due to Site COIs.
- Appendix B presents the problem formulation, risk assessment data, ecological risk-based screening, risk characterization, uncertainty analysis, conclusions, and recommendations.

4.2.1 Conceptual Ecological Exposure Model

- The CEEM (Appendix B, Figure 4-1) graphically depicts the sources of contamination, contaminant release and transport mechanisms, impacted exposure media, and exposure routes for ecological receptor types at the Site.
- Based on previous investigations and current understanding of Site conditions, the potentially contaminated exposure media for ecological receptors include:
  - Surface soil, wasterock, and tailings in the vicinity of the Site;
  - Surface water in Ochoco Creek, Scissors Creek, and the Mayflower Adit seep;
  - Pore water within Ochoco and Scissors Creeks; and
  - Sediment in Ochoco and Scissors Creeks.

4.2.2 Ecological Risk Assessment Summary

A summary of the contaminants of potential ecological concern (COPECs) are summarized in Table 7. The following sections briefly outline the findings.

4.2.2.1 Soil, Wasterock, and Tailings

- Every sample had at least one exceedance of an ecological risk based screening concentration (ERBSC) and maximum background concentrations.
- Many COPECs had multiple exceedances at multiple sample locations. This suggests that elevated concentrations of COPECs are present in all the waste piles.
- Given the magnitude of the risk ratios and the number of sample locations where concentrations exceeded ERBSCs, the COPECs of most concern are antimony, arsenic V, total arsenic, chromium III, total chromium, copper, iron, lead, manganese, mercury, methyl mercury, silver, and zinc.
- Given the multiple exceedances of ERBSCs by multiple chemicals at multiple stations, ecological risks are expected by COPECs in soil, wasterock, and tailings.
  - The most significant risk would be posed to plants and invertebrates that inhabit the soil, wasterock, and tailings in the immediate vicinity of the Mayflower Mine.
  - Mobile and wide-ranging wildlife species are unlikely to spend large amounts of time on or around the Site, and thus, are less likely to be impacted by the COPECs.

4.2.2.2 Surface Water

- Aluminum was selected for aquatic life because several samples in Ochoco Creek exceeded the ERBSCs, and one sample exceeded the highest background concentration.
- Manganese and zinc were selected for aquatic life because concentrations in the Mayflower Adit drainage sample (SMM-AD1) exceeded ERBSCs.
- Cadmium was selected because of the potential to bioaccumulate.
- No risk is expected for manganese and zinc because no aquatic life was observed in the adit drainage.
- Cadmium is not expected to bioaccumulate in the food chain because the only detection was in an area of minimal habitat (adit drainage).
- The detected concentration of aluminum (221 µg/L) was only 6 µg/l above the maximum background concentration of 215 µg/L. Therefore, ecological risks associated with aluminum are not expected because this is well within the range of background data variability.
- Given this information, ecological impacts are deemed unlikely due to COPECs in surface water.

4.2.2.3 Pore Water

- Barium, iron, and manganese were the only COPECs that exceeded both background concentrations and at least one ERBSC.
- Methyl mercury was selected as a COPEC because of the potential to bioaccumulate.
- Most of the exceedances for barium, iron, and manganese were from one station (OC-PW-4), just upstream of the Mayflower Mine.
- Overall, the ERA suggests there is a slight potential for pore water related ecological impacts posed to aquatic species exposed to primarily iron in pore water at OC-PW-4.

4.2.2.4 Sediment

- Every sediment station had at least one exceedance of an ERBSC; several COPECs have multiple exceedances at multiple sample locations.
- Aluminum, cobalt, iron, manganese, methyl mercury, silver, thallium, and vanadium were selected as COPECs solely because of a lack of ERBSCs, and thallium because of elevated detection limits.
  - These COPECs exceeded maximum background concentrations by factors of 1.2, 1.4, 1.1, 1.7, 1.04, 2.4 (compared to background detection limits), and 1.1, respectively.
  - One half of the thallium detection limit does not exceed the ERBSC.
  - Based on this, ecological impacts are not expected from these metals.

- Unacceptable risk ratios were calculated for cadmium, total chromium, total chromium, nickel, and zinc.
  - These COPECs exceeded background concentrations by factors of 1.6, 1.2, 1.7, 1.5, and 1.9, respectively.
  - Based on this, these metals are not expected to contribute significantly to ecological impacts.
- The remaining COPECs are arsenic V, total arsenic, and mercury.
  - Mercury only exceeded its respective ERBSC for invertebrates at one station (OC-06).
  - Arsenic V and total arsenic are the COPECs with the most potential for impacting ecological receptors, primarily at OC-05 and SC-02.
- Overall, the ERA suggests there is a potential ecological impact in Scissors and Ochoco Creeks related to arsenic V and total arsenic. This is supported by the benthic invertebrate enumeration results that suggest a potential impact at SC-SS-2 (Scissors Creek) and OC-SS-05 (Ochoco Creek) adjacent to the Mayflower Mine.

4.3 Streamlined Risk Assessment Summary

- Table 8 summarizes the human and ecological COPCs and COPECs for the Site.
- The risk assessment determined that there are no unacceptable human health risks from exposure to surface water, pore water, sediment, and air.
- A potential exists for unacceptable carcinogenic risk to the RME individual from dermal contact and ingestion of soil, wasterock, and tailings at the Mayflower Mine and Scissors Creek workings.
- A risk-based cleanup concentration for soil, wasterock, and tailings was calculated to be 53 mg/kg (total arsenic); however, this is below the average background arsenic concentration of 96.2 mg/kg. Therefore, the cleanup goal was adjusted to 96.2 mg/kg, to be no more stringent than that average background concentration expected around the Site.
- No human health hotspots were identified at the Site.
- Ecological impacts were predicted for terrestrial and aquatic receptors from exposure to metals in soil, wasterock, tailings, and sediment.
- Ecological risk-based cleanup concentrations cannot be calculated unless a more detailed species specific ERA is performed. However, removal or containment of soil, wasterock, and tailings to the human risk-based cleanup concentration is expected to be protective of ecological receptors.

5.0 CONCLUSIONS

Groundwater Pathway

- The groundwater pathway does not appear to be complete; further assessment is not recommended.

Surface Water Pathway

- The surface water pathway is complete because metal concentrations in surface water, pore water, and sediment are elevated near the Site. Arsenic is the primary metal of concern.
  - The highest arsenic concentration in onsite water was detected at 3.33 µg/L (Mayflower Adit).
  - The highest concentration of arsenic in surface water was detected in Scissors Creek above the confluence with Ochoco Creek at 2.78 µg/L.
- The adit drainage infiltrates into native soils prior to reaching Ochoco Creek.
- The aquatic survey results suggest only slight difference in benthic macroinvertebrate populations between pools and riffles upstream, adjacent to and downstream of the Site in Ochoco Creek.
  - Physical differences were noticed between pools at OC-04 and OC-05 from other pools in Ochoco Creek; the cause is not known, but may be related to impacts from the Mayflower Mine.
- Species diversity was lower within the riffle habitat at SC-02 in Scissors Creek than all other riffles in Ochoco and Scissors Creeks; this is most likely due to physical differences at that Station.
- Inland Columbia red-band trout, a state listed “vulnerable” an USFS “sensitive” species were observed in Ochoco Creek. No anadromous fish reside in this portion of Ochoco Creek.

- The HHRA determined that no unacceptable human health risks were expected for exposure to COPCs in surface water, pore water, and sediments.
- The ERA suggests a potential ecological impact in Scissors Creek and Ochoco Creek related to arsenic V and total arsenic.
  - This is supported by the benthic invertebrate enumeration results at SC-SS-2 (Scissors Creek) and OC-SS-05 (Ochoco Creek) adjacent to the Mayflower Mine.
  - This suggests that the mine workings in the Scissors Creek watershed are likely affecting Scissors Creek, and the Mayflower Mine is likely affecting Ochoco Creek.

Soil Pathway

- The soil exposure pathway is complete for both human and ecological receptors, and a release of hazardous substances has been documented in this SI.
- Metals of concern in soil, wasterock, and tailings at the Mayflower Mine are antimony, arsenic, cadmium, copper, lead, manganese, mercury, selenium, silver, and zinc; all were significantly above background concentrations and the lowest comparison criteria.
- Metals of concern in wasterock at the Ochoco Mine are mercury and selenium; both were significantly above the lowest comparison criteria and background concentrations. Arsenic, chromium, and vanadium exceed the lowest comparison criteria but are similar to background concentrations.
- Metals of concern in wasterock in Scissors Creek workings are antimony, arsenic, lead, manganese, mercury, silver, and zinc; all were significantly above background concentrations and the lowest comparison criteria.
- Arsenic, highest detection at 5,350 mg/kg, is the primary metal of concern for the Site.
- The HHRA suggests a potential exists for unacceptable carcinogenic risk to the RME individual from dermal contact and ingestion of arsenic impacted soil, wasterock, and tailings at the Mayflower Mine and Scissors Creek workings.
- The ERA suggests that ecological impacts are expected by COPECs in soil, wasterock, and tailings.
  - The most significant risk would be posed to plants and invertebrates that inhabit the soil, wasterock, and tailings in the immediate vicinity of the Mayflower Mine and the Scissors Creek workings.
  - Mobile and wide-ranging wildlife species are unlikely to spend large amounts of time on or around the Site, and thus, are less likely to be impacted by the COPECs.

Air Pathway

- The air pathway is complete for both human and ecological receptor.
- Further assessment is not recommended; the air pathway will be addressed if the soil pathway is reduced or eliminated.

Recommendations

- Based on the SI, CES recommends performing an Engineering Evaluation / Cost Analysis (EECA) because unacceptable risks have been identified for human and ecological receptors, mainly from the Mayflower Mine and Scissors Creek workings.
- CES also recommends that additional background samples (~six) be collected from around the Site to further quantify the average and 90UCL concentrations, and to check the accuracy of the one background sample that exhibited a high concentration of arsenic (609 mg/kg).
- The EECA will establish removal cleanup standards, and assess removal action alternatives.
- Physical dangers (i.e., opened adits, stopes, steep waste piles, etc.) should also be included as part of the EECA.

USFS Disclaimer

This abandoned mine/mill site was created under the General Mining Law of 1872 and is located solely on National Forest System (NFS) lands administered by the USDA Forest Service. The United States has taken the position and courts have held that the United States is not liable as an "owner" under CERCLA Section 107 for mine contamination left behind on NFS lands by miners operating under the 1872 Mining Law. Therefore, USDA Forest Service believes that this site should not be considered a "federal facility" within the meaning of CERCLA Section 120 and should not be listed on the Federal Agency Hazardous Waste Compliance Docket. Instead, this site should be included on the USEPA's CERCLIS database. Consistent with the June 24, 2003 OECA/FFEO "Policy on Listing Mixed Ownership Mine or Mill Sites Created as a Result of the General Mining Law of 1872 on the Federal Agency Hazardous Waste Compliance Docket," we respectfully request that the USEPA Regional Docket Coordinator consult with the Forest Service and USEPA Headquarters before making a determination to include this site on the Federal Agency Hazardous Waste Compliance Docket.

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Table 1. Surface Water Analytical Results
Mayflower and Ochoco Mines Site Inspection, Ochoco National Forest, Oregon

Sample I.D.	Sample Date	Aluminum, TR	Antimony, TR	Arsenic III, TR	Arsenic V, TR	Arsenic, TR	Barium, TR	Beryllium, TR	Cadmium, TR	Calcium, TR	Chromium III, TR	Chromium VI, TR	Chromium, TR	Cobalt, TR	Copper, TR	Iron, TR	Lead, TR	Magnesium, TR	Manganese, TR	Mercury, TR	Nickel, TR	Potassium, TR	Selenium, TR	Silver, TR	Sodium, TR	Thallium, TR	Vanadium, TR	Zinc, TR
		Results in µg/L																										
Ochoco Creek																												
OC-SW-1	6/15/2005	150	< 5.6	NA	NC	< *0.43*	4.6	< 0.66	< 0.12	16,200	< 6 C	< 10	< 6	< 6	< 3	178	< 0.6	6,750	6.7	0.00585	< 10	790	< 0.62	< 0.12	6,030	< 0.24	5.7	< 10
OC-SW-2	6/15/2005	215.0	< 5.6	<0.008 H	<0.43 C	< *0.43*	7.8	< 0.66	< 0.12	18,100	< 6 C	< 10	< 6	< 6	< 3	229	< 0.6	6,120	10.2	0.00243	< 10	970	< 0.62	< 0.12	6,720	< 0.24	< 5	< 10
OC-SW-3	6/15/2005	221.0	< 5.6	<0.008 H	<0.43 C	< *0.43*	9.4	< 0.66	< 0.12	19,100	< 6 C	< 10	< 6	< 6	< 3	218	< 0.6	6,060	8.7	0.00606	< 10	930	< 0.62	< 0.12	6,920	< 0.24	< 5	< 10
OC-SW-4	6/15/2005	116	< 5.6	NA	NC	< *0.43*	9.3	< 0.66	< 0.12	20,500	< 6 C	< 10	< 6	< 6	< 3	125	< 0.6	6,320	4.3	0.0015	< 10	870	< 0.62	< 0.12	7,070	< 0.24	< 5	< 10
OC-SW-5	6/14/2005	124	< 5.6	0.028 H	0.431 C	0.46	10.6	< 0.66	< 0.12	24,000	< 6 C	< 10	< 6	< 6	< 3	127	< 0.6	6,670	5	0.00211	< 10	1,140	< 0.62	< 0.12	7,520	< 0.24	5.2	< 10
OC-SW-6	6/14/2005	75	< 5.6	0.023 BH	0.687 C	0.71	10	< 0.66	< 0.12	27,700	< 6 C	< 10	< 6	< 6	< 3	83	< 0.6	7,480	< 4	0.00168	< 10	950	< 0.62	< 0.12	7,320	< 0.24	< 5	< 10
Scissors Creek																												
SC-SW-1	6/14/2005	< 30.0	< 5.6	NA	NC	< *0.43*	10.8	< 0.66	< 0.12	31,400	< 6 C	< 10	< 6	< 6	< 3	< 60	< 0.6	9,360	< 4	0.00105	< 10	1,020	< 0.62	< 0.12	8,920	< 0.24	< 5	< 10
SC-SW-2	6/14/2005	< 30.0	< 5.6	0.017 BH	2.763 C	2.78	7.7	< 0.66	< 0.12	28,100	< 6 C	< 10	< 6	< 6	< 3	< 60	< 0.6	8,180	< 4	0.006210	< 10	920	< 0.62	< 0.12	7,460	< 0.24	< 5	< 10
Mayflower Adit																												
SMM-AD1	6/15/2005	34.0	< 5.6	0.018 BH	3.312 C	3.33	3.2	< 0.66	0.42	119,000	< 6 C	< 10	< 6	< 6	< 3	< 60	< 0.6	42,000	4,870	0.0081	15	1,440	< 0.62	< 0.12	19,200	< 0.24	< 5	395
Standards, corrected for hardness where applicable (used 89 mg/L background for surface water samples																												
Oregon - Aquatic Life[1]		87	NS	NS	NS	*150*	NS	NS	*0.21*	NS	*65.93*	11	NS	NS	*7.1*	1,000	*2.10*	NS	NS	0.012	*40*	NS	5	0.12	NS	NS	NS	91
Oregon - Ecological Screening Level Values[2]		87	1,600	150	150	NS	4	5.3	2.2	116,000	74	11	NS	23	9	1,000	2.5	82,000	120	0.77	52	53,000	5	0.12	680,000	40	20	120
Oregon - Human Health[3]		NS	5.6	NS	NS	0.018	1,000	NS	NS	NS	NS	NS	NS	NS	1,300	300	NS	NS	50	NS	610	NS	170	NS	NS	0.24	NS	7,400
EPA - Aquatic Life (CCC)[4]		87	NS	NS	NS	*150*	NS	NS	0.196	NS	NS	NS	100	NS	6.8	1,000	1.76	NS	NS	0.77	39.4	NS	5	NS	NS	NS	NS	91
EPA - Human Health (Water+Organism)[5]		NS	5.6	NS	NS	0.018	1,000	NS	NS	NS	74	11	NS	NS	1,300	300	NS	NS	50	NS	610	NS	170	NS	NS	1.7	NS	7,400
ORNL - Surface Water PRGs[6]		87	30	190	3.1	NS	4	0.66	1.10	NS	210	11	NS	23	12	1,000	3.20	NS	120	1.3	160	NS	0.39	0.36	NS	9	20	91

Sample I.D.	Sample Date	Flow Rate	Temperature (Field)	pH (Field)*	pH (Lab)*	Turbidity*	Conductivity @ 25C (Lab)	Conductivity (Field)	Dissolved Oxygen (Field)*	Oxygen Reduction Potential (Field)	Hardness as $CaCO_3$, TR*	Field TDS*	Residue, Filterable (TDS) @180*	Residue, Non- Filterable (TSS) @105° C*	Cyanide	Sulfate*
		cfs	°C	su	su	NTU	µS/cm	µS/cm	mg/L	mV	mg/L					
Ochoco Creek																
OC-SW-1	6/15/2005	0.44	10.82	7.9	8.07	49	134	144	10.75	142	72.1	90	139	5	NA	0.61
OC-SW-2	6/15/2005	1.11	12.65	8.1	8.15	22	132	141	11.33	120	70.5	90	123	< 5	NA	0.48
OC-SW-3	6/15/2005	0.99	12.3	8.1	8.12	27	139	147	11.59	97	72.7	100	114	< 5	NA	0.95
OC-SW-4	6/15/2005	1.79	7.7	8	8.03	33	146	157	12.41	184	77.2	100	120	< 5	NA	1.6
OC-SW-5	6/14/2005	1.52	14.68	8	7.92	34	167	177	10.32	161	87.4	120	120	< 5	NA	3.63
OC-SW-6	6/14/2005	4.12	9.37	7.8	8.04	61	184	192	9.5	229	99.9	120	122	< 5	NA	6.17
Scissors Creek																
SC-SW-1	6/14/2005	0.017	9.17	7.5	7.76	34	214	164	9.69	127	117	110	150	< 5	NA	2.65
SC-SW-2	6/14/2005	0.280	11.04	7.5	7.81	12	213	223	10.04	249	115	150	143	< 5	NA	8.37
Mayflower Adit																
SMM-AD1	6/15/2005	0.005	4.93	6.8	7.56	0	807	927	12.54	228	509	600	626	< 5	NA	366
Standards																
Oregon - Aquatic Life[1]		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*0.0052*	NS
Oregon - Ecological Screening Level Values[2]		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.0052	NS
Oregon - Human Health[3]		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.14	NS
EPA - Aquatic Life[4]		NS	9-19	6.5-9	6.5-9	NS	NS	NS	9.5	NS	NS	NS	NS	NS	0.0052	NS
EPA - Human Health[5]		NS	NS	5-9	5-9	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.7	NS
ORNL - Surface Water PRGs[6]		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.0052	NS

NOTES:

All analyses except Arsenic III & Low-Level Mercury were conducted by SVL Laboratories, Inc., Kellogg, ID per EPA Method 200 series
Arsenic III and Low-Level Mercury anlyses were conducted by Brooks Rand, Seattle, WA per EPA Methods 1631 & 1632, respectively
TR = Total recoverable metals
Arsenic V was calculated from difference between Arsenic, TR and Arsenic III
Chromium VI was determied in the field
Chromium III was calculated from difference between Chromium, TR and Chromium VI
mg/L = milligrams per liter
µg/L = micrograms per liter
su = standard units
µS = micro siemans
< value = analyte not detected above method detection limit (MDL)
B=Analyte was detected above the method detection limit (MDL) but below the practical quantitation limit (PQL)
H=Storage and preservation times were not met
NA=Not analyzed
Italic values indicate that the MDL exceeds the lowest standard
NC=Not Calculated
Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded
C = Calculated

STANDARD NOTES:

1 - State of Oregon proposed Aquatic Life criteria (Toxic Compounds Criteria, May 2004)underline - corrected for hardness, *italics* - expressed as dissolved
2 - State of Oregon Level II Ecological Screening criteria (ODEQ, December 2001)*italics* - expressed as dissolved
3 - State of Oregon proposed Human Health criteria, water+organism (Toxic Compounds Criteria, May 2004)underline - corrected for hardness, *italics* - expressed as dissolved
4 - EPA recommended chronic ambient water quality criteria for freshwater aquatic life used (EPA, 2002)underline - corrected for hardness, *italics* - expressed as dissolved
5 - EPA recommended ambient water quality criteria for protection of human consumption of water and fish (EPA, 2002 NTR)*italics* - expressed as dissolved
6 - ORNL Preliminary Remediation Goals for Ecological Endpoints (ORNL, 1997)
NS = No Standard

Table 2. Pore-water Analytical Results
Mayflower and Ochoco Mines Site Inspection, Ochoco National Forest, Oregon

Sample I.D.	Sample Date	Pool (P) or Riffle (R)	Aluminum, Diss.	Antimony, Diss.	Arsenic III, Diss.	Arsenic V, Diss.	Arsenic Total, Diss.	Barium, Diss.	Beryllium, Diss.	Cadmium, Diss.	Calcium, Diss.	Chromium III, Diss.	Chromium VI, Diss.	Chromium, Diss.	Cobalt, Diss.	Copper, Diss.	Iron, Diss.	Lead, Diss.	Magnesium, Diss.	Manganese, Diss.	Mercury, Diss.	Mercury, methyl, Diss.	Nickel, Diss.	Potassium, Diss.	Selenium, Diss.	Silver, Diss.	Sodium, Diss.	Thallium, Diss.	Vanadium, Diss.	Zinc, Diss.
			Results in µg/L																											
Ochoco Creek																														
OC-PW-1	6/15/2005	P	< 30	< 5.6	NA	NC C	0.41	12.5	< 0.66	< 0.1	18,500	< 6 C	< 10	< 6	< 6	< 3	65	< 0.6	7,180	716	0.00181	NA	< 10	1,380	< 0.39	< 0.12	7,600	< 0.24	< 5	< 10
OC-PW-2	6/15/2005	R	< 30	< 5.6	0.046 H	0.229 C	0.23	10.6	< 0.66	< 0.1	14,600	< 6 C	< 10	< 6	< 6	< 3	60	< 0.6	4,780	21	0.00083	0.000034 H	< 10	1,170	< 0.39	< 0.12	6,450	< 0.24	< 5	< 10
OC-PW-3	6/15/2005	R	< 30	< 5.6	0.014 BH	0.229 C	0.23	9.3	< 0.66	< 0.1	15,300	< 6 C	< 10	< 6	< 6	< 3	< 60	< 0.6	5,030	< 4	0.00074	0.000041 BH	< 10	1,000	< 0.39	< 0.12	6,670	< 0.24	< 5	< 10
OC-PW-4	6/15/2005	P	74	< 5.6	NA	NC	1.18	22.1	< 0.66	< 0.1	24,200	< 6 C	< 10	< 6	< 6	< 3	7,860	< 0.6	6,940	894	0.00131	NA	< 10	1,080	< 0.39	< 0.12	7,490	< 0.24	< 5	< 10
OC-PW-5	6/14/2005	P	< 30	< 5.6	0.012 BH	1.439 C	1.44	11.6	< 0.66	< 0.1	19,700	< 6 C	< 10	< 6	< 6	< 3	< 60	< 0.6	5,440	< 4	0.00178	0.000059 H	< 10	1,090	< 0.39	< 0.12	7,340	< 0.24	< 5	< 10
OC-PW-6	6/14/2005	P	< 30	< 5.6	0.018 BH	0.799 C	0.8	10.2	< 0.66	< 0.1	22,600	< 6 C	< 10	< 6	< 6	< 3	< 60	< 0.6	6,210	< 4	0.00121	NA	< 10	1,000	< 0.39	< 0.12	7,050	< 0.24	< 5	< 10
Scissors Creek																														
SC-PW-1	6/14/2005	R	< 30	< 5.6	NA	NC	0.5	14.7	< 0.66	< 0.1	27,900	< 6 C	< 10	< 6	< 6	< 3	< 60	< 0.6	8,680	124	0.00404	NA	< 10	1,160	< 0.39	< 0.12	9,020	< 0.24	< 5	< 10
SC-PW-2	6/14/2005	R	< 30	< 5.6	0.018 BH	2.949 C	2.95	8.9	< 0.66	< 0.1	27,300	< 6 C	< 10	< 6	< 6	< 3	< 60	< 0.6	7,000	< 4	0.00468	0.000034 BH	< 10	950	< 0.39	< 0.12	7,360	< 0.24	< 5	< 10
Standards, corrected for hardness where applicable (used 79.43 mg/L as average in pore-water samples)																														
Oregon - Aquatic Life[1]			87	NS	NS	NS	*150*	NS	NS	*0.23*	NS	*71.36*	11	NS	NS	*7.7*	1,000	*2.37*	NS	NS	0.012	NS	*42.9*	NS	5	*0.12*	NS	NS	NS	99
Oregon - Ecological Screening Level Values[2]			87	1,600	150	150	NS	4	5.3	2.2	116,000	74	11	NS	23	9	1,000	2.5	82,000	120	0.77	NS	52	53,000	5	0.12	680,000	40	20	120
EPA - Aquatic Life (CCC)[4]			87	NS	NS	NS	*150*	NS	NS	*0.210*	NS	NS	NS	NS	NS	7.4	1,000	*1.96*	NS	NS	0.77	NS	42.8	NS	5	NS	NS	NS	NS	99
ORNL - Pore Water PRGs[6]			87	30	190	3.1	NS	4	0.66	1.10	NS	210	11	NS	23	12	1,000	3.20	NS	120	1.3	2.80E-03	160	NS	5	0.36	NS	12	20	99

Sample I.D.	Sample Date	Pool (P) or Riffle (R)	Temperature (Field)	pH (Field)*	pH (Lab)*	Conductivity (Field)	Conductivity @ 25C (Lab)	Dissolved Oxygen (Field)*	Oxygen Reduction Potential (Field)	Hardness as $CaCO_3$ TR*	Residue, Filterable (TDS) @180*	Residue, Non- Filterable (TSS) @105° C*	Cyanide, Diss.	Sulfate*
			°C	su	su	µS/cm	µS/cm	mg/L	mV	mg/L	mg/L	mg/L	mg/L	mg/L
Ochoco Creek														
OC-PW-1	6/15/05	P	11.75	7.3	7.22	177	174	5.2	14	75.8	155	NA	NA	0.31
OC-PW-2	6/15/05	R	15	7.7	7.66	145	134	6.5	112	56	112	NA	< 0.01	0.47
OC-PW-3	6/15/05	R	10	8.3	8.11	149	139	10.8	93	58.8	99	NA	< 0.01	0.91
OC-PW-4	6/15/05	P	13.3	6.9	6.99	209	185	4.5	-73	88.9	112	NA	NA	0.72
OC-PW-5	6/14/05	P	12.86	7.3	7.33	183	172	4	172	71.7	127	NA	< 0.01	3.52
OC-PW-6	6/14/05	P	11.91	7.5	7.93	195	185	10.65	223	82.1	139	NA	NA	6.18
Scissors Creek														
SC-PW-1	6/14/05	R	11.43	7.3	7.39	240	228	3.1	91	105	153	NA	NA	2.26
SC-PW-2	6/14/05	R	10.75	7.6	7.67	228	214	9.82	187	97.1	152	NA	NA	8.4
Standards														
Oregon - Aquatic Life[1]			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.005	NS
Oregon - Ecological Screening Level Values[2]			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.005	NS
Oregon - Human Health[3]			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.14	NS
EPA - Aquatic Life[4]			9-19	6.5-9	6.5-9	NS	NS	9.5	NS	NS	NS	NS	0.005	NS
EPA - Human Health[5]			NS	5-9	5-9	NS	NS	NS	NS	NS	NS	NS	0.7	NS
ORNL - Pore-water PRGs[6]			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.005	NS

NOTES:

All analyses except Arsenic III & Low-Level Mercury were conducted bySVL Laboratories, Inc., Kellogg, ID per EPA Method 200 series
Arsenic III and Low-Level Mercury anlyses were conducted by Brooks Rand, Seattle, WA per EPA Methods 1631 & 1632, respectively
Arsenic V was calculated from difference between Arsenic, TR and Arsenic III
Chromium VI was determied in the field
Chromium III was calculated from difference between Chromium, TR and Chromium VI
mg/L = milligrams per liter
< valueU = analyte not detected above method detection limit (MDL)
µg/L = micrograms per liter
su = standard units
NM = Not measured
Italic values indicate that the MDL exceeds the lowest standard
H =Holding time exceeded
B=Analyte was detected above the method detection limit (MDL) but below the practical quantitation limit (PQL)
NC=Not Calculated
Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded
NA = Not analyzed or sample not obtained

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3 - State of Oregon proposed Human Health criteria, water+organism (Toxic Compounds Criteria, May 2004)underline - corrected for hardness, *italics* - expressed as dissolved
4 - EPA recommended chronic ambient water quality criteria for freshwater aquatic life used (EPA, 2002),underline - corrected for hardness, *italics* - expressed as dissolved
5 - EPA recommended ambient water quality criteria for protection of human consumption of water and fish (EPA, 2002 NTR),*italics* - expressed as dissolved
6 - ORNL Preliminary Remediation Goals for Ecological Endpoints (ORNL, 1997)
NS = No Standard

Table 3. Sediment Analytical Results
Mayflower and Ochoco Mines Site Inspection, Ochoco National Forest, Oregon

Sample ID	Sample Date	Aluminum, Total	Antimony, Total	Arsenic III, Inorganic	Arsenic V, Inorganic	Arsenic - Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Mercury, methyl, Total	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total
		mg/kg																									
Ochoco Creek																											
OC-SS-1	6/15/2005	16,300	< 0.3	< 8.80E-02 H	3.4 C	3.4	168	0.47	0.21	7,560	33.2	11.3	36.3	33,600	3.73	2,670	620	< 0.03	NA	17.7	853	< 0.3	< 0.5	1,250	< 1.5	115	53.2
OC-SS-2	6/15/2005	15,800	< 0.3	< 8.20E-02 H	2.6 C	2.6	82.5	0.26	0.21	9,300	25.7	12.0	29	34,300	1.78	4,550	724	< 0.03	0.00025 H	17.4	714	< 0.3	< 0.5	1,420	< 1.5	107	66.2
OC-SS-3	6/15/2005	16,600	< 0.3	< 7.60E-02 H	3.3 C	3.3	89.9	0.25	< 0.20	9,580	26.6	12.1	31.8	38,200	2.05	6,010	640	< 0.03	NA	22.2	822	< 0.3	< 0.5	1,290	< 1.5	117	64.8
OC-SS-4	6/15/2005	18,200	< 0.3	< 7.10E-02 H	< 2.5 C	< 2.5	87	0.29	< 0.20	9,500	35.4	13.4	33.2	36,200	1.87	7,200	683	< 0.03	7.90E-05 H	25.2	845	< 0.3	< 0.5	1,380	< 1.5	111	60.2
OC-SS-5	6/14/2005	18,400	0.504	3.23E-01 H	55.3 C	55.6	99.7	0.44	0.28	6,910	51.3	15.6	47.9	38,500	13.2	9,680	978	< 0.03	4.1E-05 H	33.2	1,620	< 0.3	< 0.5	758	< 1.5	90.3	92.2
OC-SS-6	6/14/2005	18,900	< 0.3	2.43E-01 H	13.5 C	13.7	81.5	0.35	0.23	8,640	49.4	16.2	70.5	35,700	8.17	10,700	894	0.50	NA	36.8	1,110	< 0.3	< 0.5	1,130	< 1.5	94.7	76
OC-SS-7	6/16/2005	11,300	< 0.3	NA	< 2.5 C	< 2.5	44.3	0.24	< 0.20	7,950	24.9	11.6	50.1	26,800	1.73	10,200	394	< 0.03	NA	27.8	558	< 0.3	< 0.5	960	< 1.5	93.3	50.9
Scissors Creek																											
SC-SS1	6/14/2005	15,700	< 0.3	< 7.30E-02 H	< 2.5 C	< 2.5	59.8	0.21	< 0.20	7,760	47.9	8.95	40.4	26,000	2.16	5,600	348	< 0.03	NA	23.9	825	0.33	< 0.5	1,280	< 1.5	81.2	65
SC-SS2	6/14/2005	17,300	0.6	< 9.70E-02 H	69 C	69.2	103	0.44	0.34	6,530	56.0	14.3	48.7	34,300	38.9	7,880	1,260	0.1	0.00026 H	30.9	1,780	< 0.3	0.6	449	< 1.5	73.2	124
Standards																											
OR - Freshwater [1]		NS	3	6	NS	NS	NS	NS	0.6	NS	37	NS	36	NS	35	NS	1,100	0.2	NS	18	NS	NS	4.5	NS	NS	NS	123
EPA - Freshwater TEL [2]		NS	NS	NS	NS	5.9	NS	NS	0.596	NS	NS	NS	35.7	NS	35	NS	NS	0.17	NS	18	NS	NS	NS	NS	NS	NS	123.1
EPA - Freshwater PEL [3]		NS	NS	NS	NS	17	NS	NS	3.53	NS	NS	NS	197	NS	91.3	NS	NS	0.486	NS	35.9	NS	NS	NS	NS	NS	NS	315
ORNL - Freshwater [4]		NS	NS	NS	NS	42	NS	NS	4.2	NS	159	NS	77.7	NS	110	NS	NS	0.7	NS	38.5	NS	NS	1.8	NS	NS	NS	270

Sample ID	Sample Date	Total Organic Carbon	Size Fraction by Hydrometer			WAD Cyanide	Total Cyanide
			Clay	Sand	Silt		
		%					
Ochoco Creek							
OC-SS-1	6/15/2005	0.88	4	86	10	<50	<50
OC-SS-2	6/15/2005	0.69	6	80	14	NA	NA
OC-SS-3	6/15/2005	0.23	4	88	8	<50	<50
OC-SS-4	6/15/2005	0.36	4	88	8	NA	NA
OC-SS-5	6/14/2005	0.22	2	94	4	<50	<50
OC-SS-6	6/14/2005	0.63	2	88	10	NA	NA
OC-SS-7	6/16/2005	0.14	2	96	2	NA	NA
Scissors Creek							
SC-SS1	6/14/2005	1.08	2	90	8	NA	NA
SC-SS2	6/14/2005	1.83	6	82	12	NA	NA

GENERAL NOTES:

All analyses except Arsenic III & Methyl Mercury were conducted by SVL Laboratories, Inc., Kellogg, ID per EPA Method 200 series
B = analyte detected between MDL and practical quantification limit (PQL)
Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded
NA = Not Analyzed
mg/kg = Milligrams per kilogram
< value = Analyte not detected above Method Detection Limit (MDL, shown)
B = Analyte detected between MDL and Practical Quantification Limit (PQL, not shown)
H=Storage and preservation times were not met
Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded
C = Arsenic V was calculated from difference between Arsenic, TR and Arsenic III

STANDARD NOTES:

1 - State of Oregon, Level II Screening Level Values for Freshwater Sediment (ODEQ, 2001)

2 - EPA Threshold Effects Level (NOAA, 1999)
3 - EPA Probable Effects Level (NOAA, 1999)
4 - ORNL ecological screening level values for freshwater, lowest chronic value used (ORNL, 1997)
NS = No Standard

Table 4. Background Soil Analytical Results
Mayflower and Ochoco Mines Site Inspection, Ochoco National Forest, Oregon

Sample ID	Sample Date	Sample Depth (feet)	Paste pH	Aluminum, Total	Antimony, Total	Arsenic, Total	Arsenic III, Total	Arsenic V, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Chromium, Hexavalent	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total
			su	mg/kg																									
Background																													
BGS-1	6/16/2005	0.5-1	5.75	13,500	4.2	76.4	< 0.03	76.4 C	94.8	0.51	< 0.2	3,620	36.2	< 0.08	10.9	25.9	33,800	15.6	3,280	1,360	0.065	12.8	3,550	< 0.3	< 0.5	204	< 0.2	40	90.9
BGS-2	6/16/2005	0.5-1	6.18	11,200	12.1	609	NA	NC	73.2	0.59	< 0.2	2630	37.7	NA	16.6	49.9	44,800	49.8	3,200	2,850	0.173	24.1	2,530	< 0.3	1	104	< 0.2	47.4	114
BGS-3	6/16/2005	0.5-1	5.37	19,000	< 2	48.2	NA	NC	187	0.67	< 0.2	3560	62.1	NA	14.7	43.7	34,300	7.15	3,780	929	< 0.033	26	2,820	< 0.3	< 0.5	431	< 0.2	59.6	65.2
BGS-4	6/16/2005	0.5-1	5.7	20,700	< 2	16.3	< 0.03	16.3 C	177	0.66	< 0.2	3,950	43.6	< 0.08	13	40.7	32,000	6.51	5,070	779	0.0514	20	3,080	< 0.3	< 0.5	402	< 0.2	63.8	65.7
BGS-5	6/16/2005	0.5-1	5.7	23,600	< 2	5.51	NA	NC	137	0.7	< 0.2	10,200	62	NA	20.7	77.4	42,100	3.45	5,540	714	0.0481	32	707	0.5	< 0.5	332	< 0.2	151	44
BGS-6	6/16/2005	0.5-1	5.9	21,300	< 2	7.8	< 0.03	7.8 C	113	0.48	< 0.2	5,200	81.6	< 0.08	17.4	62.4	35,100	4.34	9,880	644	< 0.033	35	1,500	0.43	< 0.5	572	< 0.2	82.8	74.5
BGS-7	6/16/2005	0.5-1	5.5	25,600	< 2	2.14	NA	NC	242	0.86	< 0.2	12,700	29.8	NA	12.8	29.6	26,100	6.49	4,110	971	< 0.033	15	1,900	< 0.6	< 0.5	329	< 0.2	53.9	46.1
BGS-8	6/16/2005	0.5-1	5.4	22,400	< 2	4.44	< 0.03	4.44 C	177	0.52	< 0.2	5,350	64.9	< 0.08	10.1	36.4	24,000	4.9	3,820	627	< 0.033	22	1,520	0.93	< 0.5	587	< 0.2	62.9	89.1
Mean			**5.7**	**19,663**	**2.8**	**96.2**	**NC**	**26.2**	**150**	**0.62**	**NC**	**5,901**	**52.2**	**NC**	**14.5**	**45.8**	**34,025**	**12.3**	**4,835**	**1,109**	**0.0504**	**23.2**	**2,201**	**0.35**	**NC**	**370**	**NC**	**70.2**	**74**
90% UCL(Mean)			**5.8**	**22,360**	**4.9**	**209.8**	**NC**	**50.3**	**180**	**0.69**	**NC**	**7,859**	**62.0**	**NC**	**16.5**	**55.1**	**37,872**	**20.8**	**6,030**	**1,513**	**0.0794**	**27.3**	**2,720**	**0.50**	**NC**	**461**	**NC**	**89.2**	**87**
Standards																													
OR - Ecological Receptors (p=plant, i=invertebrate, b =birds, m = mammals) [1]				50 p	5 p	NS	10 p	NS	85 b	10 p	4 p	NS	NS	NS	20 p	50 i	NS	16 b	NS	100 i	0.1 i	30 p	NS	1 p	2 p	NS	1 p	2 p	50 p
EPA Indust. PRGs - Human Receptors[2]				100,000	410	1.6	NS	NS	67,000	1,900	7.4	NS	64	64	1,900	41,000	100,000	800	NS	19,000	310	20,000	NS	5,100	5,100	NS	67	1,000	100,000
EPA - Ecological Receptors (m=mammal, b=bird, i = invertebrate, p=plant)[3]				NS	21 m	37 p	NS	NS	NS	NS	29 p	NS	5 p	NS	32 b	61 i	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	120 i
ORNL - Ecological Receptors[4]				NS	5	9.9	NS	NS	283	10	4	NS	0.4	NS	20	60	NS	40.5	NS	NS	0.00051	30	NS	0.21	2	NS	1	2	8.5

NOTES:
All analyses except Arsenic III & Methyl Mercury were conducted by SVL Laboratories, Inc., Kellogg, ID per EPA Method 200 series
Arsenic III and Low-Level Mercury anlyses were conducted by Brooks Rand, Seattle, WA per EPA Methods 1631 & 1632, respectively
Arsenic V was calculated from difference between Arsenic, TR and Arsenic III
B = analyte detected between MDL and practical quantification limit (PQL)
Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded
NA = Not analyzed
mg/kg = Milligrams per kilogram
< value = Analyte not detected above Method Detection Limit (MDL, shown)
su = Standeard units
NC = Not Calculated
BGS-7 is MM-BGS-04 on the laboratory reports
BGS-8 is MM-BGS-08 on the laboratory reports
BGS-1 - BGS-6 corresponds to BG-1 - BG-6 in the laboratory reports

STANDARD NOTES:
1 - State of Oregon, Level II Ecological Screening Level Values for Soil (ODEQ, 2001); dominantly based on soluble salts
2 - EPA Region 9 Industrial Preliminary Remediation Goals - (EPA, 2004).
3 - EPA Ecological Soil Screening Levels - Lowest Criteria Listed (EPA, 2000)
4 - ORNL = Oak Ridge National Laboratory Preliminary Remediation Goals for Ecological Endpoints August 1997
NS = Not standard

Table 5. Soil and Waste Material Analytical Results
Mayflower and Ochoco Mines Site Inspection, Ochoco National Forest, Oregon

Sample ID	Sample Date	Sample Depth (feet)	Solids (SVL)	Paste pH	Aluminum, Total	Antimony, Total	Arsenic III, Total	Arsenic V, Total	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Calcium, Total	Chromium, Total	Chromium, Hexavalent	Cobalt, Total	Copper, Total	Iron, Total	Lead, Total	Magnesium, Total	Manganese, Total	Mercury, Total	Mercury, Methyl	Nickel, Total	Potassium, Total	Selenium, Total	Silver, Total	Sodium, Total	Thallium, Total	Vanadium, Total	Zinc, Total	Sulfur Forms: Total Sulfur	Sulfur Forms: Pyritic Sulfur	Sulfur Forms: Sulfate Sulfur	ABAs: Acid Generation Potential	ABAs: Acid Neutralization Potential	ABAs: Acid-Base Potential
			%	su	mg/kg																											%			t $CaCO_3$/Kt		
Ochoco Mine																																					
OM-WR1-1	6/14/2005	0.5 - 1	68.1	6.23	26,300	< 2	NA	NC	4.36	57.3	0.37	< 0.2	6,730	71.6	NA	20.3	79.9	51,900	4.53	19,900	983	0.0612	NA	35.2	1,730	< 3	< 0.5	469	< 0.2	165	76	NA	NA	NA	NA	NA	NA
OM-WR1-2	6/14/2005	0.5 - 1	86	5.96	18,300	< 2	< 0.03	25.5 C	25.5	11.1	0.43	< 0.2	37,400	40	< 0.08	19.1	90.4	44,600	5.72	9,620	751	3.12	NA	38.3	2,170	< 3	< 0.5	285	< 0.2	59.7	54	4.03	1.75	2.26	54.7	20.5	-34.2
OM-WR1-3	6/14/2005	0.5 - 1	80.8	7.72	18,800	< 2	NA	NC	1.65	21.2	0.23	< 0.2	18,000	48.7	NA	13.6	48	37,200	4.2	12,900	803	0.703	NA	17	555	3.94	< 0.5	421	< 2	77.5	65	NA	NA	NA	NA	NA	NA
OM-WR1-4	6/14/2005	0.5 - 1	86.9	8.08	18,900	< 2	< 0.03	1.2 C	1.21	29.2	0.27	< 0.2	27,500	46.5	< 0.08	11.2	42.6	35,100	3.66	10,500	866	1.42	NA	13.1	380	4.62	< 0.5	610	< 0.2	65.6	59	0.2	0.19	0.01	5.94	63.4	57.5
OM-WR1-5	6/14/2005	0.5 - 1	88.3	7.81	31,600	< 2	< 0.03	3.67 C	3.67	93.3	0.46	0.26	39,900	49.9	< 0.08	21.2	97	51,900	4.2	19,500	1,150	0.575	NA	32	2,470	< 3	< 0.5	1160	< 2	137	72	NA	NA	NA	NA	NA	NA
OM-WR1-6	6/14/2005	0.5 - 1	80.8	6.54	21,800	< 2	NA	NC	8.01	16.4	0.45	< 0.2	22,200	52	< 0.08	18.2	98.3	44,900	5.48	12,600	894	1.16	NA	33.8	1,720	< 3	< 0.5	305	< 0.2	83.5	63	NA	NA	NA	NA	NA	NA
OM-WR1-7	6/14/2005	0.5 - 1	79.3	7.73	23,000	< 2	< 0.03	2.73 C	2.73	25.7	0.31	< 0.2	20,700	64.5	< 0.08	17.5	78.7	41,300	6.61	16,700	759	2.99	NA	34.4	1,030	5.27	< 0.5	353	< 0.2	122	66	NA	NA	NA	NA	NA	NA
OM-WR1-8	6/14/2005	0.5 - 1	75.6	5.83	22,200	< 2	< 0.03	12 C	12	14.6	0.55	< 0.2	9,830	47.2	< 0.08	14.5	62	47,300	9.28	15,400	1,220	0.565	NA	23.4	1,610	< 3	< 0.5	434	< 0.2	97.7	55	0.97	0.56	0.41	17.5	13.2	-4.32
		Mean	**80.7**	**6.99**	**22,613**	**NC**	**NC**	**9.02**	**7.4**	**33.6**	**0.38**	**NC**	**22,783**	**52.6**	**NC**	**17.0**	**74.6**	**44,275**	**5.46**	**14,640**	**928**	**1.32**	**NC**	**28.4**	**1,458**	**2.67**	**NC**	**505**	**NC**	**101**	**64**	**1.733**	**0.833**	**0.893**	**NC**	**NC**	**NC**
Mayflower Mine																																					
MM-WR1-2	6/15/2005	1.5 - 5.5	83.3	5.98	11,800	11.7	< 0.03	275 C	275	90	0.58	0.63	3,530	28.5	< 0.08	14.8	51	39,200	95	3,940	3,610	0.56	NA	21.5	2,970	< 0.3	2.34	147	< 2	35.2	298	NA	NA	NA	NA	NA	NA
MM-WR1-2	6/15/2005	5.5 - 8.0	84.3	6.76	11,900	21.1	0.0055	359.99 C	360	71.8	0.43	0.32	14,100	34.9	< 0.08	14.1	46	40,400	83	6,240	3,280	0.96	NA	15.4	2,140	< 3	4.83	197	< 2	42	201	NA	NA	NA	NA	NA	NA
MM-WR1-4	6/15/2005	1.5 - 5.5	85.3	6.72	16,200	45.3	< 0.03	302.0 C	302	25.3	0.49	1.63	33,400	86.2	< 0.08	30.8	127	45,100	348	13,300	10,400	1.23	NA	81.7	1,930	< 3	14.4	144	< 2	55.8	730	2.34	0.56	1.78	17.5	45.6	28.1
MM-WR1-4	6/15/2005	4.5 - 8.0	84.6	6.63	17,300	28.6	0.191	569.81 C	570	90.6	0.3	0.35	26,300	95.8	< 0.08	20.3	100	73,700	96	14,300	1,900	1.35	NA	63.3	1,910	< 3	5.44	191	< 2	68.2	124	NA	NA	NA	NA	NA	NA
MM-WR1-5	6/15/2005	6.8 - 11.1	86.2	3.75	18,100	8	0.034	182.97 C	183	18.9	0.35	< 0.2	19,000	69.1	< 0.08	21.4	102	51,700	34	12,700	2,670	0.37	NA	42.7	2,070	< 3	9.11	126	< 2	94.4	84	1.07	0.6	0.46	18.8	38.6	19.8
MM-WP1-6	6/16/2005	0 - 2.1	83.0	NA	NA	NA	NA	NA	1,840	NA	NA	NA	NA	NA	NA	NA	NA	NA	674	NA	NA	0.96	NA	NA	NA	NA	42.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MM-WP1-6	6/16/2005	2.1 - 3	82.2	NA	NA	NA	NA	NA	476	NA	NA	NA	NA	NA	NA	NA	NA	NA	148	NA	NA	0.55	NA	NA	NA	NA	6.69	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MM-WP1-6	6/16/2005	3 - 8.5	86.2	NA	NA	NA	NA	NA	415	NA	NA	NA	NA	NA	NA	NA	NA	NA	54	NA	NA	1.21	NA	NA	NA	NA	3.88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MM-WR1-7	6/16/2005	0.5 - 2.5	84.4	6.63	15,500	70.4	0.056	576.94 C	577	86.9	0.45	0.97	27,100	83	< 0.08	20.2	88.9	50,200	248	10,300	4,020	1.35	NA	57.8	2,620	< 3	17.8	172	< 0.8	55	416	1.95	0.43	1.52	13.4	28.6	15.1
MM-WR1-7	6/16/2005	2.5 - 9.5	91.3	7.1	14,700	36.9	0.036	255.96 C	256	31.4	0.47	0.27	38,900	70.9	< 0.08	15.6	118	45,400	27	14,100	2,380	0.41	NA	45.5	2,310	< 0.6	2.96	275	< 0.4	53.7	104	2.21	1.12	1.09	35	77.1	42.1
MM-WR1-7	6/16/2005	17 - 19	81.0	6.61	19,100	24.3	< 0.03	284 C	284	64.6	0.54	0.99	15,000	77	< 0.08	19	76.2	48,500	89	9,300	2,610	0.42	NA	53.6	2,500	< 3	4.81	168	< 1	66.6	258	NA	NA	NA	NA	NA	NA
MM-WP1-8	6/16/2005	0 - 1.5	85.3	NA	NA	NA	NA	NA	350	NA	NA	NA	NA	NA	NA	NA	NA	NA	124	NA	NA	0.31	NA	NA	NA	NA	4.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MM-WP1-8	6/16/2005	1.5 - 6.8	82.0	NA	NA	NA	NA	NA	988	NA	NA	NA	NA	NA	NA	NA	NA	NA	326	NA	NA	0.79	NA	NA	NA	NA	19.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MM-WR2-1	6/16/2005	0.5 - 1	86.7	3.95	4,100	23.4	< 0.03	76.7 C	76.7	20.2	< 0.2	< 0.2	271	36.8	< 0.08	< 0.6	15.2	19,500	8	411	63	1.03	NA	6	3,910	< 3	2.32	111	0.684	22.4	24	0.52	0.09	0.43	2.81	< 0.3	-2.81
MM-WR2-2	6/16/2005	0.5 - 1	88.9	6.4	12,500	6.7	NA	NC	71.7	33.7	0.4	< 0.2	23,600	75.8	NA	19.2	69.9	38,800	7	6,450	1,770	1.21	NA	45.4	3,230	< 3	1.85	110	< 0.4	42.3	58	NA	NA	NA	NA	NA	NA
		Mean	**84.98**	**6.05**	**14,120**	**27.6**	**0.043**	**320.4**	**468.29**	**53.3**	**0.34**	**0.46**	**20,120**	**65.8**	**< 0.08**	**14.6**	**79.4**	**45,250**	**157**	**9,104**	**3,270**	**0.85**	**NC**	**43.3**	**2,559**	**NC**	**9.48**	**164**	**NC**	**53.6**	**230**	**1.618**	**0.56**	**1.056**	**NC**	**NC**	**NC**
Scissors Creek Workings																																					
MM-WRB-1	6/16/2005	0 - 0.5	85.4	7.5	17,100	7	NA	NC	357	131	0.46	1.38	29,200	50	NA	12.7	52.8	45,400	719	10,000	1,440	0.81	NA	19.3	2,990	< 3	5.58	211	< 1	45	541	NA	NA	NA	NA	NA	NA
MM-WRB-2	6/16/2005	0.5 - 1	87.7	7.06	10,700	6.5	< 0.03	290 C	290	81.8	0.47	< 0.2	3,160	53.7	< 0.08	14.8	61.6	33,600	40	3,770	1,930	0.51	NA	23.6	3,100	< 3	0.85	77	< 0.4	38.4	111	0.06	0.03	0.03	0.94	7.08	6.14
MM-WRSC-1	6/16/2005	0 - 0.5	89.2	7.8	17,100	3.5	NA	NC	235	91.7	0.54	0.94	25,900	38.2	NA	13.9	66.7	41,600	558	10,800	2,330	0.91	NA	24.6	2,430	< 3	6.09	149	< 2	62	560	NA	NA	NA	NA	NA	NA
MM-WRSC-2	6/16/2005	0.5 - 1	91.7	7.59	8,320	6.6	0.106	199.89 C	200	134	0.5	0.41	18,300	40.1	< 0.08	14.1	61.5	42,500	748	6,750	2,770	2.76	NA	21.1	2,810	< 3	5.23	163	< 1	58.2	300	0.51	0.4	0.11	12.5	57.1	44.6
		Mean	**88.5**	**7.49**	**13,305**	**5.90**	**0.061**	**245**	**271**	**110**	**0.49**	**0.71**	**19,140**	**45.5**	**NC**	**13.9**	**60.7**	**40,775**	**516**	**7,830**	**2,118**	**1.25**	**NC**	**22.2**	**2,833**	**NC**	**4.44**	**150**	**NC**	**50.9**	**378**	**0.285**	**0.215**	**0.07**	**NC**	**NC**	**NC**
Mayflower Soil																																					
MM-S1-1	6/16/2005	0.5 - 1	86.9	3.44	4,580	73.6	NA	NC	935	41	< 0.2	< 0.2	21,700	47.6	NA	0.71	47.9	42,800	354	1,820	245	0.95	NA	7.7	2,730	< 1.5	33.5	197	0.669	30.1	47.1	NA	NA	NA	NA	NA	NA
MM-S1-2	6/16/2005	2. - 3	85.7	3.71	13,500	18.7	< 0.03	639 C	639	97.9	0.22	0.33	20,900	76.9	NA	10.5	102	61,200	113	5,960	1,060	0.20	< 0.047	29.5	2,870	< 1.5	5.49	256	< 1	64.5	174	NA	NA	NA	NA	NA	NA
MM-S2-1	6/16/2005	0 - 0.5	81	5.67	6,550	54.1	0.178	688.822 C	689	33.5	0.25	2.78	22,000	47.6	< 0.08	11	81.8	39,700	645	5,670	2,420	0.68	< 0.044	29.5	2,900	< 1.5	17.3	81	< 1	29.9	410	NA	NA	NA	NA	NA	NA
MM-S2-2	6/16/2005	0.5 - 1	85	4.98	7,440	112	NA	NC	1,460	18.5	0.39	5.91	26,400	50.1	NA	13.4	126	47,300	882	6,980	3,980	1.02	NA	44.3	2,450	< 1.5	11.8	75	< 1	30.9	1,200	NA	NA	NA	NA	NA	NA
MM-S3-1	6/16/2005	0.5 - 1	85.4	4.67	11,900	50	NA	NC	1,100	96.9	0.25	0.39	22,400	61.8	NA	9.65	76.5	53,200	275	7,330	2,200	1.62	NA	23.1	2,680	< 1.5	20.7	191	< 2	44.7	273	NA	NA	NA	NA	NA	NA
MM-S3-2	6/16/2005	2. - 3	82.2	5.37	9,030	111	0.201	1,460 C	1,460	71.1	0.37	0.78	25,900	48.4	< 0.08	12.4	99.7	49,800	761	4,920	3,290	3.50	0.102 B	26.9	3,170	< 1.5	39.4	155	0.261	33.5	367	NA	NA	NA	NA	NA	NA
MM-S4-1	6/16/2005	0 - 0.5	64.1	5.43	3,870	1,770	NA	NC	5,140	81.5	0.5	9.16	12,200	23.6	NA	1.71	240	53,800	5,440	702	36,000	5.61	NA	< 1	2,620	< 3	445	< 50	< 2	12.4	4,190	NA	NA	NA	NA	NA	NA
MM-S4-2	6/16/2005	0.5 - 1.5	81.9	4.94	3,390	1,120	< 0.03	4,770 C	4,770	128	< 0.2	2.75	16,800	70.3	< 0.08	1.47	172	61,200	3,910	749	19,000	3.95	NA	7.6	2,370	< 3	259	< 50	< 2	14.7	1,620	NA	NA	NA	NA	NA	NA
MM-S5-1	6/16/2005	0.5 - 1	83.3	4.81	22,800	25.8	NA	NA	332	95.4	0.49	2.16	2,680	65.5	NA	32.8	88.7	53,300	398	11,000	11,300	0.69	NA	36.6	2,500	< 0.3	15.6	145	< 0.2	105	690.0	NA	NA	NA	NA	NA	NA
MM-S5-2	6/16/2005	1. - 2	83.3	5.07	23,100	107	< 0.03	1030 C	1,030	73.2	0.44	1.9	2,650	83.9	< 0.08	23	126	51,700	896	13,400	14,400	3.40	< 0.048	36.5	2,390	0.48	70.1	126	0.243	95.2	810	NA	NA	NA	NA	NA	NA
MM-SA-S1	6/16/2005	0.5 - 1	65.9	6.76	26,600	10.6	NA	NC	118	111	0.63	0.61	6,890	107	NA	26.9	81.8	45,300	61	12,700	6,140	0.24	NA	68.7	3,170	< 3	3.31	294	< 2	96.5	487	NA	NA	NA	NA	NA	NA
		Mean	**80.4**	**4.99**	**12,069**	**314**	**0.0848**	**1,718**	**1,607**	**77.1**	**0.34**	**2.44**	**16,411**	**62**	**NC**	**13.0**	**112.9**	**50,845**	**1,249**	**6,476**	**9,094**	**1.99**	**0.0429**	**28.26**	**2,714**	**NC**	**83.7**	**143**	**NC**	**50.7**	**933**	**NC**	**NC**	**NC**	**NC**	**NC**	**NC**
Tailings																																					
MM-TP1-1	6/16/2005	0 - 2.1	78.8	5.53	5,740	3,190	< 0.03	5,350 C	5,350	117	0.45	16	15,000	53.4	< 0.08	6.04	270	53,200	9,460	2,830	22,600	2.5	R	16.7	2,280	3.32	265	< 50	< 2	23.5	5,740	2.38	1.02	1.32	31.9	22.7	-9.19
MM-TP1-1	6/16/2005	2.1 - 5.1	77.5	5.26	30,200	13.7	< 0.03	107 C	107	80.6	0.45	1.77	9,430	119	< 0.08	34.7	111	54,000	173	17,400	17,300	0.14	R	50	1,680	< 1.5	4.09	202	< 1	124	710	0.53	0.02	0.51	0.63	13.2	12.6
MM-TP1-2	6/16/2005	0 - 0.5	80	4.52	12,400	266	< 0.03	1,720 C	1,720	68.3	0.39	1.23	1,450	32.5	< 0.08	9.33	118	45,400	1,670	5,750	8,080	1.20	R	16.4	2,690	0.84	102	96	< 2	56.1	757	NA	NA	NA	NA	NA	NA
MM-TP1-3	6/16/2005	0 - 0.5	87.7	5.44	6,910	124	< 0.03	722 C	772	29.7	0.81	14.9	8,030	48.1	< 0.08	22.8	202	35,900	735	4,200	31,700	0.52	R	71.3	2,080	< 3	33.50	< 50	< 4.00	28.6	4,590	NA	NA	NA	NA	NA	NA
MM-TP1-4	6/16/2005	0 - 0.5	82.4	3.74	6,720	186	< 0.03	1,800 C	1,800	73.7	< 0.20	< 0.20	311	37.8	< 0.08	7.55	65	51,800	1080	2,490	4,070	1.38	R	12.1	2,640	< 0.3	69.1	90	< 2	34.8	255	0.46	0.12	0.34	3.75	<0.3	-3.75
MM-TP1-5	6/16/2005	0 - 0.5	85.8	5.28	17,300	13	< 0.03	202 C	202	76.4	0.5	0.31	2,540	68.0	< 0.08	17	63.6	45,100	59	8,210	2,280	0.298	R	33.1	2,730	5.35	2.74	188	< 0.2	69.1	222	0.03	0.02	0.01	0.63	5.61	4.98
MM-TP1-6	6/16/2005	0 - 0.5	87.2	5.13	18,400	30.1	< 0.03	310 C	310	76	0.5	0.68	2,560	65.4	< 0.08	20.7	70	46,800	184	9,470	4,220	0.558	R	34	3,210	4.89	9.45	171	< 0.2	74.4	225	NA	NA	NA	NA	NA	NA
MM-TP1-7	6/16/2005	0 - 0.5	74.8	4.58	8,270	1,650	< 0.03	4,220 C	4,220	124	0.46	2.8	2,790	51.1	< 0.08	3.5	209	51,200	6670	2,970	8,680	1.4	R	12.6	2,680	< 3	236	106	< 2	32	824	0.7	0.41	0.29	12.8	<0.3	-12.8
MM-TP1-8	6/16/2005	0 - 0.5	76.4	4.55	11,600	162	< 0.03	963 C	963.0	94.3	0.36	0.25	1,090	45.2	< 0.08	15.2	81.4	40,700	850	3,340	4,410	0.0497	R	15.8	2,740	< 0.3	43.7	170	< 2	46.4	192	NA	NA	NA	NA	NA	NA
		Mean	**81.2**	**4.89**	**13,060**	**626**	**NC**	**1,710**	**1,716**	**82.2**	**0.45**	**4.23**	**4,800**	**57.8**	**NC**	**15.2**	**132**	**47,122**	**2,320**	**6,296**	**11,482**	**0.89**	**NC**	**29.1**	**2,526**	**NC**	**85.06**	**159**	**3.85**	**54**	**1,502**	**0.82**	**0.318**	**0.494**	**NC**	**NC**	**NC**
Standards																																					
OR - Ecological Receptors (p=plant, i=invertebrate, b =birds, m = mammals) [1]					50 p	5 p	10 p	NS	NS	85 b	10 p	4 p	NS	NS	NS	20 p	50 i	NS	16 b	NS	100 i	0.1 i	NS	30 p	NS	1 p	2 p	NS	1 p	2 p	50 p	NS	NS	NS	NS	NS	NS
EPA Indust. PRGs - Human Receptors[2]					100,000	410	NS	NS	1.6	67,000	1,900	7.4	NS	64	64	1,900	41,000	100,000	800	NS	19,000	310	62	20,000	NS	5,100	5,100	NS	67	1,000	100,000	NS	NS	NS	NS	NS	NS
EPA - Ecological Receptors (m=mammal, b=bird, i = invertebrate,					NS	21 m	NS	NS	37 p	NS	NS	29 p	NS	5 p	NS	32 b	61 i	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	120 i	NS	NS	NS	NS	NS	NS
ORNL - Ecological Receptors[4]					NS	5	NS	NS	9.9	283	10	4	NS	0.4	NS	20	60	NS	40.5	NS	NS	0.00051	NS	30	NS	0.21	2	NS	1	2	8.5	NS	NS	NS	NS	NS	NS

NOTES:
All analyses except Arsenic III & Methyl Mercury were conducted by SVL Laboratories, Inc., Kellogg, ID per EPA Method 200 series
Arsenic III and Low-Level Mercury anlyses were conducted by Brooks Rand, Seattle, WA per EPA Methods 1631 & 1632, respectively
C = Arsenic V was calculated from difference between Arsenic, TR and Arsenic III
B = analyte detected between MDL and practical quantification limit (PQL)
Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded
NA = Not analyzed
mg/kg = Milligrams per kilogram
< value = Analyte not detected above Method Detection Limit (MDL, shown)
su = Standeard units
Italic values indicate that the MDL exceeds the lowest standard
R = Rejected value due to matrix interference and sample concentrations below MDL
MM-WRSC -1 = Street Adit waste rock
MM-WRB = Brien O Lynn Adit

STANDARD NOTES:
1 - State of Oregon, Level II Ecological Screening Level Values for Soil (ODEQ, 2001); dominantly based on soluble salts
2 - EPA Region 9 Industrial Preliminary Remediation Goals - (EPA, 2004).
3 - EPA Ecological Soil Screening Levels - Lowest Criteria Listed (EPA, 2000)
4 - ORNL = Oak Ridge National Laboratory Preliminary Remediation Goals for Ecological Endpoints August 1997
NS = Not standard

Table 6. Synthetic Precipitation Leaching Procedure and Toxicity Characterization Leaching Procedure Results for Soil and Waste Material Samples. Mayflower and Ochoco Mines Site Inspection, Ochoco National Forest, Oregon

Sample ID	Sample Date	Sample Depth (feet)	SPLP Arsenic	TCLP Arsenic	SPLP Barium	TCLP Barium	SPLP Cadmium	TCLP Cadmium	SPLP Chromium	TCLP Chromium	SPLP Lead	TCLP Lead	SPLP Mercury	TCLP Mercury	SPLP Selenium	TCLP Selenium	SPLP Silver	TCLP Silver
			mg/L															
Mayflower Mine																		
MM-TP-1-1	6/16/2005	0-2'	< 0.025	0.064	0.0196	0.04	0.0472	0.18	< 0.006	< 0.006	0.0201	2.17	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	0.007
MM-TP-1-4	6/16/2005	0-6"	< 0.025	< 0.025	0.0458	0.07	< 0.002	< 0.002	< 0.006	< 0.006	< 0.008	< 0.008	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
MM-TP-1-5	6/16/2005	0-6"	< 0.025	< 0.025	0.0050	0.12	< 0.002	< 0.002	< 0.006	< 0.006	< 0.008	0.0075	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
MM-TP-1-7	6/16/2005	0-6"	< 0.025	0.03	0.0329	0.09	0.0082	0.018	< 0.006	< 0.006	0.063	0.96	< 0.0002	< 0.0002	< 0.04	< 0.04	0.0061	0.013
MM-WR1-7	6/15/2005	0.5 - 2.5'	< 0.025	0.05	0.0080	0.03	< 0.002	0.004	< 0.006	< 0.006	< 0.008	0.01	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
MM-WR2-1	6/16/2005	0.5 - 1'	< 0.025	< 0.025	0.0067	0.02	< 0.002	< 0.002	< 0.006	< 0.006	< 0.008	< 0.008	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
MM-WRB-2	6/16/2005	0.5 - 1'	0.044	0.03	0.0342	0.11	< 0.002	< 0.002	< 0.006	< 0.006	< 0.008	< 0.008	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
MM-WRSC-2	6/16/2005	0.5 - 1'	< 0.025	< 0.025	0.0048	0.59	< 0.002	0.01	< 0.006	< 0.006	< 0.008	0.15	< 0.0002	< 0.0002	< 0.04	0.044	< 0.005	< 0.005
Ochoco Mine																		
OM-WR1-2	6/14/2005	0.5 - 1'	< 0.025	< 0.025	0.0046	0.0175	< 0.002	< 0.002	< 0.006	< 0.006	< 0.008	< 0.008	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
OM-WR1-8	6/14/2005	0.5 - 1'	< 0.025	< 0.025	0.0049	0.02	< 0.002	< 0.002	< 0.006	< 0.006	< 0.008	< 0.008	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
Subsurface																		
MM-TP-1-1	6/16/2005	2 - 5'	< 0.025	< 0.025	0.0077	0.0309	0.0062	0.0355	< 0.006	< 0.006	< 0.008	0.0083	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
MM-WR1-4	6/15/2005	1.5 - 4.5'	< 0.025	< 0.025	0.0172	0.132	< 0.002	0.004	< 0.006	< 0.006	< 0.008	0.0082	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
MM-WR1-5	6/15/2005	6.8 - 11.1'	< 0.025	0.062	0.0038	0.0341	< 0.002	< 0.002	< 0.006	< 0.006	< 0.008	0.0151	< 0.0002	< 0.0002	< 0.04	0.05	< 0.005	< 0.005
MM-WR1-7	6/15/2005	2.5 - 9.5	< 0.025	0.057	0.0035	0.043	< 0.002	0.003	< 0.006	< 0.006	< 0.008	0.0156	< 0.0002	< 0.0002	< 0.04	< 0.04	< 0.005	< 0.005
Applicable Standards																		
RCRA TCLP Disposal Limits			5	5	100	100	1	1	5	5	5	5	0.2	0.2	1	1	5	5

NOTES: All analyses were performed by SVL Laboratories, Inc., Kellogg, ID per EPA Method 6000 series
Shaded values indicate that the value exceeds one or more standard; exceeded criteria also shaded
NA = Not analyzed
mg/Lg = Milligrams per liter
< value = Analyte not detected above Method Detection Limit (MDL, shown)

Table 7. Summary of Contaminants of Potential Ecological Concern
Mayflower - Ochoco Mine Complex Site Inspection, Ochoco National Forest, Oregon

Analyte	Soil/Waste Material	Surface Water	Sediment	Pore Water
Aluminum	P, I, B, M	A	I, B, M	
Antimony	P, B, M			
Arsenic, V	P, I, B, M		I, B, M	
Arsenic	P, I, B, M		I, B, M	
Barium				A
Beryllium			I	
Cadmium		B, M	B, M	
Chromium, III	P, I, B			
Chromium, Total	P, I, B		I	
Cobalt			I, B, M	
Copper			I, B, M	
Iron	P, I, B, M		I, B, M	A, B, M
Lead	P, B			
Manganese	P, I	A	B, M	A
Mercury	I		I	
Methyl mercury	P, I		I, B, M	A, B, M
Nickel			I	
Silver	P, B, M		B, M	
Thallium	B		I, B, M	
Vanadium	P, I		I, B, M	
Zinc	P, I, B, M	A	B, M	

Notes:
Abbreviations: P – Plants; I – Invertebrates; B – Birds; M – Mammals; A – Aquatic Life

Table 8. Summary of Human and Ecological Contaminants of Potential Concern
Mayflower - Ochoco Mine Complex Site Inspection, Ochoco National Forest, Oregon

Analyte	Soil/Waste Material		Surface Water		Sediment		Groundwater (Human)/Pore Water (Ecological)	
	Human	Ecological	Human	Ecological	Human	Ecological	Human	Ecological
Aluminum		X		X		X[1]		
Antimony	X	X			X			
Arsenic, V		X				X		
Arsenic	X	X	X		X	X		
Barium								X
Cadmium				X[2]		X		
Chromium, III		X						
Chromium, Total	X	X			X	X		
Cobalt						X[1]		
Copper						X		
Iron	X	X			X	X[1]		X
Lead	X	X			X			
Manganese	X	X	X	X	X	X[1]		X
Mercury		X				X		
Methyl mercury						X[1,2]		X[1, 2]
Nickel						X		
Silver		X				X[1]		
Thallium		X[1]				X[1]		
Vanadium		X				X[1]		
Zinc		X		X		X		

Notes:
1. Identified as a COPC/COPEC due solely to a lack of risk-based screening concentrations.
2. Identified as a COPEC based on its bioaccumulative potential only.

FIGURES

Figure 1. **Mayflower and Ochoco Mine Watershed Boundary with 1- and 4-mile radius**
Figure 2. **Aquatic, Background, and Offsite Sample Locations**
Figure 3. **Site Layout and Sampling Locations – Mayflower Mine**
Figure 4. **Site Layout and Sampling Locations – Ochoco Mine**

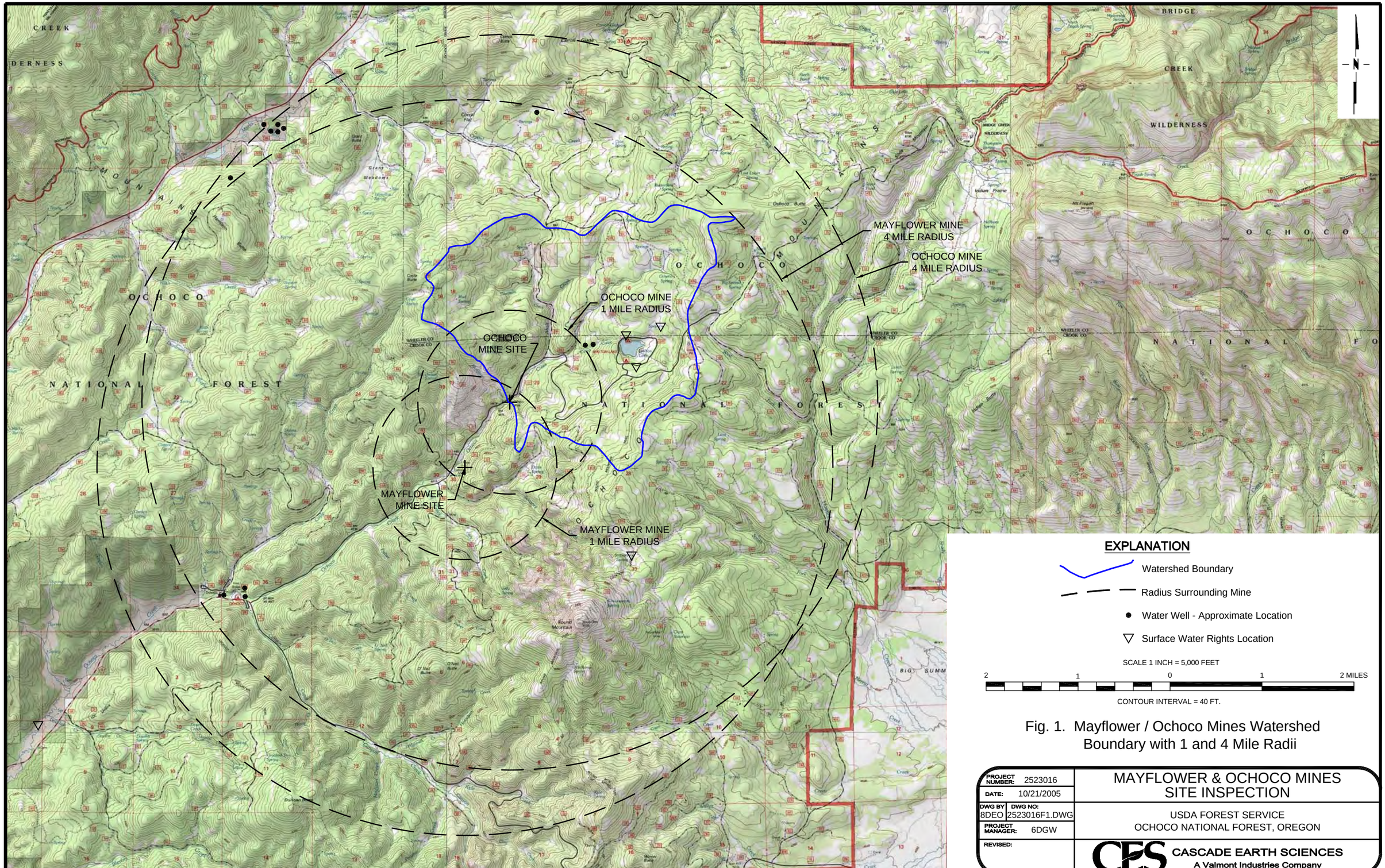
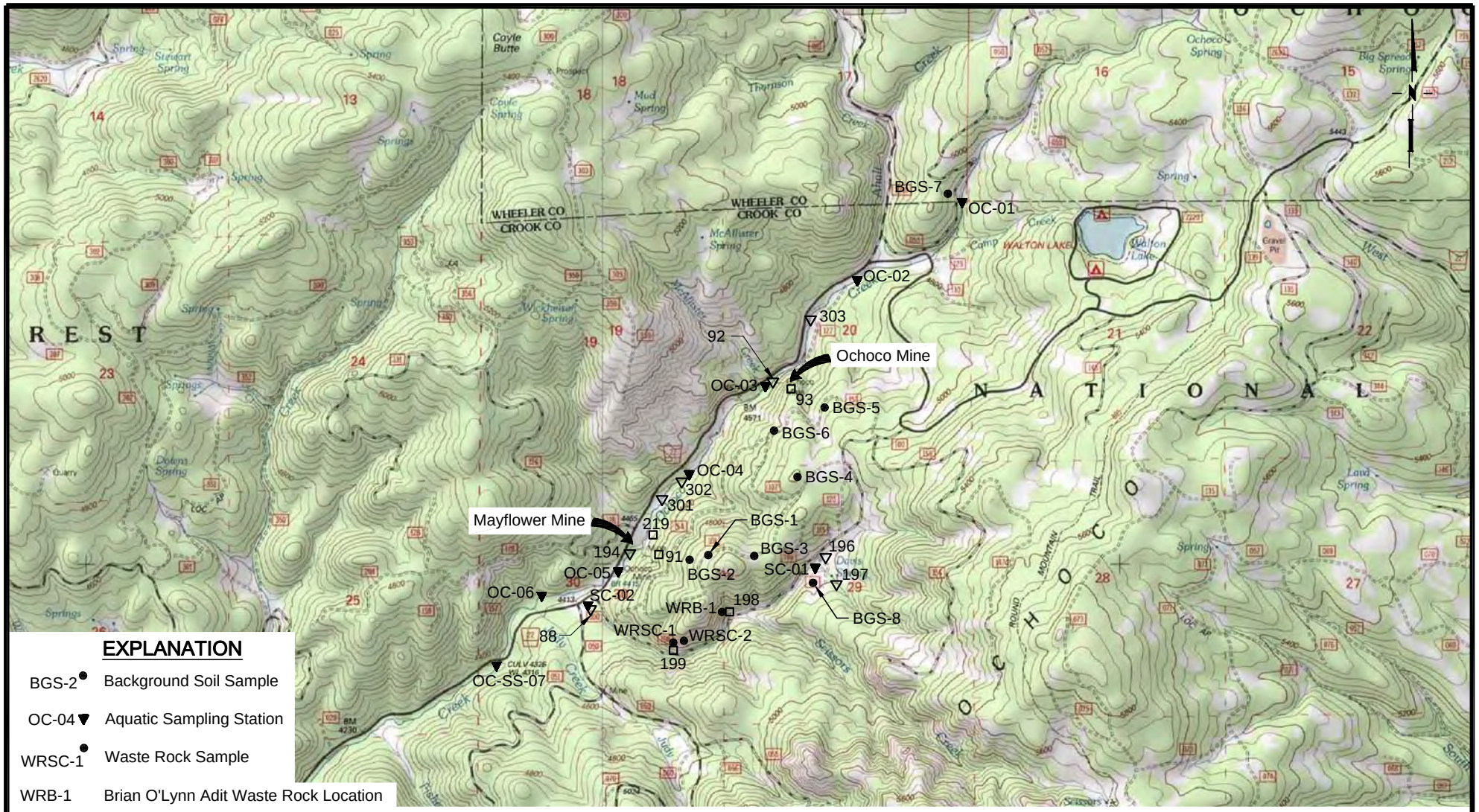


Fig. 1. Mayflower / Ochoco Mines Watershed Boundary with 1 and 4 Mile Radii

PROJECT NUMBER: 2523016	MAYFLOWER & OCHOCO MINES SITE INSPECTION
DATE: 10/21/2005	
DWG BY 8DEO / DWG NO: 2523016F1.DWG	USDA FOREST SERVICE OCHOCO NATIONAL FOREST, OREGON
PROJECT MANAGER: 6DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company



EXPLANATION

BGS-2 ●	Background Soil Sample
OC-04 ▼	Aquatic Sampling Station
WRSC-1 ●	Waste Rock Sample
WRB-1	Brian O'Lynn Adit Waste Rock Location
WRSC-1	Street Adit Waste Rock Location
WRSC-2	Little Giant Adit Waste Rock Location
▫ 93	1982 DOGAMI Soil Sample Location
▽ 92	1982 DOGAMI Sediment Sample Location (Number refers to DOGAMI Report Map Number)

NOTE:
The prefix "MM" (Mayflower Mine) has been removed from the sample ID'S.

0 3000 FEET

(SCALE & LOCATIONS ARE APPROXIMATE)

CONTOUR INTERVAL = 40 FEET

Figure 2. Aquatic, Background and Offsite Sample Stations

PROJECT NUMBER: 2523016	MAYFLOWER & OCHOCO MINES SITE INSPECTION
DATE: 11/1/2005	
DWG BY: 8DEO / DWG NO: 2523016F2.DWG	USDA FOREST SERVICE OCHOCO NATIONAL FOREST, OREGON
PROJECT MANAGER: 4MAA	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company

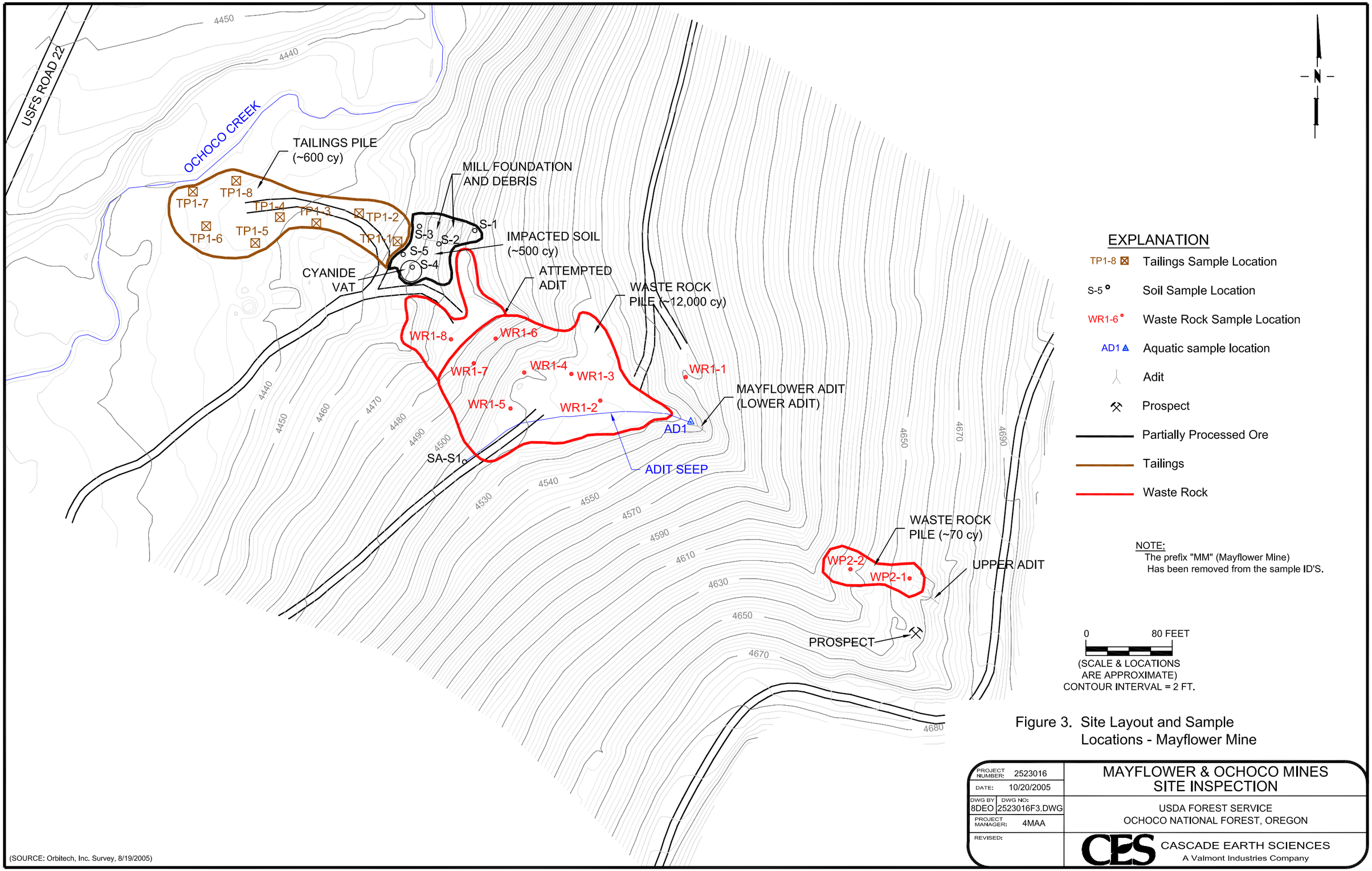
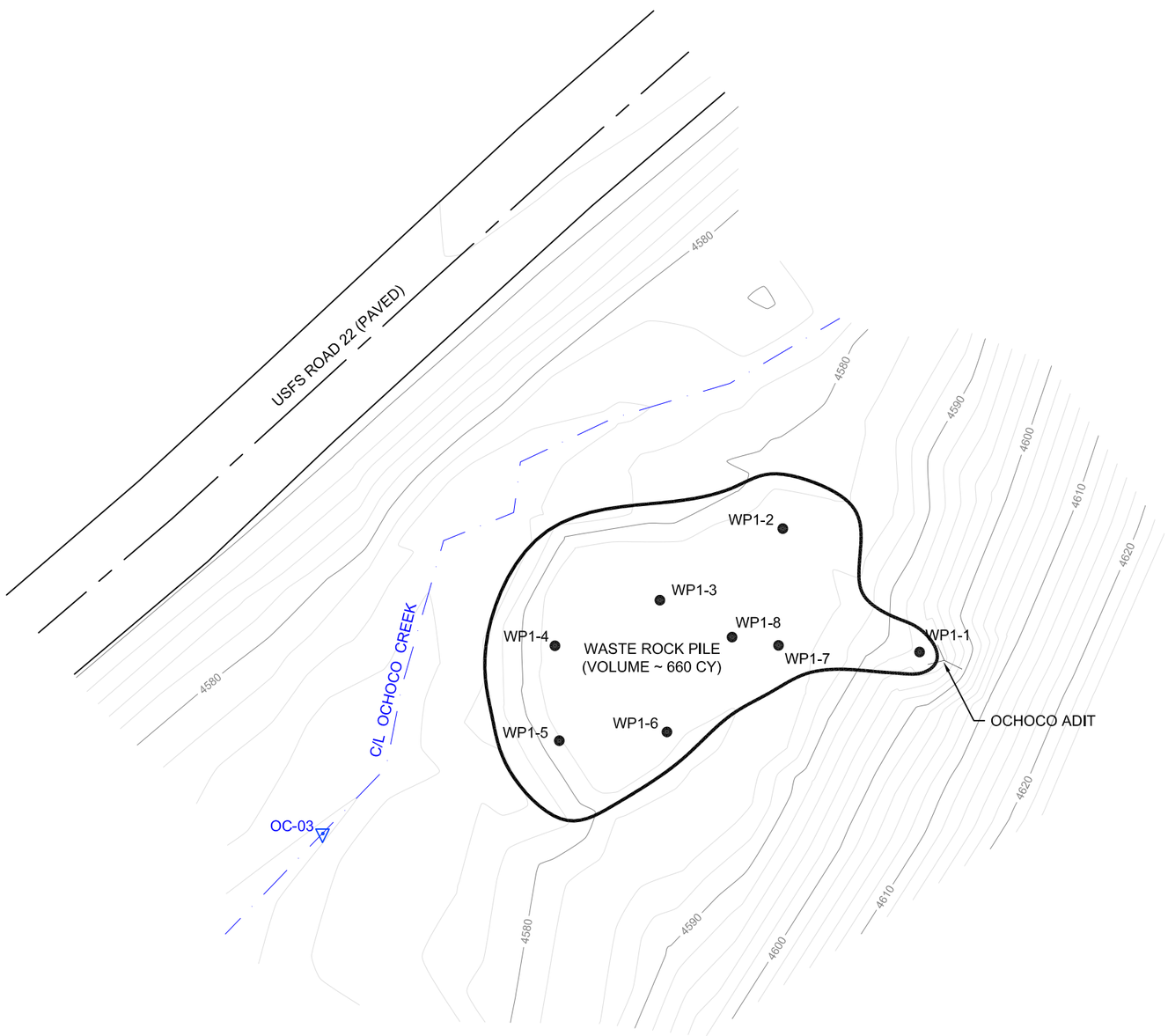


Figure 3. Site Layout and Sample Locations - Mayflower Mine



EXPLANATION

OC-03 Aquatic Sample Station

WP1-4 Waste Rock Sample

Adit

Waste Rock Boundary

NOTE:
The prefix "OM" (Ochoco Mine) has been removed from the sample ID'S.

Figure 4. Site Layout and Sample Locations - Ochoco Mine

0 30 FEET

(SCALE & LOCATIONS ARE APPROXIMATE)
CONTOUR INTERVAL = 2 FT.

(SOURCE: Orbitech, Inc. Survey, 8/29/2005)

PROJECT NUMBER: 2523016	MAYFLOWER & OCHOCO MINES SITE INSPECTION
DATE: 10/20/2005	
DWG BY 8DEO / DWG NO: 2523016F4.DWG	USDA FOREST SERVICE OCHOCO NATIONAL FOREST, OREGON
PROJECT MANAGER: 4MAA	
REVISED:	CES CASCADE EARTH SCIENCES A Valmont Industries Company

APPENDICES

Appendix A **Photographs**
Appendix B. **Mayflower Mine Map**
Appendix C. **Ecological Survey**
Appendix D. **Human and Ecological Risk Assessments**

Appendix A.

Photographs

Photograph 1. View downstream at Station OC-01. (CES -6-15-05)

Photograph 2. View upstream at Station OC-02. (CES 6-15-05)

Photograph 3. View downstream at Station OC-03, the Ochoco Mine waste rock pile is visible in the background. (CES 6-15-05)

Photograph 4. View downstream at Station OC-04. (CES 6-15-05)

Photograph 5 View downstream at Station OC-05. (CES 6-14-05)

Photograph 6. View downstream at Station OC-06. (CES 6-14-05)

Photograph 7. View upstream at Station SC-01. (CES 6-15-05)

Photograph 8. View upstream at Station SC-02. (CES 6-14-05)

Photograph 9. Portal of the Lower Adit (Mayflower Adit) at Mayflower Mine. (CES 6-15-05)

Photograph 10. View south at the Lower Adit, water flowing across wasterock pile. (CES 6-15-05)

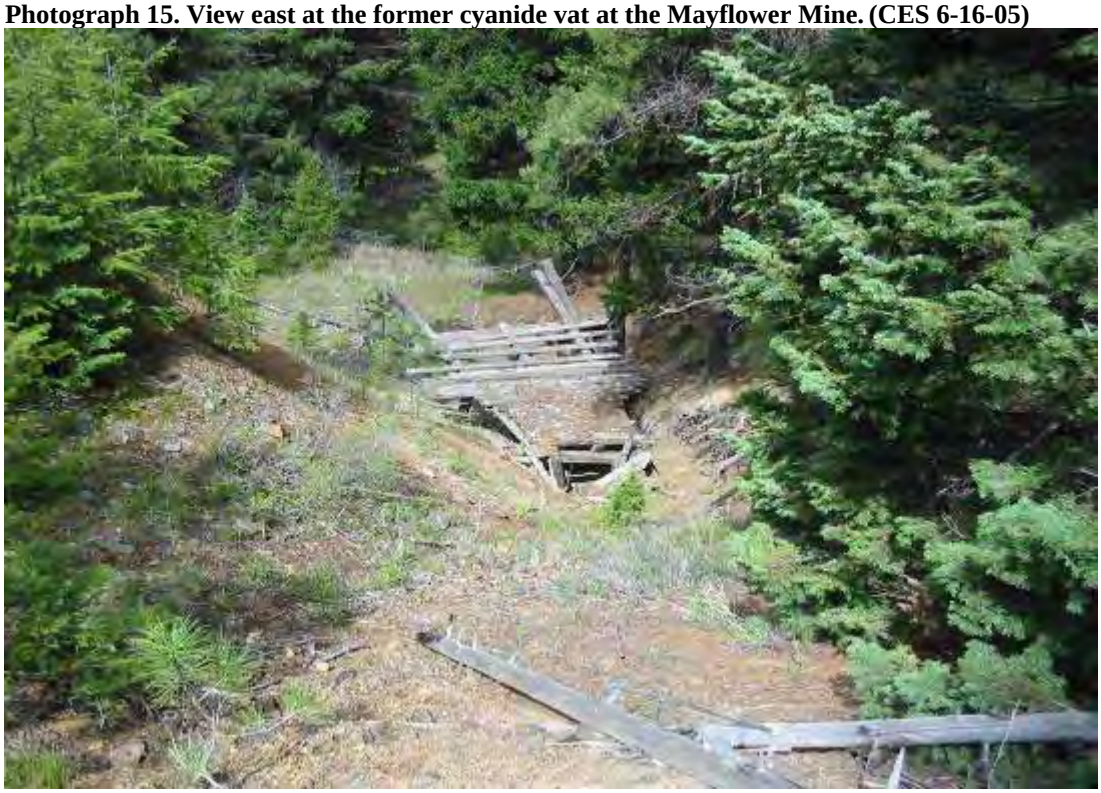
Photograph 11. View south at Upper Adit at the Mayflower Mine. (CES 6-16-05)

Photograph 12. Wasterock pile below a prospect above the Mayflower Adit. (CES 6-16-05)

Photograph 13. View south of a short prospect uphill from the Upper Adit. (CES 6-16-05)

Photograph 14. Remains of the former mill at the Mayflower Mine. (CES 6-16-05)

Photograph 15. View east at the former cyanide vat at the Mayflower Mine. (CES 6-16-05)



Photograph 16. View south of the timbers remaining from an attempt to drain the Mayflower Adit. (CES 6-16-05)

Photograph 17. View south of the Ochoco Adit portal at the Ochoco Mine. (CES 6-16-05)

Photograph 18. View west at the Ochoco Mine wasterock pile. (CES 6-16-05)

Photograph 19. View south at the large wasterock pile at Mayflower Mine. (CES 6-15-05)

Photograph 20. Close-up of tailings deposits downhill from the Mayflower Mill. (CES 6-15-05)

Photograph 21. View north at the Brian O'Lynn Adit wasterock pile. (CES 6-16-05)

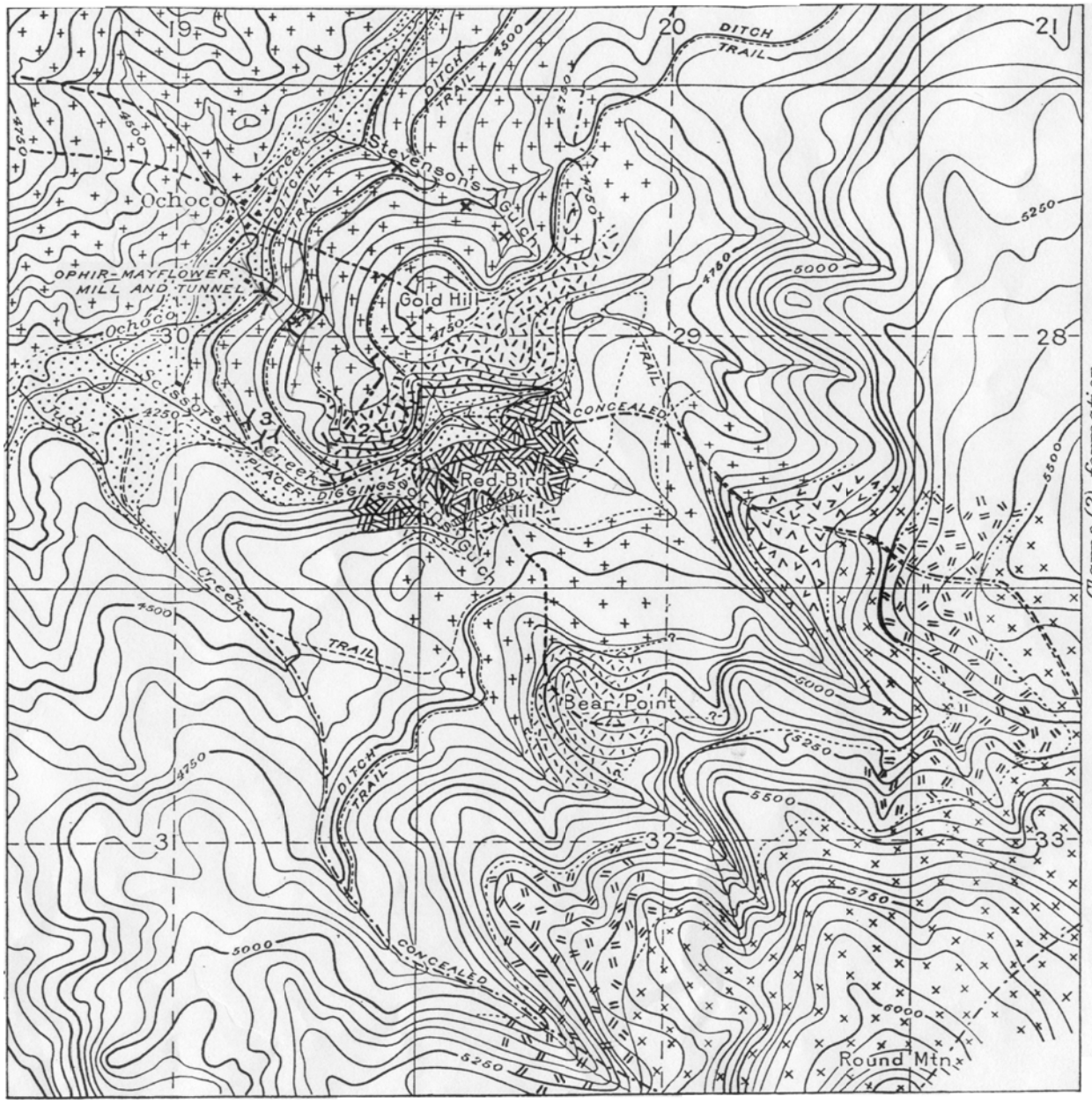
Photograph 22. View east at the wasterock pile below the Little Giant Adit.(CES 6-16-05)

Photograph 23. Apparent collapsed Street Adit above Scissors Creek. (CES 6-16-05)

Photograph 24. View from top of Street Adit wasterock pile next to Scissors Creek. (CES 6-16-05)

Appendix B.

Mayflower Mine Map



EXPLANATIO

Alluvium
(Stream gravel)

Clarno (?) formation

Basaltic member

Olivine basalt

Breccia

Porphyritic hypersthene augite andesite

Andesitic member

Dense andesite
(including one dike)

Porphyritic hornblende andesite

Andesite breccia

Areas without pattern not studied.

Geologic traverse

Tunnel

Prospect

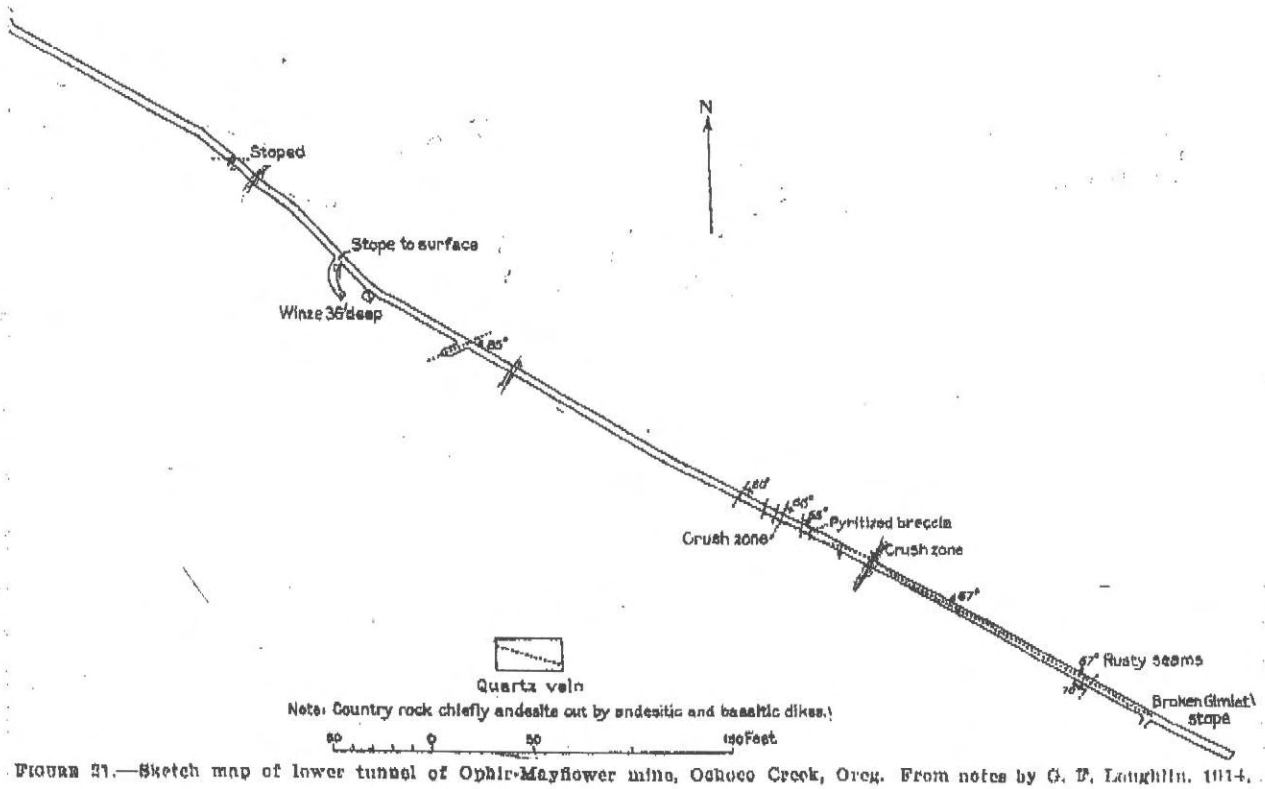


FIGURE 21.—Sketch map of lower tunnel of Ophir-Mayflower mine, Ochoco Creek, Oreg. From notes by G. F. Laughlin, 1914.

Appendix C.

Ecological Survey

AQUATIC ECOLOGICAL SURVEY

Aquatic surveys were conducted within Ochoco and Scissors Creeks to assess the potential impacts of the Site on the instream habitat, benthic macroinvertebrate community, and presence of fish species due to the site-related physical habitat alteration or chemical contamination.

In the vicinity of the both mines, Ochoco Creek is a small, perennial second order stream (Armantrout 1998). At the time of our investigation in June, flow was moderately high and likely higher than base flow conditions. The ephemeral Scissors Creek joins Ochoco Creek approximately 200 meters (610 feet) downstream of Mayflower Mine, between OC-05 and OC-06. Judy Creek joins Ochoco Creek within 1 km (0.6 miles) downstream of the Mayflower mine and is approximately 100 m downstream of OC-06. The volume of Ochoco Creek increased with distance downstream from the mines. Ochoco Creek flows into the Crooked River near Prineville, Oregon.

Six stream reaches, each approximately 50 m long, were established on Ochoco Creek, with one (OC-06) downgradient of both mines, one (OC-05) immediately downstream of Mayflower Mine, one approximately midway between the two mines (OC-04), one immediately downstream of Ochoco Mine (OC-03), and two reference sampling reaches upstream of the two mines (OC-02 and 01); with OC-01 near the headwaters of Ochoco Creek. Two reaches were placed on Scissors Creek (SC-02 and SC-01), one near the point where the water flow ends and one at Davis Spring on a small tributary of Scissors Creek. Stream reach locations are shown in Figure 2 in the Site Inspection (SI) Report. An attempt was made to conduct benthic macroinvertebrate sampling in both riffle and pool habitats in each of the five selected stream reaches. However, no pools were present in or near the established sampling reaches at SC-02 or SC-01.

Numeric habitat ratings were developed for each reach using U.S. Environmental Protection Agency (USEPA) Rapid Bioassessment Protocol - Habitat Assessment Field Data Sheets for High Gradient Streams (Barbour 1999). Using this method, ten instream and riparian habitat parameters are each scored separately and then these individual habitat scores are summed to provide a habitat total score. The individual habitat parameter scores were used to differentiate habitat quality between stream reaches. Additional instream characterization was conducting with the Physical Characterization Field Data Sheet (Barbour 1999). The following habitat conditions were noted:

- Habitat total scores were 170, 189, 186, 175, 177, and 159 at stations OC-06, 0C-05, 0C-04, 0C-03, OC-02, and OC-01, respectively. For Scissors Creek the habitat scores were 153 and 181 at SC-02 and SC-01, respectively. This indicates the overall instream physical habitat conditions were suboptimal at OC-01 and SC-02 and optimal for all other reaches.

- At OC-06, OC-05, and OC-04 the individual habitat parameter velocity/depth regime was rated as suboptimal because the fast/deep regime was absent.

- At OC-03 and OC-02, the individual habitat parameter embeddedness was rated suboptimal and the velocity/depth regime was rated marginal due to the absence of the fast/deep and slow/deep conditions.

- At OC-01, the individual habitat parameters substrate/available cover and frequency of riffles were rated suboptimal. Embeddedness and velocity/depth regime were both rated marginal due to 50%-70% fine sediment surrounding the gravels, and a lack of fast/shallow and slow/shallow conditions, respectively.

- At SC-02, the individual habitat parameter substrate/available cover was rated suboptimal, the velocity/depth regime was rated poor due to the presence of only the slow/shallow regime, and channel flow status was rated marginal due to a lack of water.

- At SC-01, the individual habitat parameters substrate/available cover, embeddedness (25%-50% embedded) and velocity/depth regime (no fast/deep) were rated suboptimal.

The habitat scores are more indicative of riffle habitat quality, and may not be correlated with pool habitat quality. Overall, stations OC-2 through OC-06 had quite similar riparian and instream conditions, with slightly more silt at OC-02 and OC-03. The channel was braided at OC-02, so the amount of water within the sample channel was lower than at the other downstream reaches. At OC-01 and SC-01, the channel was small and incised into a boggy, grassy meadow. At SC-02 there was little or no riparian vegetation and the channel appeared to have been straightened. OC-01 was most similar to SC-01, but SC-01 had slightly better instream riffle conditions because it was not incised as deep into the organic soil.

Large woody debris (LWD) was common at stations OC-02 through OC-06 and SC-02. Stations OC-01 and SC-01 had low amounts of LWD due to their open meadow/boggy nature. Channel pattern was good with a sinuous channel and a variety of velocity/depth regimes at all Stations except OC-06 and SC-02.

No pools were present at the two Scissors Creek stations. All of the Ochoco Creek pools were instream, often a result of woody debris dams. The pools at OC-03 through OC-06 were similar in nature, with some increase in fine sediment apparent at OC-04 and 05 where the stream is all one channel (i.e., not braided) and meandering.

Generally, the fine substrate at OC-01 and SC-01 was similar organic material, but there was more gravel at the SC-01 riffle compared to large coble and bedrock at OC-01. A slightly lower percentage of boulders and cobble was noted at OC-05 compared to OC-02, 03, 04, and 06.

No obvious mine-related erosional features were noted in Ochoco Creek. Braided stream channels between the two mines appeared man-made and may have been related to past instream mining, logging, or other activity. Overall, the instream and riparian habitat was good at all stations except SC-02. No fish barriers were noted in Ochoco Creek between the sample reaches. However, the Ochoco Reservoir dam near Prineville (approximately 25 km downstream of the mines) is a barrier for anadromous fishes.

Laboratory enumeration was completed to the species level, when possible, for at least 300 individuals in each sample. The identified benthic macroinvertebrates are listed in Table C-7. Abundance, diversity, and several biological indices were examined for the benthic macroinvertebrates present in each pool and riffle sample, and qualitatively compared between stations. Pool data were only compared to other pool data and riffle data were only compared to other riffle data. No rare, threatened, or endangered (RTE) benthic macroinvertebrate species were identified.

The abundance and diversity data provide understanding of the number of individual benthic macroinvertebrates and the number of species, respectively, at each station. The metals tolerance index was developed in Montana (Montana Department of Environmental Quality [MTDEQ], 1995) and is based upon a correlation of benthic macroinvertebrate species present in known metals contaminated streams versus those present in unpolluted streams. A higher metals tolerance index value indicates that a higher percentage of the benthic macroinvertebrate species present are known to be tolerant of the presence of metals contamination. The Shannon-Weaver index is a measure of the number of species (i.e., diversity) and the number of individuals within each species (i.e., evenness). A higher Shannon-Weaver index indicates more diversity and a lower likelihood of impacted benthic macroinvertebrate populations. The fine sediment biotic index is a measure of the number of species present that are

tolerant of increased sediment in the stream substrate. A higher fine sediment biotic index indicates there are more sediment tolerant species present in the sample. The intolerant species index is a measure of how many pollution sensitive species are present in each sample. A lower number in intolerant species suggests the benthic macroinvertebrate population may be impacted. The Oregon Level III evaluation provides an understanding of how the potentially impacted stream compares to unimpacted streams in Oregon.

The results of the benthic macroinvertebrate investigation in pool (P) habitats show that:

- The estimated numbers of all benthic macroinvertebrates were 1023, 366, 4021, 1540, 869, and 978 at OC-01P, 02P, 03P, 04P, 05P, and 06P, respectively.

- Diptera (primarily Chironomidae) were the most abundant species at OC-01P, 02P, 03P, 04P, and 05P, but showed a decreasing trend from OC-01P through OC-04P, increased at OC-05P, then decreased to their lowest level at OC-06P. Ephemeropteran, Plecopteran, and Trichopteran (i.e., EPT) species were similar at OC-01P through 05P, then increased noticeably at OC-06P, for reasons unknown. Oligochaeta were highest at OC-03P. The first dominant taxon increased steadily from OC-01P through 04P, then decreased consecutively at OC-05P and 06P. These results are shown on Figure C-1.

- The overall pattern of species diversity was similar at OC-01P and 02P and similar between OC-03P through 06P, but different between these two groups of Stations (Figure C-2). The number of species was noticeably lower at OC-04P and 05P, primarily due to fewer Chironomidae and EPT species. Chironomidae diversity was consecutively less at OC-01P through 05P, then increased at OC-06P. EPT diversity was relatively high at OC-03P, decreased at OC-04P and 05P, and then increased noticeably at OC-05P. The reason for the decrease at OC-04P is unknown, but may be due to the change in physical conditions.

- The composition of functional feeding groups varied greatly between the stations. Filterers and gatherers were most numerous at OC-01P, 03P, 04P, and 06P, predators were most numerous at OC-02P and 05P, scrapers were most numerous at OC-03, and shredders were numerous at OC-01P, decreased consecutively at OC-02P, 03P, and 04P, then increased at OC-05P and 06P (Figure C-3).

- The metals tolerance index decreased between at OC-02P and 04P, increased at OC-05P, and then decreased slightly again at OC-06P. The Shannon-Weaver species diversity index (log e) decreased between OC-01P and 04P, then increased at OC-05P and 06P. The numbers of intolerant (i.e. sensitive) species were low at OC-01P, 02P, 04P, and 05P, and elevated at OC-03P and 06P. These results are shown in Figure C-4.

The decreased number of benthic macroinvertebrates at OC-02P is indicative of lower quality pool habitat. However, the observed pool habitat included a higher amount of fine sediment, suggesting higher quality pool habitat. One difference between OC-02P and the other downstream stations was a lower amount of water in the channel due to the braided channels at OC-02P. Regardless, it is not clearly obvious why there are much lower numbers of benthic macroinvertebrates at OC-02P and higher numbers of benthic macroinvertebrates at OC-03P compared to the other Stations. The higher numbers of both EPT and Oligochatae species suggest both riffle and pool characteristics where encountered at OC-03P.

Similarity in the percentage of species present at OC-01P and OC-02P (Figure C-1) confirms the similarity in habitat conditions at these pool Stations with an abundance of fine-grained sediment. The distribution of species at OC-03P and 06P suggests the stations have similar habitat expressing both pool and riffle characteristics. OC-04P and 05P also have similar species distributions suggesting the pool

habitat may be more pool-like than O3P and 06P, but less pool-like than the two upstream stations. These findings suggested by Figure C-1 reflect observations made in the field. However, the low EPT abundance and increasing dominant taxon at OC-04P and 05P may reflect decreasing pool habitat conditions.

The species diversity shown in Figure C-2 closely reflects the abundance data shown in Figure C-1 with similar diversity at OC-01P and 02P, diversity that reflects higher quality riffle habitat at OC-03P and 06P, and potentially reflects intermediate riffle habitat quality at OC-04P and 05P. However, the EPT and non-chironomid/non-oligochaete diversity is lower or similar to that at OC-01P and 02P, when habitat conditions would suggest they should be higher. This suggests a potential for mine-related impacts at stations OC-04P and 05P, but not at 03P, which is immediately downgradient of the Ochoco Mine.

As shown in Figure C-3, the functional group diversity shows very few, if any patterns across the pool stations. Gatherers may show a decreasing trend between OC-03P, 04P, and 05P. This decrease may reflect the decreased chironomid diversity at these stations as seen in Figure C-2.

The Shannon-Weaver index (Figure C-4) suggests slightly lower species diversity at OC-03P, 04P, and 05P. The intolerant (i.e., sensitive) taxa index suggests a potential impact at stations OC-04P and 05P. However, the consistent and low metals tolerance indices at OC-03P, 04P, 05P, and 06P suggest that metals are not causing any impact in Ochoco Creek downstream of the mines. Thus, poor instream pool habitat conditions are suggested at OC-03P, 04P, and 05P.

Generally, pool habitats are representative of instream sediment quality. The benthic macroinvertebrate survey results for pool habitats provide no clear evidence of mine-related chemical impact downstream of the Mayflower and Ochoco Mines. Apparent physical alterations to the stream channel were observed, resulting in the braided nature of the channel in the vicinity of OC-03P and 04P. The abandoned roadway downstream of OC-02P, and other apparent vehicle crossing areas may indicate past physical disturbance of the stream channel related to timber harvest, mining, and/or other activities. Similar physical disturbances were not clearly noticed at OC-05P adjacent to the Mayflower Mine, so potential chemical impacts are not as readily ruled out at this station compared to the others.

Results of the benthic macroinvertebrate investigation in riffle (R) habitats suggest that:

- The numbers of benthic macroinvertebrates were 450, 201, 905, 1352, 1207, 1464, 3624, and 1017 at stations SC-01R, SC-02R, and OC-01R through 06R, respectively.

- Dipteran (primarily chironomid) and EPT species were the most abundant at all Stations. Coleroptera were relatively abundant at SC-01R and OC-01R and lower but generally consistent at OC-02R, 03R, 04R, 05R, and 06R. The first dominant taxon was relatively low at most stations, but increased across SC-01R, OC-01R, and reaches a maximum at SC-02R, then decreased at each consecutive downstream station. These findings are shown graphically in Figure C-5.

- The diversity of species at OC-02R, 03R, 04R, 05R, and 06R were remarkably similar to each other. The diversity of species was also similar between SC-01R, SC-02R, and OC-01R, but was lower overall at these Stations than at the downstream Ochoco Creek Stations. However, the distribution of species diversity was similar across all stations except SC-02R, as displayed in Figure C-6.

- The composition of functional feeding groups showed gatherers were dominant at all Stations except SC-02R. Other than at SC-02R, the prominence of scrapers and shredders was higher

at the downstream Ochoco Creek stations. Figure C-7 shows the distributions of functional feeding groups at each riffle station.

- The metals tolerance index was low and consistent, and the Shannon-Weaver species diversity index (log e) was consistent, across all stations (Figure C-8). The number of intolerant taxa varied somewhat, but other than SC-02R and OC-04R, generally showed an increasing trend with each consecutive downstream station.

Differences in the number of benthic macroinvertebrates at each Station suggest lower quality riffle habitat in Scissors Creek. This is especially true at SC-02R, which had a straightened channel and very little water present. The relative abundance of EPT species across all Stations except SC-01R, suggest that decent quality riffle conditions exist at these Stations. The relatively high abundance of dipteran (primarily chironomid) species also suggests that Ochoco Creek contains a significant amount of fine-grained material, even within the riffles. This was consistent with field observations in that, once the top layer of gravel/cobble substrate was disturbed, clouds of fine-grained material were also noticed, primarily consisting of organic material. Observed conditions at SC-01R and OC-01R were clearly different than the remaining Stations, including much higher organic material and less gravel substrate present. Overall the community composition data in Table C-5 suggest that lower quality riffle conditions exist at Stations SC-01R, OC-01R, and SC-02R; and that riffle conditions at the remaining downstream stations are consistently similar. Thus, potential chemical impacts cannot be eliminated as a cause of the difference in benthic macroinvertebrate abundance. The species diversity and functional feeding group composition shown in Tables C-6 and C-7, respectively also support this conclusion, with slightly higher quality riffle conditions occurring at downstream stations within Ochoco Creek.

The intolerant taxa and metals tolerance index (Figure C-8) suggest a potential impact at Station SC-02R. The increasing intolerant species index at consecutive downstream Ochoco Creek stations indicates that mine-related impacts are not occurring in Ochoco Creek riffle habitats.

Generally, riffle habitats are representative of instream water quality. The benthic macroinvertebrate enumeration data for riffle habitats provided only slight evidence of mine-related impacts at SC-02.

The potential presence of fish was documented by visual observation during the ecological survey. One approximately 15 cm red-band trout (*Oncorhyncus mykiss gairdnerii*) was caught using the benthic macroinvertebrate kick-net and identified prior to release. Other red-band trout were seen in the creek. The red-band trout is a state vulnerable species. Other fish species that may be present in the vicinity of the mines (including in Walton Lake upstream of the Site) include brook trout (*Salvelinus fontinalis*), longnose and speckled dace (*Rhinichthys* spp.), bridgelip and largescale suckers (*Catastomus* spp), sculpin (*Cottus* spp), and brown bullhead (*Ictalurus nebulosus*) (USFS, 2004). The Ochoco Reservoir dam prohibits anadromous fish passage into Ochoco Creek in the vicinity of the mines.

TERRESTRIAL ECOLOGICAL SURVEY

Terrestrial habitats and animals that are present or likely at, and surrounding, the mine were documented during the ecological survey and via communication with regional biologists. Four 30-minute bird surveys were also conducted. During the field effort: first the Site was inspected to determine the dominant vegetation communities at and surrounding the mines; then the dominant plant species were identified (Cooke, 1997; Hitchcock and Cronquist, 1978; Niehaus and Ripper 1976, Pojar and Mackinnon, 1994; Little, 1980) within each of the communities and documented on field forms. Qualitative surveys also were conducted at and surrounding the mine for mammal and terrestrial invertebrate presence. Lists of rare, threatened, or endangered (RTE) plants and animals likely or known

to be present in the vicinity of the site were obtained from the U.S. Forest Service (USFS), Oregon Department of Fish and Wildlife (ODFW), and Oregon Natural Heritage Program (ONHP) and are provided in the USFS Project File. In addition, plant species lists and associations for the Blue Mountains ecoregion were acquired (ONHP 2001).

The mine site is within the Middle Rocky Mountain Steppe/Coniferous Forest/Alpine Meadow ecoregion (Bailey 1995). This ecoregion is characterized by relatively mild average temperatures (-3 to 16 degrees Celsius) and 51 to 76 cm (20 to 30 inches) of precipitation per year. The majority of the precipitation occurs between October and June, approximately 50 percent as snow. The dominant plant communities in this ecoregion vary, including sagebrush (*Artemisia tridentata*) semi-desert/steppe at lower elevations, Ponderosa pine (*Pinus ponderosa*) at moderate elevations, Douglas fir (*Pseudotsuga menziesii*) forests at higher elevations, and subalpine/alpine tundra at even higher elevations. The Site is within the Ponderosa pine zone which is comprised predominantly of a Ponderosa pine/elk sedge plant association common to the Blue Mountains (ONHP 2001). Three distinct plant communities were observed on or adjacent to the mines including disturbed mine, open Ponderosa pine forest, and riparian. The two mines had similar vegetation. The terrestrial RTE plant species potentially present near the mines are listed in Table C-1; however, no listed RTE plants were observed during the site visit.

The disturbed mine areas were primarily waste rock or excavated/disturbed gravelly soil. Numerous colonizing and weedy species were present, with no canopy layer, and a patchy herbaceous layer. Young ponderosa pine and elk sedge (*Carex geyeri*) were the dominant species. Other common species included young Douglas fir (*Pseudotsuga menziesii*), young grand fir (*Abies grandis*), Timothy (*Phleum pratense*), colonial bentgrass (*Agrostis capillaries*), Kentucky bluegrass (*Poa pratensis*), orchard grass (*Dactylis glomerata*), California buttercup (*Rannunculus californicus*), sweet-scented bedstraw (*Galium triflorum*), and Oregon grape (*Mahonia aquifolium*).

The open ponderosa pine forest was dominated by ponderosa pine and elk sedge. Other common species included grand fir, grasses (*Festuca* and *Agrostis* species), yarrow (*Achillea millefolium*), and snowberry (*Symphoricarpos albus*).

The riparian corridor along Ochoco creek varied in width from 0 to approximately 150 ft. and primarily consisted of low-lying trees, shrubs, and grasses. The dominant species were Sitka alder (*Alnus sinuata*), pacific willow (*Salix lucida*), ponderosa pine, snowberry, colonial bentgrass, small-flowered bulrush (*Scirpus macrocarpus*), and northern clustered sedge (*Carex arcta*). The species identified within the three observed plant communities are listed in Table C-2.

The mines were within the forest community and adjacent to the riparian community. There was a distinct difference between the onsite and offsite plant communities and variations in frequency and percent cover of individual species appeared to be dependent on proximity to past mine activity. The riparian community did not appear impacted by mining activities.

Terrestrial invertebrates noted on and near the mine included black carpenter ants (*Camponotus pennsylvanicus*), butterflies, moths, and many small black flies. None of these or any other invertebrates in the vicinity of the mine are known RTE species. The terrestrial invertebrate species observed, expected, or possible in the vicinity of the mine are listed in Table C-3

One bird survey station (BS-01) was established at the same elevation as the Mayflower mine near the border of the forest and disturbed habitats and a second (BS-02) downgradient of the Ochoco mine within riparian habitat. Two 30 minute surveys were conducted from each station. Birds observed during the surveys or during the vegetation, mammal, or stream surveys, and birds expected or possible at the Site are listed in Table C-4. No RTE bird species were listed by the ONHIC for the area within a 3.2-km (2-

mile) radius of the Site. The USFS lists the bald eagle, band-tailed pigeon, black-backed woodpecker, ferruginous hawk, golden eagle, mountain quail, and peregrine falcon as rare or sensitive species within the Ochoco National Forest. Of these only the black-backed woodpecker and mountain quail are possible long term inhabitants of the Site.

Game trails were not clearly present at the mines, but evidence of mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) was observed suggesting they are present at and surrounding the mines. No RTE mammal species were listed by the ONHIC for the area within 3.2 kilometers of the site. As shown in Table C-1, the gray wolf (*Canis lupus*; federally threatened) and the wolverine (*Gulo gulo*; federal species of concern) are the only two RTE mammals species expected by the USFS to inhabit the region surrounding the Site. However, given their habitat preferences, both of these species are likely to be transient, in present in the Site vicinity. No bats have been documented in the mine workings. Other mammals expected or possible at the Site are listed in Table C-5.

A garter snake was noted in the vicinity of the Mayflower mine. No other herpetiles were noted during the field effort. No RTE herpetile species were listed by the ONHIC for the area within 3.2 kilometers of the site. The RTE herpetile species expected or possibly present in the vicinity of the Site are listed in Table C-1. Other herpetiles observed, expected, or possible at the Site are listed in Table C-6.

Chemical impacts to terrestrial species would be expected only if they reside or are consistently feeding within the disturbed mine area. Thus, immobile or relatively immobile species such as plants and terrestrial invertebrates are the species most at risk. However, while individual plants and invertebrates may be at risk, impacts to populations of these species are unlikely; and because the mining-related disturbed areas at the Site are small in relation to the available surrounding undisturbed habitat, impacts to most mobile terrestrial species are not expected. Thus, individuals of listed RTE plant and terrestrial invertebrate species are the primary concern and other RTE species are the secondary concern.

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FIGURES

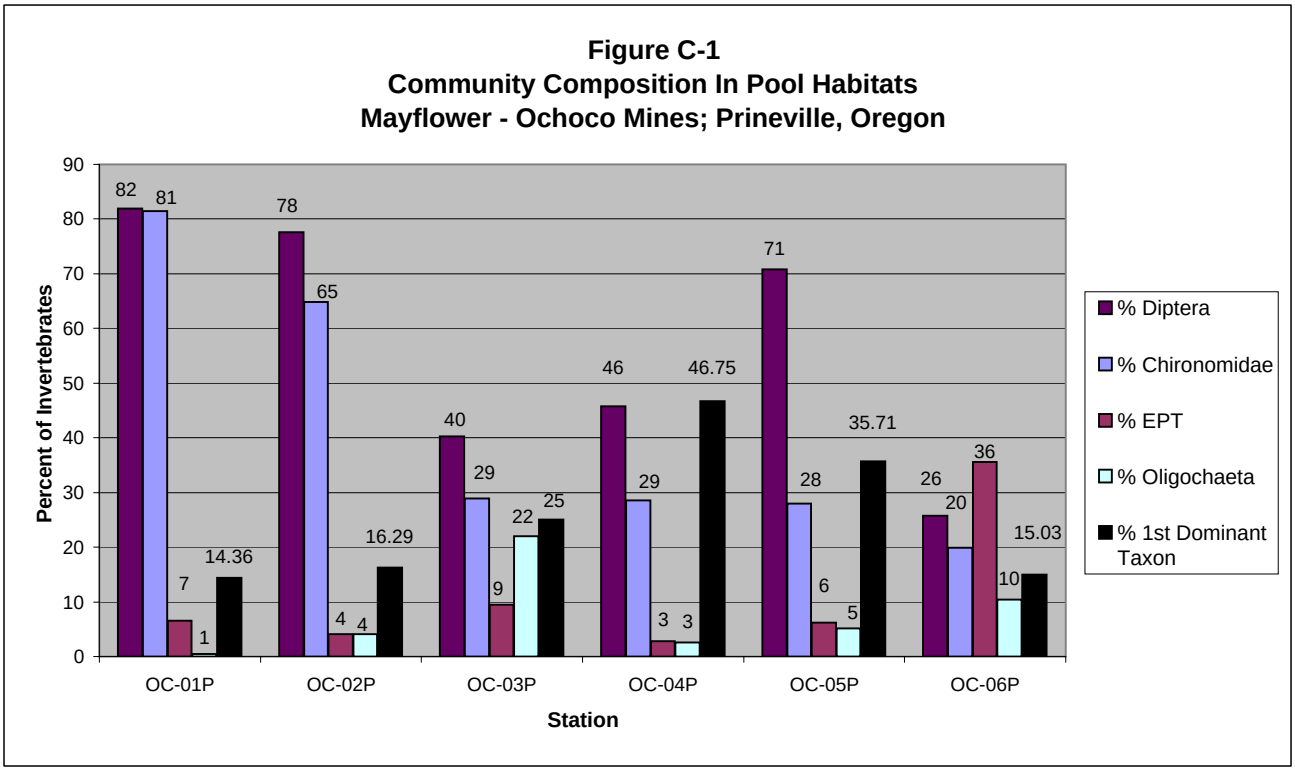
Figure C-1
Community Composition In Pool Habitats
Mayflower - Ochoco Mines; Prineville, Oregon
Percent of Invertebrates
Station
OC-01P
OC-02P
OC-03P
OC-04P
OC-05P
OC-06P
% Diptera
% Chironomidae
% EPT
% Oligochaeta
% 1st Dominant Taxon

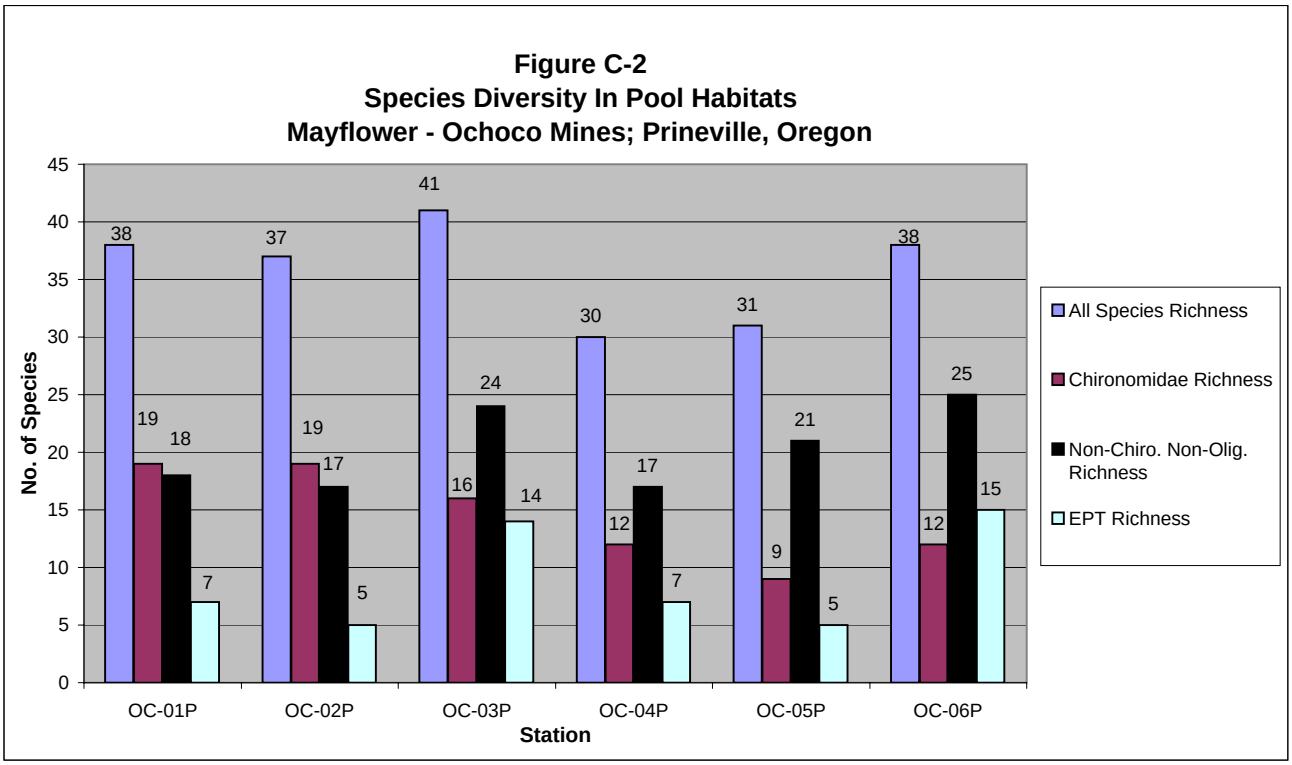
Figure C-2
Species Diversity In Pool Habitats
Mayflower - Ochoco Mines; Prineville, Oregon
No. of Species
Station
OC-01P
OC-02P
OC-03P
OC-04P
OC-05P
OC-06P
All Species Richness
Chironomidae Richness
Non-Chiro. Non-Olig. Richness
EPT Richness

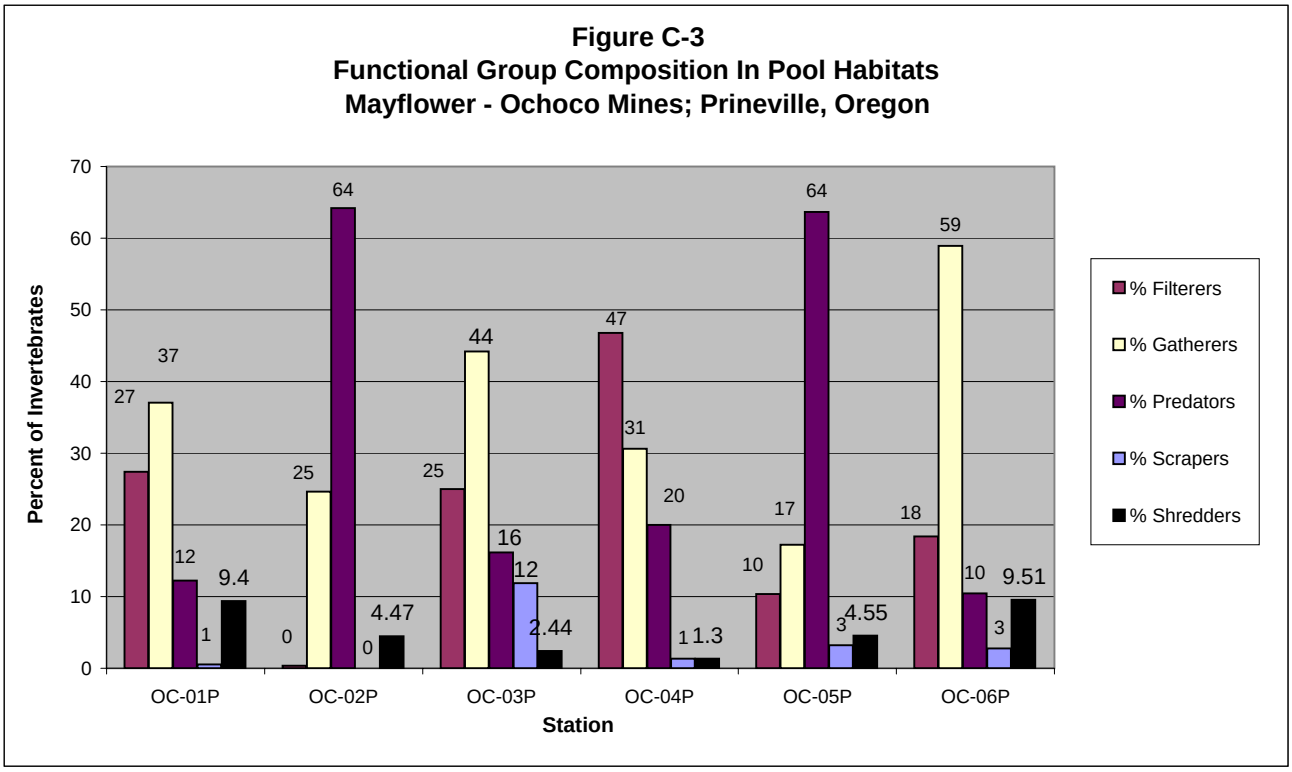
Figure C-3
Functional Group Composition In Pool Habitats
Mayflower - Ochoco Mines; Prineville, Oregon
Percent of Invertebrates
70
60
50
40
30
20
10
0
27
37
12
1
9.4
0
25
64
0
4.47
25
44
16
12
2.44
47
31
20
1
1.3
10
17
64
3
4.55
18
59
10
3
9.51
OC-01P
OC-02P
OC-03P
OC-04P
OC-05P
OC-06P
Station
% Filterers
% Gatherers
% Predators
% Scrapers
% Shredders

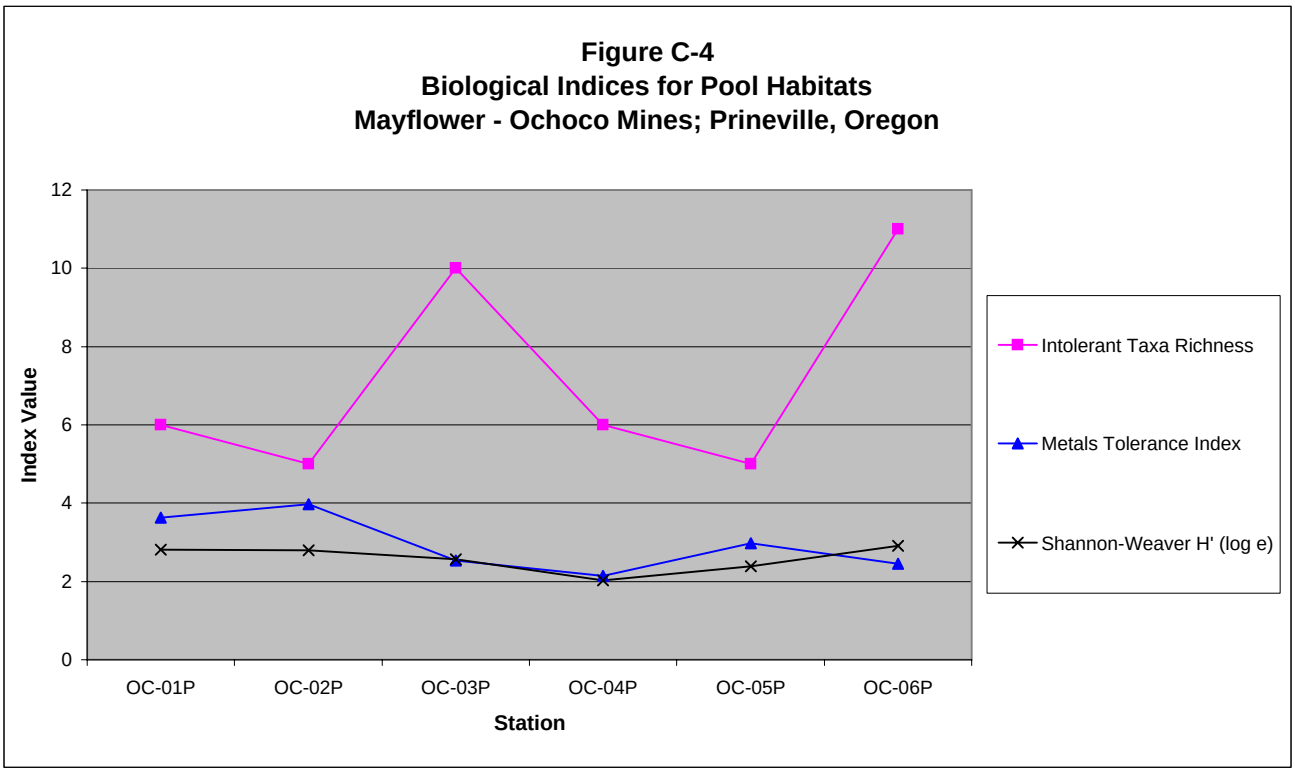
Figure C-4
Biological Indices for Pool Habitats
Mayflower - Ochoco Mines; Prineville, Oregon
Index Value
12
10
8
6
4
2
0
OC-01P
OC-02P
OC-03P
OC-04P
OC-05P
OC-06P
Station
Intolerant Taxa Richness
Metals Tolerance Index
Shannon-Weaver H' (log e)

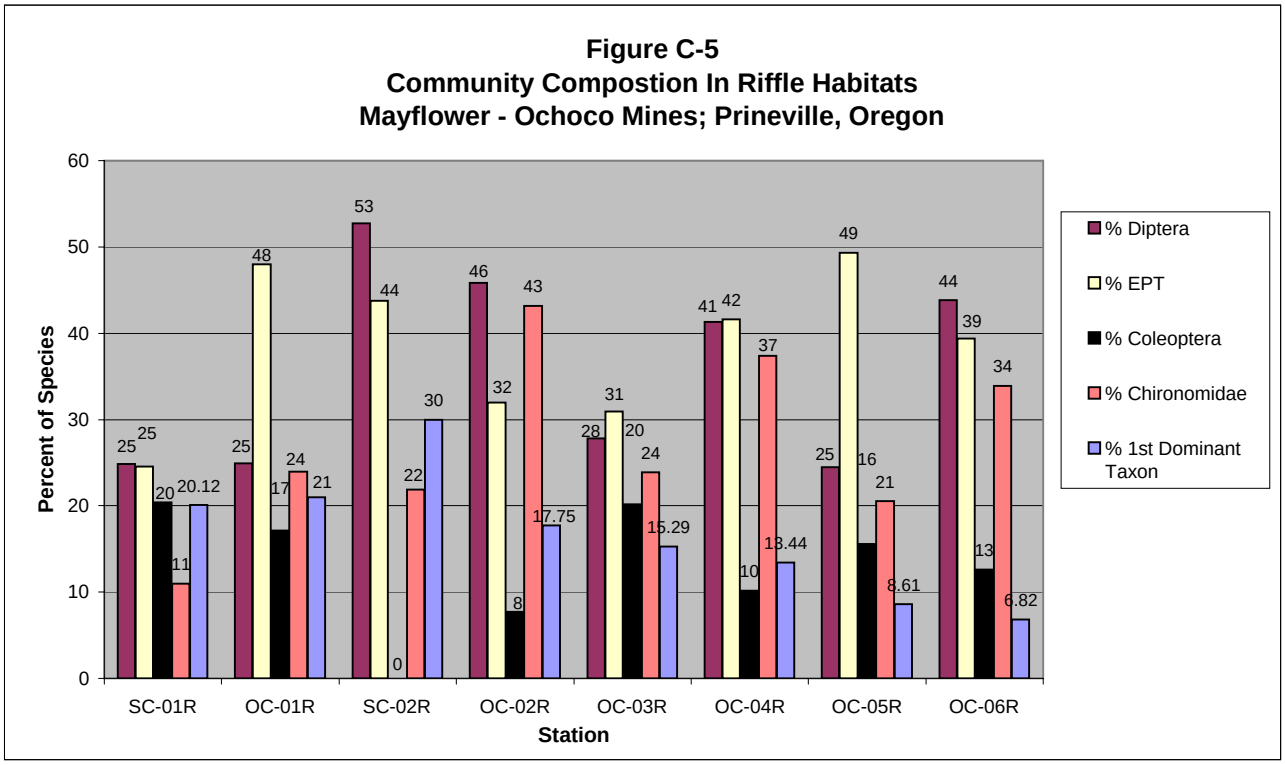
Figure C-5
Community Compostion In Riffle Habitats
Mayflower - Ochoco Mines; Prineville, Oregon
Percent of Species
Station
SC-01R
OC-01R
SC-02R
OC-02R
OC-03R
OC-04R
OC-05R
OC-06R
% Diptera
% EPT
% Coleoptera
% Chironomidae
% 1st Dominant Taxon

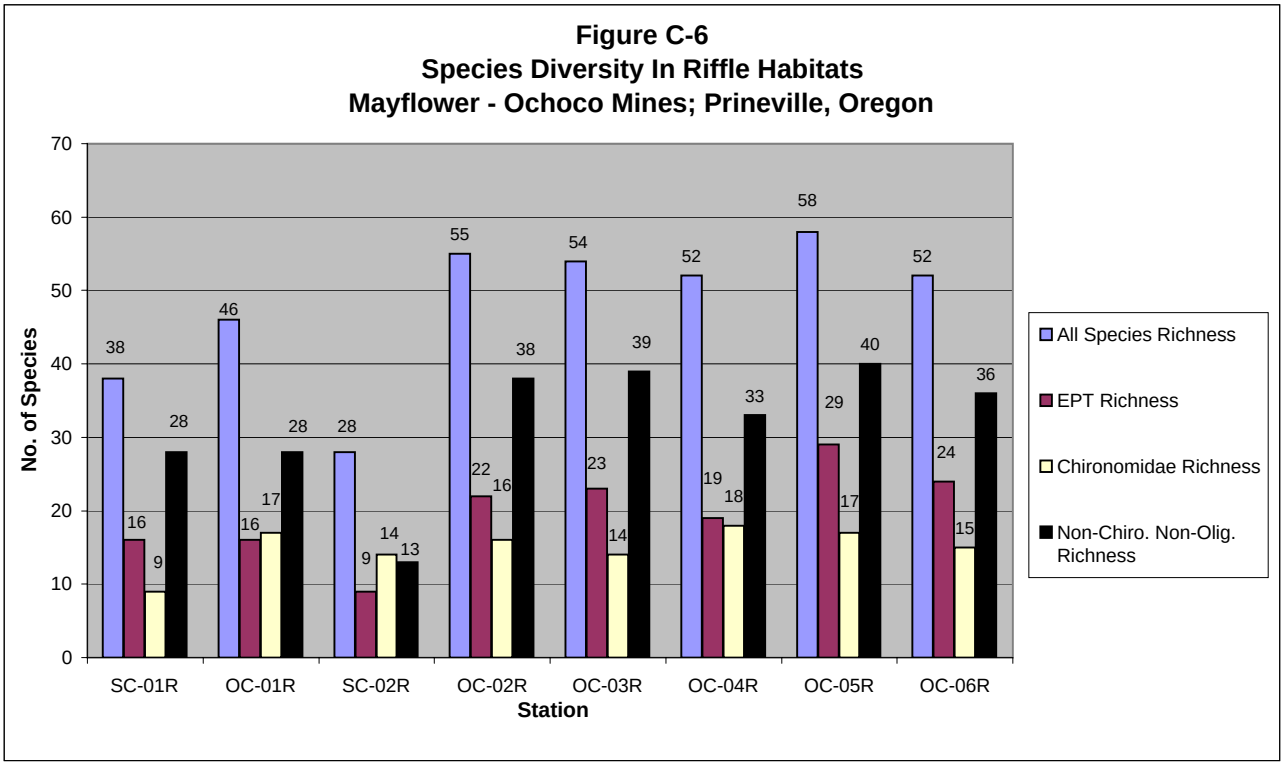
Figure C-6
Species Diversity In Riffle Habitats
Mayflower - Ochoco Mines; Prineville, Oregon
No. of Species
Station
SC-01R
OC-01R
SC-02R
OC-02R
OC-03R
OC-04R
OC-05R
OC-06R
All Species Richness
EPT Richness
Chironomidae Richness
Non-Chiro. Non-Olig. Richness

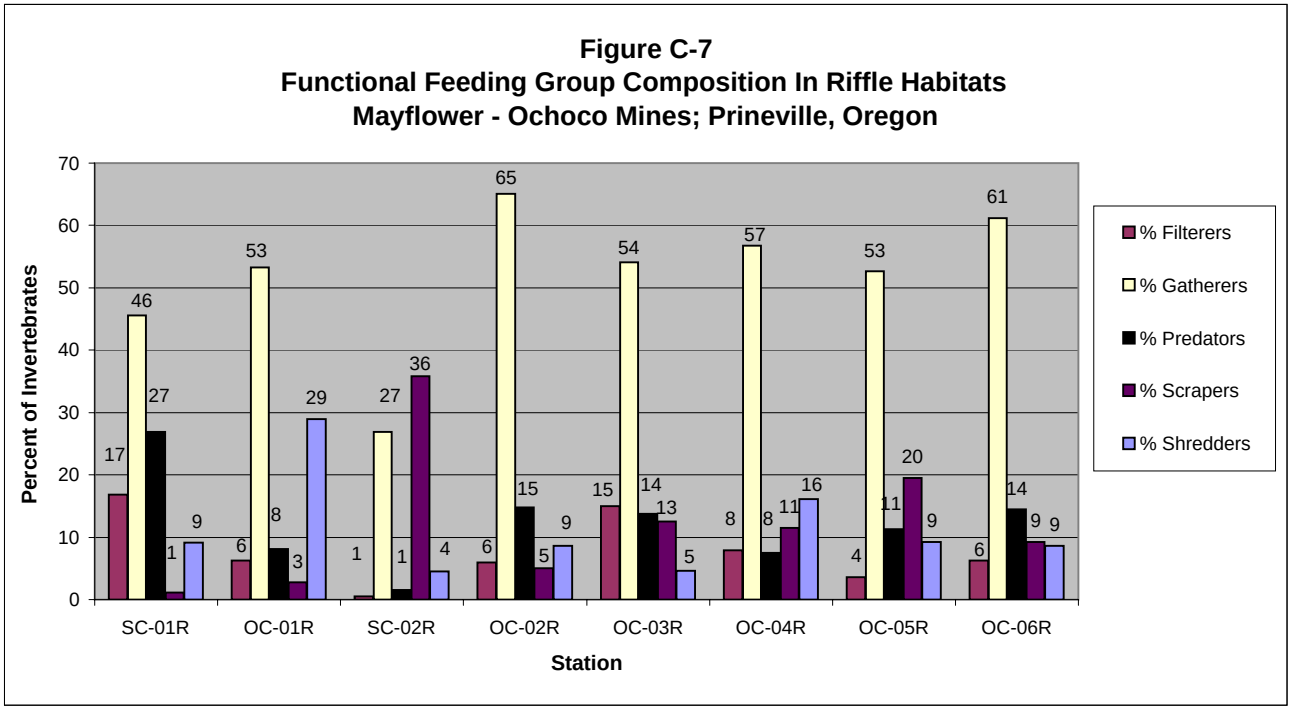
Figure C-7
Functional Feeding Group Composition In Riffle Habitats
Mayflower - Ochoco Mines; Prineville, Oregon
Percent of Invertebrates
70
60
50
40
30
20
10
0
17
46
27
1
9
6
53
8
3
29
1
27
1
36
4
6
65
15
5
9
15
54
14
13
5
8
57
8
11
16
4
53
11
20
9
6
61
14
9
9
SC-01R
OC-01R
SC-02R
OC-02R
OC-03R
OC-04R
OC-05R
OC-06R
Station
% Filterers
% Gatherers
% Predators
% Scrapers
% Shredders

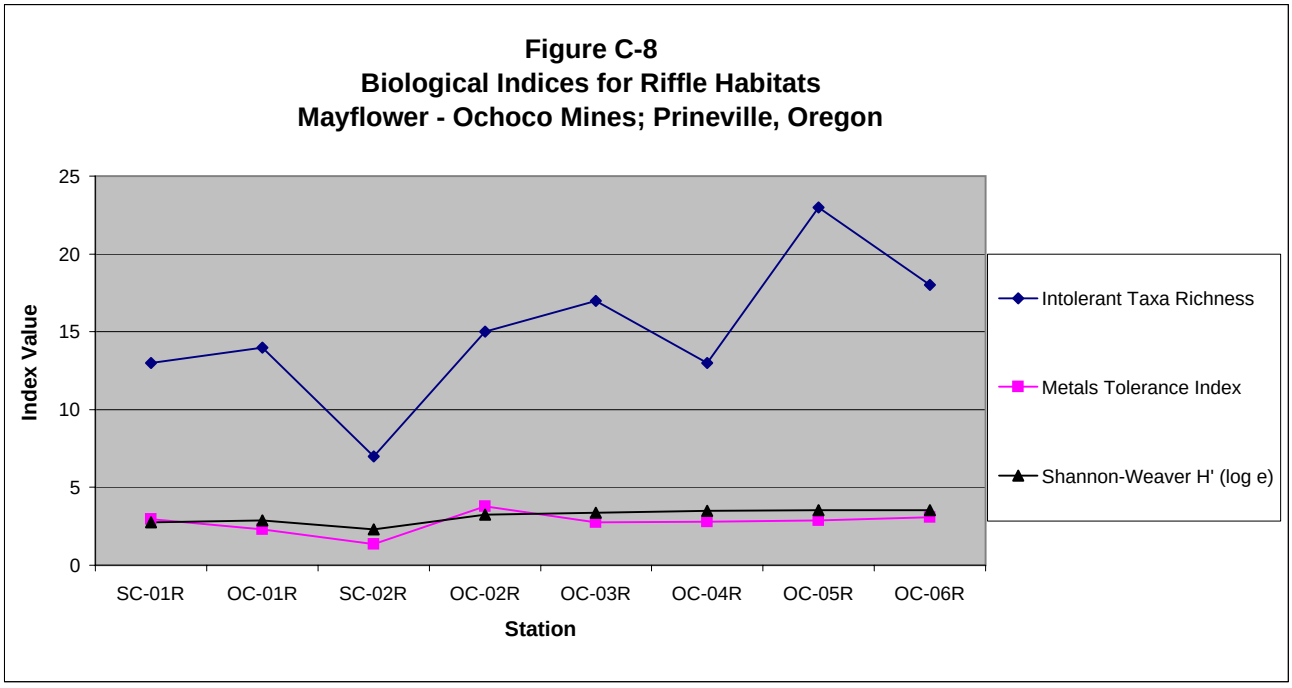
Figure C-8
Biological Indices for Riffle Habitats
Mayflower - Ochoco Mines; Prineville, Oregon
Index Value
25
20
15
10
5
0
SC-01R
OC-01R
SC-02R
OC-02R
OC-03R
OC-04R
OC-05R
OC-06R
Station
Intolerant Taxa Richness
Metals Tolerance Index
Shannon-Weaver H' (log e)

TABLES

TABLE C-1
SUMMARY OF RARE, THREATENED, OR ENDANGERED SPECIES IN THE VICINITY
MAYFLOWER - OCHOCO MINES
PRINEVILLE, OREGON

Common Name	Species Name	Oregon State Status	Federal Status	U.S. Forest Service Status	Observed/ Expected/ Possible
AQUATIC INVERTEBRATES					
None					
FISH					
Inland Columbia Basin red-band trout	*Oncorhyncus mykiss gairdnerii*	Vulnerable/Rare	Concern	Sensitive	Observed
PLANTS					
Peck's mariposa lily	***Calochortus longebarbatus var. peckii***	**Candidate/Rare**	**Concern**	**Sensitive**	**Expected**
Columbia yellowcress	*Rorippa columbiae*	Candidate/Rare		Sensitive	Possible
Este's artemesia	*Artemisia ludoviciana Nutt. ssp. estesii*	Imperiled	Concern		Possible
Ochoco lomatium	*Lomatium ochocense*	Critical	Concern	Sensitive	Possible
TERRESTRIAL INVERTEBRATES					
silver-bordered fritillary	*Boloria selene atrocostalis*	Imperiled	Possible	Sensitive	Possible
REPTILES AND AMPHIBIANS (HERPETILES)					
Western toad	***Bufo boreas***	**Vulnerable/Rare**	**Concern**		**Expected**
Columbia spotted frog	*Rana Lutieventris*	Candidate/ Imperiled	Concern		Possible
BIRDS					
Northern Flicker	*Colaptes auratus (Colaptes cafer)*			MIS	Observed
Lewis' Woodpecker	***Melanerpes lewis (Asyndesmus lewis)***	**Candidate/Imperiled**	**Concern**	**Sensitive**	**Expected**
loggerhead shrike	***Lanius ludovicianus***	**Vulnerable/Rare**	**Concern**		**Expected**
olive-sided flycatcher	***Contopus borealis***	**Vulnerable/Rare**	**Concern**		**Expected**
Pileated woodpecker	*Dryocopus pileatus*			MIS	Expected
three-toed woodpecker	***Picoides tridactylus***	**Candidate/Rare**		**Sensitive**	**Expected**
white-headed woodpecker	***Picoides albolarvatus (Dendrocopos albolarvatus)***	**Candidate/Imperiled**	**Concern**	**Sensitive**	**Expected**
American peregrin falcon	*FALCO PEREGRINUS ANATUM*		Concern	Rare	Possible
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened	Sensitive	Possible
band-tailed pigeon	*Columba fasciata*	Rare	Concern	Sensitive	Possible
black-backed woodpecker	*Picoides arcticus*	Candidate/Rare		Sensitive	Possible
ferruginous hawk	*BUTEO REGALIS*	Candidate/Rare	Concern	Sensitive	Possible
golden eagle	*Aquila chrysaetos*			Sensitive	Possible
gray flycatcher	*Empidonax wrightii*			Sensitive	Possible
mountain quail	*Oreortyx pictus*		Concern	Sensitive	Possible
Northern goshawk	*Accipiter gentilis*	Candidate/ Imperiled	Concern	Sensitive	Possible
American peregrine falcon	*Falco peregrinus anatum*	Endangered/Imperiled		Sensitive	Possible
Swainson's Hawk	*Buteo swainsoni*	Vulnerable/Rare			Possible
White-headed woodpecker	*Picoides albolarvatus*			MIS	Possible
MAMMALS					
Gray wolf	*Canis Lupus*		Threatened	Sensitive	Possible
long-eared myotis	*Myotis evotis*		Concern	Sensitive	Possible
long-legged myotis	*Myotis volans*	Rare	Concern	Sensitive	Possible
Townsend big-eared bat	*Plecotus townsendii townsendii*	Candidate/Imperiled	Concern	Sensitive	Possible
wolverine	*Gulo gulo luteus*	Threatened	Concern	Sensitive	Possible
yuma myotis	*Myotis yumanensis*		Concern		Possible

Notes:
Bold indicates a rare, threatened, or endangered species observed or expected at or near the Site.
Blank status indicates the species is not rare, threatened, or endangered under that jurisdiction.

TABLE C-2
OBSERVED PLANT SPECIES
MAYFLOWER - OCHOCO MINES
PRINEVILLE, WASHINGTON

Common Name	Scientific Name	Habitat Type	Estimated Percent Cover	Oregon Status	Federal Status	U.S. Forest Service Status
TREES						
Sitka alder	*Alnus sinuata*	Disturbed - Mine	<5			
western larch (tamarack)	*Larix occidentalis*	Disturbed - Mine	<5			
ponderosa pine	*Pinus ponderosa*	Disturbed - Mine	60			
ponderosa pine	*Pinus ponderosa*	Forest	70			
grand fir	*Abies grandis*	Forest	15			
black cottonwood	*Populus trichocarpa*	Riparian	<5			
grand fir	*Abies grandis*	Riparian	<5			
western juniper	Juniperus occidentalis	Riparian	<5			
Sitka alder	*Alnus sinuata*	Riparian	50			
ponderosa pine	*Pinus ponderosa*	Riparian	15			
trembling aspen	*Populus tremulloides*	Riparian	5			
SHRUBS						
black gooseberry	*Ribes lacustre*	Disturbed - Mine	<5			
Douglas fir (sapling)	*Pseudotsuga mensiezii*	Disturbed - Mine	10			
grand fir (sapling)	*Abies grandis*	Disturbed - Mine	10			
Oregon grape	*Mahonia aquifolium*	Disturbed - Mine	10			
saskatoon/serviceberry	*Amelanchier alnifolia*	Disturbed - Mine	5			
Snowberry	*Symphoricarpos albus*	Forest	10			
wild/baldhip rose	*Rosa gymnocarpa*	Forest	5			
chokecherry	*Prunus virginiana*	Riparian	<5			
tea-leaved willow	*Salix phylicifolia*	Riparian	<5			
Snowberry	*Symphoricarpos albus*	Riparian	50			
Small-flowered bulrush	*Scirpus macrocarpus*	Riparian	20			
Pacific willow	*Salix lucida*	Riparian	15			
GROUNDCOVER						
cow parsnip	*Heracleum lanatum*	Disturbed - Mine	<5			
false Solomon’s seal	*Smilacina racemosa*	Disturbed - Mine	<5			
Fendler's meadowrue	*Thalictrum fendleri*	Disturbed - Mine	<5			
fireweed	*Epilbium angustifolium*	Disturbed - Mine	<5			
lupine - silky	*Lupinus sericeus*	Disturbed - Mine	<5			
Richardson's geranium	*Geranium richarsonii*	Disturbed - Mine	<5			
sheep sorrel	*Rumex acetosella*	Disturbed - Mine	<5			
thistle, Canada	*Cirsium arvense*	Disturbed - Mine	<5			
thistle, spaced-out	*Circerum remotifolium*	Disturbed - Mine	<5			
grass, colonial bentgrass	*Agrostis capillaries*	Disturbed - Mine	50			
grass, Kentucky bluegrass	*Poa pratensis*	Disturbed - Mine	50			
sedge, elk	*Carex geyeri*	Disturbed - Mine	35			
grass, timothy	*Phleum pratense*	Disturbed - Mine	15			
California buttercup	*Ranunuculs californicus*	Disturbed - Mine	10			
orchard grass	*Dactylis glomerata*	Disturbed - Mine	10			
sweet-scented bedstraw	*Galium triflorum*	Disturbed - Mine	10			
blue stickseed/Jessica stickseed	*Hackelia micrantha*	Disturbed - Mine	7			
dandelion	*Taraxicum officianale*	Disturbed - Mine	7			
American vetch	*Vicia american*	Disturbed - Mine	5			
black medic	*Medicago lupulina*	Disturbed - Mine	5			
Blue-eyed mary	*Collinsia parviflora*	Disturbed - Mine	5			
large-leaved lupine	*Lupinus polyphyllus*	Disturbed - Mine	5			
Menzie's larkspur	*Delphinium menziesii*	Disturbed - Mine	5			
miner’s lettuce	*Claytonia perfoliata*	Disturbed - Mine	5			
mountain sweet cicely	*Osmorhiza chilensis*	Disturbed - Mine	5			
red columbine	*Aquilegia formosa*	Disturbed - Mine	5			
wild strawberry	*Fragaria virginiana*	Disturbed - Mine	5			
yarrow	*Achillea millefolium*	Disturbed - Mine	5			
sedge, elk	*Carex geyeri*	Forest	85			
grass, bentgrass	*Agrostis sp.*	Forest	10			

TABLE C-2
OBSERVED PLANT SPECIES
MAYFLOWER - OCHOCO MINES
PRINEVILLE, WASHINGTON

Common Name	Scientific Name	Habitat Type	Estimated Percent Cover	Oregon Status	Federal Status	U.S. Forest Service Status
grass, fescue species	*Festuca sp.*	Forest	10			
American vetch	*Vicia american*	Forest	5			
meadow birds-foot trefoil	*Lotus denticulata*	Forest	5			
Scouler's hawkweed	*Hieracium scouleri*	Forest	5			
western hound's tongue	*Cynoglossum occidentale*	Forest	5			
American bistort	*Bistorta bistortoides*	Riparian	<5			
common horsetail	*Equisetum arvense*	Riparian	<5			
Douglas water hemlock	*Cicuta douglasii*	Riparian	<5			
false Solomon’s seal	*Smilacina racemosa*	Riparian	<5			
fireweed	*Epilbium angustifolium*	Riparian	<5			
large-leaved arnica	*Arnica cordifolia*	Riparian	<5			
tall larkspur	*Delphinium glaucum*	Riparian	<5			
thistle, spaced-out	*Cirsium remotifolium*	Riparian	<5			
whitewater buttercup	*Ranunuculus aquatilis*	Riparian	<5			
grass, colonial bentgrass	*Agrostis capillaries*	Riparian	25			
small-flowered bulrush	*Scirpus macrocarpus*	Riparian	20			
sedge, northern clustered	Carex arcta	Riparian	15			
grass, timothy	*Phleum pratense*	Riparian	10			
cow parsnip	*Heracleum lanatum*	Riparian	5			
curly dock	*Rumex crispus*	Riparian	5			
cut-leaf geranium	*Geranium dissectum*	Riparian	5			
large leaved avens	*Geum macrophyllum*	Riparian	5			
meadow foam	*Limnanthes douglasii*	Riparian	5			
Menzie's delphinium		Riparian	<5			
sedge, elk	*Carex geyeri*	Riparian	5			
sedge, shore	*Carex lenticularis*	Riparian	<5			
sticky cinquefoil	*Potentilla glandulosa*	Riparian	5			

Notes:

Blank status indicates the species is not rare, threatened, or endangered.

TABLE C-3
TERRESTRIAL INVERTEBRATES
MAYFLOWER - OCHOCO MINES
PRINEVILLE, WASHINGTON

Common Name	Scientific Name	Federal Status	State Status	U.S. Forest Service Status	Observed/ Expected/ Possible
bees	Order *Hymenoptera*				Observed
black carpenter ants	*Camponotus pennsylvanicus*				Observed
black flies	*Simulium* sp.				Observed
mosquitos					Observed
butterflies and moths	Order *Lepidoptera*				Observed
red ants	*Formica* sp.				Observed
slug					Observed
spiders	Order *Araneae*				Observed
wasps	Order *Hymenoptera*				Expected
yellow jackets	*Vespula* sp.				Expected
alderflies	*Sialis* sp.				Expected
centipedes	Order *Chilopoda*				Expected
common black ground beetle	*Pterostichus* sp.				Expected
grasshoppers and crickets	Order *Orthoptera*				Expected
mayflies	Order *Ephemeroptera*				Expected
mites and ticks	Order *Acarina*				Expected
daddy-long-legs	Order Opiliones				Possible

Notes:

Bold indicates regulated or managed species observed or expected at the site.

Blank status indicates the species is not rare, threatened, or endangered.

TABLE C-4
DOCUMENTED OR EXPECTED BIRDS
MAYFLOWER - OCHOCO MINES
PRINEVILLE, OREGON

Common Name	Scientific Name	Oregon Status	Federal Status	U.S. Forest Service Status	Observed/ Expected/ Possible
American robin	*Turdus migratorius*				Observed
Brewer's Blackbird	*Euphagus cyanocephalus*				Observed
common raven	*Corvus corax*				Observed
dark-eyed junco (slate-colored)	*Junco hyemalis*				Observed
dusky flycatcher (Wright's flycatcher)	*Empidonax oberholseri*				Observed
golden-crowned kinglet	*Regulus satrapa*				Observed
hairy woodpecker	*Picoides villosus (Dendrocopos villosus)*				Observed
MacGillivray's warbler	*Oporornis tolmiei*				Observed
northern flicker	*Colaptes auratus (Colaptes cafer)*			MIS	Observed
pine siskin	*Carduelis pinus (Spinus pinus)*				Observed
red-breasted nuthatch	*Sitta canadensis*				Observed
red-tailed hawk	*Buteo jamaicensis*				Observed
song sparrow	*Melospiza melodia*				Observed
Steller's jay	*Cyanocitta stelleri*				Observed
Swainson's thrush	*Catharus ustulata (Hylocichla ustulata)*				Observed
Townsend's solitaire	*Myadestes townsendi*				Observed
warbling vireo	*Vireo gilvus*				Observed
yellow-rumped warbler	*Dendroica coronata*				Observed
American crow	*Corvus brachyrhynchos*				Expected
American dipper	*Cinclus mexicanus*				Expected
barred owl	*Strix varia*				Expected
belted kingfisher	*Megaceryle alcyon*				Expected
Black-billed Magpie	*Pica pica*				Expected
black-headed grosbeak	*Pheucticus melanocephalus*				Expected
Bohemian Waxwing	*Bombycilla garrula*				Expected
brown creeper	*Certhia familiaris*				Expected
brown-headed Cowbird	*Molothrus ater*				Expected
Calliope hummingbird	*Stellula calliope*				Expected
cedar waxwing	*Bombycilla cedrorum*				Expected
chipping sparrow	*Spizella passerine*				Expected
common nighthawk	*Chordeiles minor*				Expected
downy woodpecker	*Picoides pubescens (Dendrocopos pubescens)*				Expected
flammulated owl	***Otus Flammeolus***	**Candidate**			**Expected**
fox sparrow	*Passerella iliaca*				Expected
great horned owl	*Bubo virginianus*				Expected
Hammond's flycatcher	*Empidonax hammondii*				Expected
hermit thrush	*Catharus guttatus (Hylochichla guttata)*				Expected
Lewis' Woodpecker	***Melanerpes lewis (Asyndesmus lewis)***	**Candidate/Imperiled**	**Concern**	**Sensitive**	**Expected**
loggerhead shrike	*Lanius ludovicianus*	**Vulnerable/Rare**	**Concern**		Expected
mountain chickadee	*Parus gambeli*				Expected
olive-sided flycatcher	***Contopus borealis***	**Vulnerable/Rare**	**Concern**		**Expected**
orange-crowned warbler	*Vermivora celata*				Expected
pileated woodpecker	***Dryocopus pileatus***	**Candidate**		**MIS**	**Expected**
poor-will	*Phalaenoptilus nuttallii*				Expected
pygmy nuthatch	*Sitta pygmaea*				Expected
pygmy owl	*Glaucidium gnoma*				Expected
red crossbill	*Loxia curvirostra*				Expected
red-winged blackbird	*Agelaius phoeniceus*				Expected
ruby-crowned kinglet	*Regulus calendula*				Expected
saw-whet owl	*Aegolius acadicus*				Expected
screech owl	*Otus asio*				Expected
sharp-shinned hawk	*Accipiter striatus*				Expected
spotted towhee	*Pipilo erythrophthalmus*				Expected
three-toed woodpecker	***Picoides tridactylus***	**Candidate/Rare**		**Sensitive**	**Expected**
turkey vulture	*Cathartes aura*				Expected
varied thrush	*Ixoreus naevius*				Expected
violet-green Swallow	*Tachycineta thalassina*				Expected
western bluebird	*Sialia mexicana*				Expected
western flycatcher	*Empidonax difficilis*				Expected
western tanager	*Piranga ludoviciana*				Expected
western wood pewee	*Contopus sordidulus*				Expected
white-breasted nuthatch	*Sitta carolinensis*				Expected
white-crowned sparrow	*Zonotrichia leucophrys*				Expected
white-headed woodpecker	***Picoides albolarvatus (Dendrocopos albolarvatus)***	**Candidate/Imperiled**	**Concern**	**Sensitive**	**Expected**
Williamson's sapsucker	*Sphyrapicus thyroideus*				Expected
willow flycatcher (Traill's flycatcher)	*Empidonax traillii*	**Rare**	**Concern**	**Sensitive**	Expected
yellow warbler	*Dendroica petechia*				Expected

TABLE C-4
DOCUMENTED OR EXPECTED BIRDS
MAYFLOWER - OCHOCO MINES
PRINEVILLE, OREGON

Common Name	Scientific Name	Oregon Status	Federal Status	U.S. Forest Service Status	Observed/ Expected/ Possible
yellow-bellied sapsucker	*Sphyrapicus varius*				Expected
American redstart	*Wetophaga ruticilla*				Possible
ash-throated flycatcher	*Myiarchus cinerascens*				Possible
bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened	Sensitive	Possible
band-tailed pigeon	*Columba fasciata*	Rare	Concern	Sensitive	Possible
black-backed woodpecker	*Picoides arcticus*	Candidate/Rare		Sensitive	Possible
black-chinned hummingbird	*Archilochus alexandri*				Possible
black-throated gray warbler	*Dendroica nigrescens*				Possible
blue grouse	*Dendragapus obscurus*				Possible
bushtit	*Psaltriparus minimus*				Possible
California quail	*Callipepla californica*				Possible
Cassin's Finch	*Carpodacus cassinii*				Possible
Cooper's hawk	*Accipiter cooperii*				Possible
evening grosbeak	*Hesperiphona vespertina*				Possible
golden eagle	*Aquila chrysaetos*			Sensitive	Possible
gray flycatcher	*Empidonax wrightii*		Threatened	Sensitive	Possible
gray jay	*Perisoreus canadensis*				Possible
Lazuli Bunting	*Passerina amoena*				Possible
Lincoln's Sparrow	*Melospiza lincolnii*				Possible
long-eared owl	*Asio otus*				Possible
mountain bluebird	*Sialia currucoides*				Possible
northern goshawk	*Accipiter gentilis*	Candidate/Imperiled			Possible
northern oriole (Bullock's oriole)	*Icterus galbula (Icterus bullockii)*				Possible
northern shrike	*Lanius excubitor*				Possible
osprey	*Pandion haliaetus*				Possible
American peregrine falcon	*Falco peregrinus anatum*	Endangered/Imperiled		Sensitive	Possible
purple finch	*Carpodacus purpureus*				Possible
red-breasted sapsucker	*Sphyrapicus ruber*				Possible
red-naped sapsucker	*Sphyrapicus nuchalis*				Possible
ruffed grouse	*Bonasa umbellus*				Possible
rufous hummingbird	*Selasphorus rufus*				Possible
Say's phoebe	*Sayornis saya*				Possible
solitary vireo	*Vireo solitarius*				Possible
Swainson's Hawk	***Buteo swainsoni***	**Vulnerable/Rare**			**Possible**
Townsend's warbler	*Dendroica townsendi*				Possible
turkey	*Meleagris gallopavo*				Possible
western kingbird	*Tyrannus verticalis*				Possible
white-winged crossbill	*Loxia leucoptera*				Possible
Wilson's warbler	*Wilsonia pusilla*				Possible

Notes:

Bold indicates regulated or managed species observed or expected at the site.

Blank status indicates the species is not rare, threatened, or endangered.

TABLE C-5
DOCUMENTED OR EXPECTED MAMMALS
MAYFLOWER - OCHOCO MINES
PRINEVILLE, OREGON

Common Name	Scientific Name	Washington Status	Oregon Status	Federal Status	U.S. Forest Service Status	Observed/ Expected/ Possible
mule deer	*Odocoileus hemionus hemionus*					Observed
Rocky Mountain Elk	*Cervus canadensus nelsoni*				MIS	Observed
big brown bat	***Eptisicus fuscus***				**Sensitive**	**Expected**
black bear	*Ursus americanus*					Expected
bobcat	*Lynx rufus*					Expected
coyote	*Canis latrans*					Expected
deer mouse	*Peromyscus maniculatus*					Expected
least chipmunk	*Eutamias minimus*					Expected
longtail weasel	*Mustela frenata*					Expected
mink	*Mustela vision*					Expected
mountain cottontail	*Sylvilagus nuttalli*					Expected
cougar (mountain lion)	*Felis concolor*					Expected
mountain vole	*Microtus montanus*					Expected
raccoon	*Procyon lotor*					Expected
red fox	*Vulpes fulva*					Expected
yellow pine chipmunk	*Eutamias amoenus*					Expected
badger	*Taxidea taxus*					Possible
beaver	*Castor canadensis*					Possible
big freetail bat	*Tadarida molossa*					Possible
bushytail woodrat	*Neotoma cinerea*					Possible
California myotis	*Myotis californicus*					Possible
fisher	*Martes pennanti*	Endangered	Critical	Concern	Sensitive	Possible
fringed myotis	*Myotis thysanodes*	Vulnerable		Concern	Sensitive	Possible
golden-mantled ground squirrel	*Spermophilus lateralis*					Possible
gray fox	*Urocyon cinereoargenteus*					Possible
gray wolf	*Canis lupus*		Endangered	Threatened	Sensitive	Possible
hoary bat	*Felis concolor*					Possible
little brown myotis	*Myotis lucifugus*				Sensitive	Possible
long-eared myotis	*Myotis evotis*			Concern	Sensitive	Possible
long-legged myotis	*Myotis volans*		Rare	Concern	Sensitive	Possible
longtail vole	*Microtus longicaudus*					Possible
marten	*Martes americana*				Sensitive	Possible
Merriam's Shrew	*Sorex merriami*					Possible
northern grasshopper mouse	*Onychomys leucogaster*					Possible
northern pocket gopher	*Thomomys talpoides*					Possible
Pacific fringe-tailed Bat	*Myotis thysanodes vespertinus*				Sensitive	Possible
pallid bat	*Antozous pallidus*	Vulnerable	Vulnerable/Imperiled	Concern	Sensitive	Possible
River Otter	*Lutra canadensis*					Possible
shorttail weasel (ermine)	*Mustela erminea*					Possible
silver-haired bat	*Lasionycteris noctivagans*				Sensitive	Possible
small-footed myotis	*Myotis leibii*		Rare	Concern		Possible
spotted skunk	*Spilogale putorius*					Possible
striped skunk	*Mephitis mephitis*					Possible
Townsend big-eared bat	*Plecotus townsendii townsendii*	Candidate	Candidate/Imperiled	Concern	Sensitive	Possible
vagrant shrew	*Sorex vagrans*					Possible
westerm pipistrel	*Pipistrellus hesperus*					Possible
western big-eared bat	*Plecotus townsendii*	Critical		Concern	Sensitive	Possible
wolverine	*Gulo gulo luteus*		Threatened	Concern	Sensitive	Possible
yellow-bellied marmot	*Marmota flaviventris*					Possible
yuma myotis	*Myotis yumanensis*			Concern		Possible
aplodontia (mountain beaver)	*Aplodontia rufa*					
Baird's Shrew	*Sorex bairdii bairdii*				Sensitive	
Belding ground squirrel	*Citellus beldingi*					
bighorn sheep	*Ovis canadensis*					
blacktail jackrabbit	*Lepus californicus*					
boreal redback vole	*Clethrionomys gapperi*					
brush rabbit	*Sylvilagus bachmani*					
Californai redback vole	*Clethrionomys occidentalis*					
California ground squirrel	*Citellus beecheyi*					
Canada lynx	***Lynx canadensis***	**Threatened**		**Threatened**	**Sensitive**	
Cascade golden-mantled ground squirre	*Citellus sateratus*					
coast mole (Pacific mole)	*Scapanus ororius*					
Columbia blacktailed deer	***Odocoileus hemionus columbianus***	**Priority**				
Columbian ground squirrel	*Citellus columbianus*					
dark kangaroo mouse	*Microdipodops megacephalus*					
douglas squirrel (chickaree)	*Tamiasciurus douglasi*					
dusky shrew	*Sorex obscurus*					
dusky-footed woodrat	*Neotoma fuscipes*					
elk	*Cervus canadensis*					
giant pocket gopher	***Thomomys bulbivorus***					
Great Basin kangaroo rat	*Dipodomys microps*					
Great Basin pocket mouse	*Perognathus parvus*					
grizzly bear	***Ursus arctos***			**Threatened**		
Heerman kangaroo rat	*Dipodomys heermanni*					
hoary marmot	*Marmota caligata*					
house mouse	*Mus musculus*					
Keen's myotis	***Myotis keenii***	**Candidate**				
masked shrew	*Sorex cinereus*					
Mazama pocket gopher	*Thomomys mazama*					
meadow vole	*Microtus pennsylvanicus*					
moose	*Alces alces*					
mountain goat	*Oreamnos americanus*					
mountain phenacomys (heather vole)	*Phenacomys intermedius*					
muskrat	*Ondatra zibethica*					
northern bog lemmiing	*Synaptomys borealis*					
northern flying squirrel	*Glaucomys sabrinus*					
northern water shrew	*Sorex palustris*					
Norway rat	*Rattus norvegicus*					
Nuttal's Cottontail	*Sylvilagus nuttalli*					
Olympic marmot	*Marmota olympus*					
opossum	*Didelphis marsupialis*					
Ord kangaroo rat	*Dipodomys ordi*					
Oregon vole	*Microtus oregoni*					
Pacific Jumping Mouse	*Zapus trinotatus*					
Pacific phenacomys	*Phenacomys albipes*					
pika	*Ochotona princeps*					
porcupine	*Erethizon dorsatum*					
Preble's shrew	***Sorex preblei***	**Concern**			**Sensitive**	
Pronghorn antelope	*Antilocapra americana*					
Pygmy rabbit	*Sylvilagus idahoensis*					
pygmy shrew	*Microsorex hoyi*					
red bat	*Lasiurus borealis*					
red squirrel	*Tamiasciurus hudsonicus*					
red tree vole	***Aborimus longicaudus***				**Sensitive**	
Roosevelt elk	***Cervus elaphus roosevelti***	**Priority**			**Sensitive**	
Roosevelt elk	***Cervus elaphu rooseveltii***				**Sensitive**	
sagebrush vole	*Lagurus curtatus*					
shrew-mole	*Neuotrichus gibbsi*					
snowshoe hare	*Lepus americanus*					
Townsend big-eared bat	***Plecotus townsendii townsendii***	**Candidate**		**Concern**	**Sensitive**	
Townsend vole	*Microtus townsendi*					
Townsend's chipmunk	*Eutamias townsendi*					
Townsend's ground squirrel	*Citellus townsendi*					
tree phenacomys	*Phenacomys longicaudus*					
Trowbridge's shrew	*Sorex trowbridgei*					
Washington ground squirrel	*Citellus washingtoni*					
water vole (Richardson vole)	*Microtus richardsoni*					
western gray squirrel	***Sciurus griseus***			**Concern**		
western harvest mouse	*Reithrodontomys megalotis*					
western jumping mouse	*Zapus princeps*					
whitetail deer	*Odocoileus virginianus*					
whitetail jackrabbit	*Lepus tonsendi*					
woodchuck	*Marmota monax*					

Notes:
Bold indicates regulated or managed species observed, or expected at the site.
Blank status indicates the species is not rare, threatened, or endangered.

TABLE C-6
DOCUMENTED OR EXPECTED AMPHIBIANS AND REPTILES
MAYFLOWER - OCHOCO MINES
PRINEVILLE, OREGON

Common Name	Scientific Name	Federal Status	Washington Status	Oregon Status	U.S. Forest Service Status	Observed/ Expected/ Possible
AMPHIBIANS						
Pacific treefrog	*Hyla regilla*					Expected
western toad	***Bufo boreas***	**Concern**	**Candidate**	**Vulnerable/Rare**		**Expected**
Great basin spadefoot	*Scaphiopus intermontanus*					Possible
long-toed salamander	*Ambystoma macrodactylum*					Possible
northern leopard frog	***Rana pipiens***			**Critical**		**Possible**
Columbia spotted frog	***Rana luteiventris***			**Candidate/ Imperiled**	**Sensitive**	**Possible**
REPTILES						
common garter snake	*Thamnophis sirtalis*					Observed
rubber boa	*Charina bottae*					Expected
Western garter snake	*Thamnophis elegans*					Expected
Western skink	*Eumeces skiltonianus*					Expected
Gopher snake (bull snake)	*Pituophis melanoleucus*					Possible
Western fence lizard	*Sceloporus occidentalis*					Possible
Western rattlesnake	***Crotalus viridis***			**Vulnerable**		**Possible**

Notes:

Bold indicates regulated or managed species observed, expected, or possible at the site.

Blank status indicates the species is not rare, threatened, or endangered.

TABLE C-7
DOCUMENTED AQUATIC INVERTEBRATE SPECIES
MAYFLOWER - OCHOCO MINES
PRINEVILLE, OREGON

Taxonomic Group	Scientific Name
Ephemeroptera	Ameletus sp.
	Baetis sp.
	Baetis tricaudatus
	Centroptilum sp.
	Cinygma sp.
	Cinygmula sp.
	Diphetor hageni
	Drunella coloradensis/flavilinea
	Drunella doddsi
	Drunella sp.
	Drunella spinifera
	Epeorus longimanus
	Epeorus sp.
	Ephemerella inermis/infrequens
	Ephemerellidae
	Heptageniidae
	Ironodes sp.
	Paraleptophlebia sp.
	Rhithrogena sp.
	Serratella sp.
	Serratella teresa
	Serratella tibialis
Odonata	Cordulegaster dorsalis
	Cordulegaster sp.
Plecoptera	Calineuria californica
	Capniidae
	Chloroperlidae
	Doroneuria sp.
	Eucapnopsis brevicauda
	Hesperoperla pacifica
	Leuctridae
	Malenka sp.
	Perlodidae
	Plumiperla sp.
	Suwallia sp.
	Sweltsa sp.
	Taeniopterygidae
	Visoka cataractae
	Yoraperla sp.
	Zapada oregonensis gr.
	Zapada sp.
Coleoptera	Chrysomelidae
	Cleptelmis addenda
	Heterlimnius sp.
	Hydraena sp.
	Lara sp.
	Narpus sp.
	Optioservus sp.
	Oreodytes sp.
	Sanfillipodytes sp.
	Zaitzevia sp.
Megaloptera	Sialis sp.
Diptera-Chironomidae	Alotanypus sp.
	Brillia sp.
	Chaetocladius sp.
	Corynoneura sp.
	Cricotopus (Nostoc.) nostocicola
	Cricotopus sp.
	Eukiefferiella brehmi gr.
	Eukiefferiella brevicalcar gr.
	Eukiefferiella claripennis gr.
	Eukiefferiella coerulescens gr.
	Eukiefferiella devonica gr.
	Eukiefferiella gracei gr.
	Eukiefferiella tirolensis
	Heleniella sp.
	Heterotrissocladius marcidus gr.
	Hydrobaenus sp.
	Krenosmittia sp.
	Larsia sp.
	Macropelopia sp.
	Macropelopiini
	Micropsectra sp.
	Microtendipes rydalensis gr.
	Monodiamesa sp.
	Odontomesa sp.
	Orthocladius (Symp.) lignicola
	Orthocladius Complex
	Orthocladius sp.

Taxonomic Group	Scientific Name
Diptera-Chironomidae (continued)	Pagastia sp.
	Paracladopelma sp.
	Parametriocnemus sp.
	Paratendipes sp.
	Parorthocladius sp.
	Pentaneura sp.
	Polypedilum sp.
	Pseudodiamesa sp.
	Psilometriocnemus sp.
	Radotanypus sp.
	Reomyia sp.
	Rheocricotopus sp.
	Rheotanytarsus sp.
	Stempellinella sp.
	Tanytarsus sp.
	Thienemanniella sp.
	Thienemannimyia gr. sp.
	Tvetenia bavarica gr.
	Zavrelimyia sp.
Diptera	Antocha sp.
	Bezzia/Palpomyia sp.
	Ceratopogon sp.
	Ceratopogoninae
	Dicranota sp.
	Glutops sp.
	Hexatoma sp.
	Neoplasta sp.
	Pericoma/Telmatoscopus sp.
	Pilaria sp.
	Probezzia sp.
	Prosimulium sp.
	Ptychoptera sp.
	Simulium sp.
	Stilobezzia sp.
	Syrphidae
	Tabanidae
	Twinnia sp.
Trichoptera	Amiocentrus aspilus
	Chyranda centralis
	Dicosmoecus gilvipes
	Glossosomatidae
	Heteroplectron californicum
	Hydropsyche sp.
	Hydroptila sp.
	Lepidostoma sp.
	Limnephilidae
	Micrasema sp.
	Neophylax rickeri
	Neophylax sp.
	Onocosmoecus sp.
	Parapsyche sp.
	Philopotamidae
	Polycentropodidae
	Psychoglypha sp.
	Rhyacophila betteni gr.
	Rhyacophila brunnea gr.
	Rhyacophila narvae
	Rhyacophila sp.
	Wormaldia sp.
Gastropoda	Menetus opercularis
	Physa (Physella) sp.
Bivalvia	Pisidium sp.
Annelida	Oligochaeta
Acari	Acari
	Atractides sp.
	Estelloxus sp.
	Lebertia sp.
	Mideopsis sp.
	Oribatei
	Protzia sp.
	Sperchon sp.
	Sperchonopsis sp.
	Testudacarus sp.
	Torrenticola sp.
	Wandesia sp.
Crustacea	Ostracoda
Other Organisms	Nematoda
	Polycelis sp.

Appendix D.

Human and Ecological Risk Assessments

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

Mayflower – Ochoco Mine Complex
Ochoco National Forest
Crook County, Oregon

Prepared For

USDA Forest Service
Ochoco National Forest

on behalf of

Cascade Earth Sciences
P.O. Box 14725
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November 2005

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FIGURE 3-1: Conceptual Human Health Exposure Model
FIGURE 4-1: Conceptual Ecological Exposure Model

APPENDIX D1: Initial Screening Results (USFS Project File)
APPENDIX D2: Human Health Risk Calculations (USFS Project File)
APPENDIX D3: Ecological Scoping Checklist (USFS Project File)
APPENDIX D4: Ecological Risk-Based Screening Tables (USFS Project File)

ACRONYMS

APA	Abbreviated Preliminary Assessment
bgs	below ground's surface
CEEM	conceptual ecological exposure model
CES	Cascade Earth Sciences
COI	chemical of interest
COPC	chemical of potential concern for human health
COPEC	chemical of potential ecological concern
ODEQ	Oregon Department of Environmental Quality
ERA	ecological risk assessment
ERBSC	ecological risk-based screening concentration
HHRA	human health risk assessment
PA	Preliminary Assessment
PRG	Preliminary Remediation Goals
SI	Site Inspection
SOC	species of concern
RTE	rare, threatened, or endangered
TAS	Technical Assessment Services
90UCL	90th percentile upper confidence limit on the arithmetic mean
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service

1.0 INTRODUCTION

Potential human health and ecological risks associated with mining-related contamination at the Mayflower - Ochoco Mines Complex (Site) were assessed as part of the Site Inspection (SI) through a streamlined risk assessment process. The mines are located near each other, approximately 42 km (26 miles) and 45 km (28 miles) east of Prineville, Oregon, respectively. Due to the small size and close proximity of the two mines, data sets were combined for purposes of the risk evaluation. The risk assessment process follows U.S. Environmental Protection Agency (USEPA) and Oregon Department of Environmental Quality (ODEQ) guidelines. Potential risks and hazards were evaluated using site-specific concentrations of chemicals of interest (COIs) and selected exposure pathways. Section 2.0 describes the data used for the risk analysis. The human health risk assessment (HHRA) and ecological risk assessment (ERA) are presented in Sections 3.0 and 4.0, respectively. Conclusions and recommendations based on the results of the risk assessments are presented in Section 5.0. All appendices are located in the USFS Project File.

2.0 RISK ASSESSMENT DATA AND INITIAL SCREENING

This section describes the data set used in this risk analysis and the preliminary screening for the HHRA and ERA. Data was selectively collected in areas where contamination was known or suspected to occur. Therefore, the data set is skewed towards an understanding of the level of contamination onsite rather than to provide characterization across and surrounding the extent of mine-related impacts. Because of the metal mining that occurred at the Site, metals were the COIs. Analytical results were initially screened against detection frequency, background concentrations, and reporting limits. Those chemicals that met the screening criteria or are considered essential nutrients were removed from further consideration. The remaining chemicals were further evaluated in the HHRA and ERA sections of the report.

The data used in the risk assessment are from soil, wasterock, tailings, surface water, pore water, and sediment samples collected during June 2005. Up to 42 surface soil, wasterock, and tailings samples; 4 subsurface soil, wasterock, and tailings samples; 6 surface water samples (including one adit water sample); 5 pore water samples; and 6 sediment samples were analyzed primarily for metals. In addition, 8 soil samples, 3 surface water samples, 3 pore water samples, and 3 sediment samples were collected to represent background conditions and analyzed primarily for metals. Total or total recoverable concentrations of COIs were analyzed and used in the HHRA and the ERA, except in pore water for which only dissolved COI concentrations were determined and used. Standard laboratory quality control procedures were used and analytical results were quality assured by the laboratory. Qualifiers were applied to the data by the laboratory and these were incorporated into determinations of the usability of the data for the risk assessment. Other than 9 soil samples with rejected methyl mercury analytical results, the analytical data were considered good quality and useable for the risk assessment. The rejected methyl mercury results had poor surrogate recovery because of interference between methyl mercury and silver. The soil, wasterock, tailings, surface water, pore water, and sediment data were then used in the initial screening, and in the HHRA and ERA as summarized in sections 3.0 and 4.0, respectively. Overall, the data were collected from locations that are likely to overestimate the concentrations found across the Site because samples were located to represent the areas of highest COI concentrations, not areas representative of overall human and ecological receptor exposure. This is a conservative approach that is appropriate for screening level risk assessments.

Initially, all data collected during the SI and deemed appropriate for use in the risk assessment were used to calculate the 90% percentile upper confidence level on the arithmetic mean (90UCL) for each medium. The 90UCL is an upper-bound (i.e., conservative) estimate of mean chemical concentration and is specified as an appropriate exposure point concentration (EPC) in Oregon's Revised Cleanup Rules (OAR 340-122-084). If fewer than 10 samples are available in a given medium, it is inappropriate to

calculate a 90UCL (USEPA 2003). In these cases and if the calculated 90UCL exceeded the maximum detected concentration, the maximum detected concentrations was used as an appropriate substitute for the 90UCL. The equations used to calculate the 90UCL are provided by the USEPA (1997). A data summary, including the calculated 90UCL is provided in Tables D1-1 through D1-5 in Appendix D1.

The data were then screened using the ODEQ's Guidance for Conduct of Deterministic Risk Assessments (1998), which allows for prescreening of COIs based on the following criteria:

- Essential Nutrients: calcium, magnesium, potassium, and sodium were removed from further assessment because they are considered to be essential nutrients.
- Frequency of Detection: COIs in each medium that were detected in 5% or less of the samples site-wide were removed from further assessment. This includes assurance that the detection limits of undetected COIs are below risk-based screening and background concentrations.
- Background: $90\%_{UCL}$ or maximum (as described above) concentrations of naturally-occurring chemicals that were present at concentrations less than maximum background concentrations were eliminated from further assessment.

The results of these initial screening procedures for each potential exposure medium are also shown in Tables D1-1 through D1-5 in Appendix D1. The tables also show a sample reporting limit screening to ensure that undetected chemicals had detection limits below background and lowest applicable risk-based screening concentrations.

3.0 HUMAN HEALTH RISK ASSESSMENT

A human health risk evaluation is an analysis of the potential adverse health effects that could result from current or future exposures to hazardous substances released from a site, in the absence of any action to control or mitigate these releases. The objective of this evaluation is to incorporate analytical data and information on potential human exposure to the COIs in order to provide a baseline assessment of the potential for human health risks to be realized due to Site-related contamination. The following are primary elements of the HHRA:

- **Hazard Identification and Selection of Contaminants of Potential Concern (COPCs)**
  Evaluation of site data and identification of elevated concentrations of COIs in human health exposure media.

- **Exposure assessment**
  Identification of areas that pose human health risks under current or potential future site uses and conservative estimation of exposure.

- **Toxicity assessment**
  Quantification of the relationship between chemical exposure and adverse effects.

- **Risk characterization**
  Development of quantitative risk estimates using exposure and toxicity information previously developed for the COPCs.

3.1 HAZARD IDENTIFICATION AND SELECTION OF COPCS

This section presents the rationale for the selection of the COPCs. Prescreening of the COIs was described in Section 2.0. The media of interest for human health included soil, wasterock, tailings, surface water, and sediment. Those COIs that were retained for further assessment following the initial screening

are shown in the last column of Tables D1-1 through D1-4 for surface soil, subsurface soil, surface water (including one adit water sample), and sediment, respectively. Maximum concentrations of these COIs were screened against USEPA Region IX Preliminary Remediation Goals (PRGs). Industrial PRGs were selected as the most appropriate screening criteria for soils and sediment; and tap water PRGs represent a very conservative screen for surface water and groundwater. In addition to individual screening, ODEQ requires consideration of potential risks due to multiple chemicals and, where more than one medium is contaminated, multiple media. Tables D2-1 and D2-2 present the PRG screening and results, respectively. Based on this screening, antimony, arsenic, chromium, iron, lead, and manganese were identified as COPCs for the Site.

3.2 EXPOSURE ASSESSMENT

Assessing the exposure at a given site includes the identification of potentially exposed populations, the selection of relevant exposure pathways, and the calculation of exposure point concentrations and chronic daily intakes.

3.2.1 Potentially Exposed Population

The Ochoco Mine consists of an adit and a small wasterock pile within a ½ acre area. The Mayflower Mine is approximately 1 to 2 acres in size and consists of two adits, several open prospects in the hill slope above the adit, several large wasterock piles, a tailings area, a collapsed mine-mill building, and a former cyanide vat. A seep emanates from the adit. Both mines are adjacent to Ochoco Creek. There are no onsite workers, or occupied structures on the Site. Access is currently not restricted by fencing, nor were any “No Trespassing” signs observed. In general, land uses in this area are limited to recreation (hiking, fishing, camping, hunting, etc.) and possibly some minerals prospecting on nearby claims.

Given the types of human uses expected, long-term exposure to Site-related contaminants is considered very low. However, the ingestion, dermal contact, and air exposure pathways are considered complete, because hikers, hunters, and campers have the potential to access the Site. Fish consumption was eliminated as a potential pathway of concern because it was determined that the number of fish in Ochoco Creek is too few to support even a recreational fisher scenario.

3.2.2 Identification of Potential Exposure Pathways

This section evaluates and selects potential pathways for human exposures to the identified COPCs. In general, an exposure pathway consists of four elements: a source of chemical release into the environment, an environmental medium for transport of the chemical (e.g., air, surface water, groundwater, or soil), a point of potential human exposure (exposure point), and a route of exposure of the chemical into the body (e.g., breathing, eating, drinking, or skin contact). The human health conceptual exposure model is presented in Figure 3-1.

Exposures to COPCs were evaluated for all complete pathways for which there was a receptor. These pathways were determined to be inhalation of soil particulates, dermal contact with soil, incidental ingestion of surface soil, dermal contact with sediment, and incidental ingestion of sediment by current and future recreational receptors.

3.2.3 Current and Potential Future Receptors

The Site is not currently occupied, nor is it expected to be occupied or developed in the near future. The only likely current and future receptors identified for the Site are hikers, campers, and hunters.

3.2.4 Exposure Assumptions

Exposure assumptions include factors such as body weight, averaging time, exposure frequency, exposure duration, and chemical bioavailability. Separate assumptions are made for both average or central tendency exposure (CTE) and reasonable maximum exposure (RME). In general, CTE represents a less conservative model of the Site risk, using exposure factors that are more indicative of the average recreational user rather than a maximally exposed user.

Neither USEPA nor ODEQ have developed default scenarios for recreational or camping exposure scenarios. Therefore, recreational exposure assumptions used for this HHRA were selected from those developed by USEPA for the Upper Tenmile Creek Mining Area Superfund site (CDM, 2000). Use of the exposure assumptions developed for a similar mine site were deemed appropriate. The exposure factors and assumptions used in this risk assessment are presented in Table D2-3.

3.2.5 Exposure Point Concentrations

An EPC is needed to calculate the Average Daily Dose (ADD) of a contaminant. Generally, the EPC is not the maximum concentration detected because, in most situations, it is not reasonable to assume long-term contact with the maximum concentration. When sufficient data exists, statistical average concentrations (90UCL) are used because toxicity criteria are based on lifetime average exposures, and an average concentration is most representative of the concentration contacted over time, based on the assumption that an exposed individual moves randomly across an exposure area. The equations used to calculate the EPC and ADD are found in USEPA, 1997.

Risk calculations were based on 42 surface soil, wasterock, and tailings samples; 6 surface water samples; and 6 sediment samples (5 for antimony). Where data was limited to less than 10 samples, the maximum detected concentration was used as the EPC. Where the data set contained greater than 10 samples, the 90UCL was calculated and used as the EPC as described in Section 2.0. The EPCs calculated for the HHRA are presented in Table 3-1 below.

Table 3-1
Exposure Point Concentrations

Contaminant of Potential Concern	N	Maximum	CTE[1]	RME[2]	Basis
Surface Soil milligrams per kilogram (mg/kg)					
Antimony	38	3.19E+03	2.45E+02	4.20E+02	90UCL
Arsenic	42	5.35E+03	9.40E+02	1.27E+03	90UCL
Chromium	38	1.19E+02	5.25E+01	6.22E+01	90UCL
Iron	38	6.12E+04	4.58E+04	4.79E+04	90UCL
Lead	42	9.46E+03	9.22E+02	1.34E+03	90UCL
Manganese	38	3.60E+04	6.36E+03	1.14E+04	90UCL
Surface Water micrograms per liter (µg/L)					
Arsenic	6	3.33E+00	1.29E+00	3.33E+00	MAX
Manganese	6	4.87E+03	8.15E+02	4.87E+03	MAX
Sediment (mg/kg)					
Antimony	5	6.11E-01	2.42E-01	6.11E-01	MAX
Arsenic	6	6.92E+01	2.41E+01	6.92E+01	MAX
Chromium	6	5.60E+01	4.06E+01	5.60E+01	MAX
Iron	6	3.85E+04	3.50E+04	3.85E+04	MAX
Lead	6	3.89E+01	1.10E+01	3.89E+01	MAX
Manganese	6	1.26E+03	8.08E+02	1.26E+03	MAX

[1] Simple average concentration
[2] 90UCLif greater then 10 data points; Maximum concentration if less than 10 data points
N = number of samples
EPC = exposure point concentration
90UCL= 90% upper confidence limit
MAX = maximum concentration detected

3.2.6 Exposure Doses

The EPCs are then entered into exposure dose calculations to calculate the ADD of a contaminant for each receptor type. While presented individually in the equations, USEPA Region X allows for the calculation of Summary Intake Factors (Intake Factors). Intake Factors represent the sum of lifetime exposure to contaminated soil, water, or air through the pathway. The Intake Factors are presented in Table D2-4. In addition, dermal absorption factors are required to calculate dermal exposures to surface water and these are shown in Tables D2-5 and D2-6. The Intake Factor represents everything except the chemical concentration in the generic intake equation. Exposure for a chemical can be calculated using the exposure point concentration in units of milligrams per liter (mg/L) for water, milligrams per kilogram (mg/kg) for soil or milligrams per cubic meter (mg/m^3) for air. The Intake Factors when multiplied by the EPC provide the ADD for each chemical.

3.3 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to present the critical toxicity values for the COPCs. Toxicity is defined as the ability of a chemical to induce adverse effects at some dosage in biological systems. The purpose of the toxicity assessment is twofold:

- To identify the carcinogenic (cancer) and non-carcinogenic (non-cancer) effects that may arise from direct or indirect exposure of humans to the COPCs; and,
- To provide an estimate of the quantitative relationship between the magnitude and duration of exposure, and the probability or severity of adverse effects.

3.3.1 Toxicity Values

Toxicity values are used to quantitatively describe the relationship between the extent of exposure to a COPC and the potential increased likelihood, or severity, of adverse effects. Where toxicity values are available, the following USEPA sources have been used to obtain this information.

- Integrated Risk Information System (IRIS) computer database (USEPA, 2004)
- Health Effects Assessment Summary Table (HEAST) (USEPA, 1997)

Both carcinogenic and non-carcinogenic health effects were quantitatively evaluated. The endpoints for these two different types of effects are assessed differently because the mechanisms by which chemicals cause cancer are assumed to be fundamentally different from the processes that cause non-carcinogenic effects. The principal difference reflects the assumption that non-carcinogenic effects are assumed to exhibit a threshold dose below which no adverse effects occur, where USEPA assumes no such threshold exists for carcinogenic effects. Because exposure to some chemicals may result in both carcinogenic and non-carcinogenic effect, both endpoints associated with a COPC were evaluated quantitatively when sufficient toxicity data are available.

3.3.2 Categorization of Chemicals as Non-carcinogens or Carcinogen

Chemicals are classified into those that cause cancer (carcinogens) and those that cause other, non-cancer, health effects (noncarcinogens). The method for assessing the potential for these two different types of health effects are different. Where a chemical can cause both non-cancer and cancer health effects, the risk evaluation calculates the potential for both types of effects. The following sections provide background information on the toxicity values for carcinogenic and noncarcinogenic chemicals, how they are determined, and how they are used in the risk analysis.

3.3.2.1 Potential Adverse Non-carcinogenic Health Effect

Reference doses (RfDs) are critical toxicity factors for chemicals that can cause non-carcinogenic health effects. An RfD represents an estimated intake rate that is unlikely to produce measurable adverse effects over a lifetime of exposure (USEPA, 1989a). RfDs are determined by the USEPA RfD Work Group or from the health effects assessment documents developed by the USEPA Office of Research and Development. USEPA-established RfDs have been verified by a USEPA-directed peer review of available information.

A RfD assumes a threshold for adverse non-carcinogenic effects. An ADD below the RfD is considered unlikely to cause adverse health effects. A RfD is expressed in units of milligrams per kilogram per day (mg/kg-day). RfDs are route-specific; that is, RfDs may be different for ingestion, inhalation or other routes of exposure. RfDs are derived using uncertainty factors (UFs) and modifying factors (MFs). The UFs reflect scientific judgment regarding the data used to estimate an RfD. A UF of 10 is usually used to account for variation in human sensitivity among populations. An additional 10-fold factor is used to account for each of the uncertainties assumed when extrapolating from animal data to humans, when extrapolating from a lowest-observed adverse effect level (LOAEL) to a no-observed-adverse-effect-level (NOAEL) and when estimating from subchronic to chronic exposure. To reflect professional assessment of the uncertainties of the study and the data set not explicitly addressed by the above UFs, an additional UF or MF ranging from >0 to 10 can be applied. The default value for MF is 10. The Critical Toxicity Factors for the non-carcinogenic COPCs are presented in Table 3-2.

Table 3-2
Critical Toxicity Values for the Non-carcinogenic COPCs

Contaminant	Chronic RfD (mg/kg-day)		Confidence in RfD	Endpoint
	Oral	Inhalation		
Antimony	0.0004		Low	blood glucose, cholesterol
Arsenic	0.0003		Medium	hyperpigmentation, vascular
Iron	0.3			metabolic acidosis
Manganese	0.024	0.000014	Medium	CNS

* RfD value from Region IX PRG Tables
COPCs = Chemicals of Potential Concern
RfD = Non-carcinogenic reference dose

3.3.2.2 Potential Carcinogenic Effects

Carcinogenic toxicity is not assumed to have a threshold concentration below which adverse effects do not occur. Therefore, carcinogenic risk from exposure to a COPC is expressed in terms of the probability that an exposed receptor will develop cancer over their lifetime. Contaminant-specific dose response curves are used to establish slope factors (SFs) that represent an upper-bound excess cancer risk from a lifetime exposure. Dose response curves for human carcinogens are developed from tumorgenic and laboratory studies; the SF is generated from the $90\%_{UCL}$ of the extrapolated dose curve using probabilistic methods and represents a conservative upper-bound estimate of the potential risk associated with exposure. Based on USEPA guidelines documents, critical toxicity data for arsenic and chromium are presented in Table 3-3 (refer to USEPA 1999 for additional information).

Table 3-3
Critical Toxicity Values for the Carcinogenic COPCs.

Contaminant	Slope Factor (mg/kg/day)-1		Weight of Evidence Classification	Type of cancer	Basis of Slope Factor
	Oral	Inhalation	Ingestion/Inhalation	Ingestion/ Inhalation	oral/inhalation
Arsenic	1.5E+00	1.5E+01	A	Skin	EPI Studies
Chromium		4.2E+01	A	Lung	EPI Studies

COPCs = Chemicals of Potential Concern
CAS Number = Chemical Abstracts Scientific (Registration) Number
A = Known Human Carcinogen

3.3.2.3 Lead Critical Toxicity Values

Meaningful oral and inhalation critical toxicity values have not been developed for lead. Many of the non-carcinogenic effects associated with lead may not exhibit a threshold, especially in young children. USEPA considers Lead to be a B2 carcinogen. In lieu of a reference dose or slope factor, USEPA has developed the Integrated Exposure Uptake/Biokinetic Model (IEUBK) and the Adult Lead Model (ALM) which correlate dose with blood lead levels.

The LOAEL of lead is considered to be 10 micrograms per deciliter (µg/dl) in children and fetuses and 30 µg/dl in adults. Empirically-derived ratios of 0.16 and 0.04 µg/dl per µg/day ingested by children and adults respectively, recommended by USEPA (1986) and FDA (1990), are used to predict concentrations in young children and adults. Applying an uncertainty factor of 10 results in provisional tolerable intake levels of 6 µg/day for children six or less, 15 µg/day for children over six, 25 µg/day for pregnant women, and 75 µg/day for men.

3.4 RISK CHARACTERIZATION

Potential human health impacts associated with exposure to COPCs at the Site were evaluated by estimating the potential for both non-carcinogenic and carcinogenic health effects. The following sections discuss the assessment of non-carcinogenic hazards, carcinogenic risks, and lead risk associated with exposure to COPCs at the Site. The sampling locations were selected at locations where levels of concentrations were suspected to be the highest. Targeted sampling identifies the worst-case situations, and is intended to be a conservative data set that is sufficient for the specific purposes of risk assessment.

3.4.1 Non-Carcinogenic Hazard Assessment

Non-carcinogenic hazard is estimated as the ratio of the ADD of the non-carcinogenic chemical through a specific exposure route to the chronic (or subchronic) RfD for that exposure route. For example, intakes from the ingestion route are compared to oral RfDs.

The ADD divided by the RfD for an individual chemical is termed the Hazard Quotient (HQ). HQs greater than 1.0 indicate the potential for adverse health effects because the intake exceeds the RfD (USEPA, 1986b). An HQ is calculated for each chemical that elicits a non-carcinogenic health effect if a RfD is available for the chemical and exposure route. The sum of all individual chemical-specific HQs is termed the Hazard Index (HI) and is calculated under each exposure pathway.

The HI considers exposure to a mixture of chemicals having non-carcinogenic effects based on the assumption that the effects of chemical mixtures are additive (USEPA, 1986b). A HI greater than 1.0 indicates the potential for adverse non-carcinogenic effects. When the HI is greater than 1.0, the USEPA guidance allows for segregating HIs by critical effect categories. Major categories of critical effects include neurotoxicity, developmental effects, and effects on target organs to name a few.

3.4.2 Excess Cancer Risk Assessment

Carcinogenic risk is estimated as the probability that a compound will produce a carcinogenic effect. The excess lifetime carcinogenic risk is the incremental increase in the probability of developing cancer compared to the background incremental probability of developing cancer with no exposure to site contaminants. An excess cancer risk (ECR) of 1×10^{-6}, for example, represents an increase of one additional case of cancer (above background) in one million people exposed to a carcinogen over their lifetime (70 years). Estimates of carcinogenic risk using the slope factors developed by USEPA are generally upper-bound estimates; actual risks from exposures to chemical constituents at the Sites would likely be lower than the risks estimated herein.

For estimating carcinogenic risk from exposure to more than one carcinogenic chemical from a single exposure route, risks from each individual chemical are summed to estimate total excess cancer risk.

3.4.3 Potential Noncancer Hazards and Excess Cancer Risks for the Recreational Receptor

3.4.3.1 Discussion of Noncarcinogenic Hazards

The following provides a brief summary of the non-carcinogenic risks for each media. HQs are outlined in Table D2-10.

- Soils, Wasterock, Tailings. Antimony, arsenic, chromium, iron, lead and manganese were identified as the COPCs for this media. The 90UCL concentrations were used as the EPCs. None of the individual constituents exceeded the regulatory standard of 1.0 under CTE and RME exposure conditions.

- Sediments. Antimony, arsenic, chromium, iron, lead, and manganese were quantitatively evaluated in sediments. The HQs are below the regulatory standard of 1.0 for all constituents under both the RME and CTE exposure scenarios.

- Surface water: Arsenic and manganese were quantitatively evaluated in surface water. The HQs are below the regulatory standard of 1.0 for all constituents under both the RME and CTE exposure scenarios.

- The HI, sum of the HQs, did not exceed the regulatory standard of 1.0 for noncarcinogens under CTE conditions. However, the HI for RME conditions was 2.0 which exceeded the regulatory standard of 1.0. Therefore, COPCs were segregated by critical health effect and HIs calculated, this process is allows by the USEPA to segregating HIs by critical effect categories. None of the constituents exceeded the regulatory standard of 1.0 under CTE and RME exposure conditions (Table 3-4).

Table 3-4
Summary of Non-Carcinogenic HIs for
Recreational Receptors by Critical Health Effects

COPC	Critical Effect	CTE	RME
Antimony	Blood glucose, cholesterol	1.E-03	1.E-02
Arsenic	Hyperpigmentation, vascular	2.E-01	1.E+00
Iron	Metabolic acidosis	4.E-03	2.E-02
Manganese	Central nervous system	7.E-02	8.E-01

3.4.3.2 Discussion of Potential Excess Cancer Risks

The following provides a brief summary of the carcinogenic risks for each media. ECR values are outlined in Table D2-11.

- Soil, Wasterock, and Tailings. The only carcinogenic constituent identified was arsenic. The average concentration and the 90UCL concentration were used as the EPCs for the CTE and RME exposures, respectively. The ECR did not exceed the regulatory standard of 1×10^{-6} under CTE exposure conditions. However, under the RME exposure condition, ECRs for ingestion (1×10^{-5}) and dermal contact (9×10^{-6}) of arsenic exceeded the regulatory standard of 1×10^{-6}. Therefore, a carcinogenic risk is possible for exposure to arsenic impacted soil, wasterock, and tailings under the RME exposure scenario.

- Sediments. The only carcinogenic constituent identified in sediment is arsenic. The ECRs for arsenic in sediment ranged from 6×10^{-7} (RME) to 2×10^{-8} (CTE). Therefore, no carcinogenic risk is expected from exposure to sediment.

- Surface Water and Air: No carcinogenic constituent were identified in surface water or air.

- The risk characterization determined no unacceptable ECR from exposure to sediment. However, there is a potential for unacceptable cancer risk from ingestion and dermal contact with arsenic in soil, wasterock, and tailings under RME conditions.

3.4.3.3. Estimation of Potential Human Health Impacts from Exposure to Lead

The USEPA's lead models simulate soil lead exposures at a single location. Two models have been developed, the IEUBK model and the ALM. These models require a minimum of three months of continuous exposure of at least one day per week. Three months is considered to be the minimum exposure to produce a quasi-steady-state lead concentration. The reliability of the models for predicting lead concentrations for exposure durations shorter than three months has not been assessed. In order to address non continuous exposures, the USEPA Office of Solid Waster and Emergency Response (OSWER) has developed a guidance document for evaluating intermittent exposures to lead for scenarios such as recreational users and trespassers. Since the exposure frequency is less than three months, predicted intake values were compared with the provisional values discussed in Section 3.3.2.3. Table 3-5 presents the results of the lead intake calculations and lead screening. Only the ingestion pathway is quantified.

TABLE 3-5 Lead Intake Screening

EPC (Soil) (mg/kg)		**Intake (kg/day)**		**Predicted Intake (ug/day)**		**USEPA Provisional Intake Value (ug/day)**	**USEPA Provisional Intake Value (ug/day)**
CTE	**RME**	**CTE**	**RME**	**CTE**	**RME**	**Men**	**Children <6**
922	1,340	6.70E-07	2.70E-06	0.62	3.6	75	6
EPC (Sediment) (mg/kg)		**Intake (kg/day)**		**Predicted Intake (ug/day)**		**Provisional Intake Value (ug/day)**	**Provisional Intake Value (ug/day)**
CTE	**RME**	**CTE**	**RME**	**CTE**	**RME**	**Men**	**Children <6**
11	38.9	2.60E-07	2.10E-06	0.003	0.08	75	6
			TOTAL INTAKE	**0.623**	**3.68**	**75**	**6**

- Soil, Wasterock, and Tailings: Using an exposure point concentration (EPC) of 922 mg/kg (CTE – arithmetic mean) and 1,340 mg/kg (RME = 90UCL) the predicted intake was calculated to be 0.62 µg/day (CTE) and 3.6 µg/day (RME). The USEPA provisional ingestion intake value for men (most likely receptor) is 75 µg/day and children under six (least likely receptor) is 6 µg/day. If you assume that the total intake from dermal exposure and inhalation is equal to the intake from ingestion, no risk is expected for exposure to lead in soil, wasterock, and tailings.

- Sediment: Using an EPC of 11 mg/kg (CTE – arithmetic mean) and 38.9 mg/kg (RME = maximum concentration) the predicted intake was calculated to be 0.003 µg/day (CTE) and 0.08 µg/day (RME). Using the USEPA provisional ingestion intake listed above, no risk is expected for exposure to lead in sediment.

- Surface Water: The USEPA maximum containment level (MCL) for lead is 15 µg/L. No lead was detected above the method detection limit of 0.6 µg/L in any water sample from the Site. Therefore, exposure to lead in drinking water is not expected to be a risk.

3.5 CALCULATION OF CLEANUP GOALS

Site specific cleanup goals protective of the RME recreational users were calculated for soil, wasterock, and tailings based on the regulatory standard of 1 x 10^{-6} ECR. The site-specific cleanup goal was calculated to be 53 mg/kg. However, this concentration is below the average background concentrations (96.2 mg/kg) found around the Site. Therefore, the cleanup goal was adjusted to 96.2 mg/kg, to be no more stringent than that average background concentration expected around the Site.

3.6 DETERMINATION OF POTENTIAL HOTSPOTS

The 1995 amendments to Oregon Revised Statute [ORS 465.315] and 1997 amendments to the Hazardous Substance Remedial Action Rules [OAR 340-122], commonly referred to as the Environmental Cleanup Rules, require that certain actions be taken for "hotspots" of contamination. These actions are: a) the identification of hotspots as part of the Remedial Investigation and Feasibility Study, and b) the treatment of hotspots, to the extent feasible, as part of a remedial action selected or approved by the Director of the ODEQ. The intent of the hotspot rule is to require treatment only for the worst contamination, as opposed to preferring treatment for all contamination at the Site. A hotspot in soil is generically defined as an area where the contamination is highly concentrated, highly mobile, or cannot be reliably contained.

The assessment of "highly concentrated" hotspots is performed by comparing the concentration of each individual site contaminant to its "highly concentrated" hotspot level. The "highly concentrated" hotspot levels correspond to a lifetime excess cancer risk of 1 x 10^{-4} for carcinogens and a hazard quotient of 10 for non-carcinogens. Only arsenic in surface soil exceeded the regulatory standards for carcinogenic health effects. Therefore the hotspot evaluation was conducted for surface soil only. The results of the hotspot evaluation are presented in Table D2-15 in Appendix D-2. Using an ECR of 1 x 10^{-4} a hotspot concentration for arsenic was calculated to be 8,664 mg/kg. This concentration was compared with the sampling results at the Site. No hotspots were identified at the Site.

3.7 SUMMARY OF HUMAN HEALTH RISKS

Three individual metals (antimony, arsenic, and lead) were identified as COPCs in surface soil. No individual COPCs were identified in subsurface soil; however chromium, iron, and manganese were identified as multiple chemical COPCs in subsurface soils. Arsenic and manganese were identified in surface water. Only arsenic was identified as an individual COPC in sediment. ODEQ guidance also requires a multiple media screening. Six COPCs were identified on the basis of the multiple media screening (antimony, arsenic, chromium, iron, lead, and manganese). Based on current and future land use, individuals who might come in contact with site related contaminants through recreational activities such as hunting, hiking, and camping were the only potential receptors identified. The quantitative risk assessment determined that no unacceptable non-carcinogenic health effects are anticipated.

Arsenic was the only carcinogenic COPC identified at the site. No unacceptable human health risks were identified from exposure to arsenic under the CTE exposure conditions. Risks from ingestion and dermal contact with arsenic impacted soil under the RME exposure conditions exceeded the ODEQ's regulatory standard of 1 x 10^{-6} ECR. A cleanup goal based on the risk assessment was calculated to be below the average arsenic concentrations found around the Site. Therefore, the cleanup goal of 96.2 mg/kg, representing the average arsenic concentration around the Site, is recommended. No hotspots were identified at the Site.

4.0 ECOLOGICAL RISK ASSESSMENT

The goal of the ERA is to provide an understanding of the potential for ecological risks due to Site-related contamination and to determine whether there is a need for more detailed ERA. This report consists of:

- Description of the ecology of the Site and potential ecological receptors (including rare, threatened, or endangered [RTE] species) at or near the Site;
- Presentation of the conceptual ecological exposure model (CEEM), which provides a summary of potential and likely exposure media and pathways;
- Delineation of assessment and measurement endpoints;
- Ecological risk-based screening; and
- Risk characterization to assess the potential for ecological effects due to Site related COIs.

An ecological survey was conducted as part of the SI. The SI ecological survey report documented ecological features and conditions at and near the Site. In addition, the potential for Site impacts was assessed via an examination of stream benthic macroinvertebrate abundance and diversity. The ecological information collected during the SI has been incorporated into this risk assessment as appropriate. An ODEQ ecological scoping checklist was completed for this ERA, based on the SI ecological survey, and is provided in Appendix D3.

4.1 PROBLEM FORMULATION

The physical and chemical characteristics of the Site and the important ecological habitats, plants, invertebrates, fish, and wildlife that exist are described in this section. This information is utilized to identify the COIs, the ecological receptors of concern, exposure pathways, and the exposure media. This in turn, allows development of the CEEM which graphically depicts the expected fate and transport of chemicals at the Site, the potential exposure media, and likely exposure pathways for ecological receptor types of concern. The problem formulation concludes with identification of the ecological endpoints that delineate the objectives of the remainder of the ERA. Generally, problem formulation includes a description of the Site and summary of previous investigations; however, this information is provided in the SI, and is not repeated herein.

4.1.1 Ecological Stressors

Ecological receptors may be affected through exposure to chemicals (i.e., toxicity), physical stresses (i.e., destruction of habitat), and biological stresses (i.e., viruses and bacteria). While biological stressors may affect ecological receptors, they are more frequently associated with waste food or human waste and in areas where wildlife congregate in large numbers. Because the remote nature of the Site limits human presence and wastes, they are not considered to pose a threat to ecological receptors. Because of the lack of suitable habitat, ecological receptors are also unlikely to congregate in the vicinity of the Site in numbers that could result in significant biological infection or passage of wildlife diseases. Thus, biological stressors are unlikely to be a significant factor and are not considered further.

Past physical disturbances include development and operation of the mines and supporting structures and possibly historical logging operations. Because the Site has been abandoned for decades and vehicle access is limited, current physical disturbance is reduced to a relatively low number of recreational users that visit the Site. Given the relatively remote nature of the Site within the Ochoco National Forest, the ecological impacts of current physical disturbances are very limited.

As described in Section 2.0, the primary chemicals of interest at the Site are metals. The metals included as COIs for the ERA are listed in Tables D1-1 through D1-5 in Appendix D1.

4.1.2 Ecological Setting

The regional and Site-specific ecology are briefly described in this section to provide an understanding of the climate, plants, invertebrates, wildlife, and fish that may inhabit the Site and surrounding region. Other than RTE species that must be considered on an individual level, a particular species must be potentially present on or utilize the Site in numbers adequate to allow an exposure level that may result in effects to the species' population. Such significant exposure to Site related COIs will only occur for those species known or expected to use the Site on a regular basis and in high numbers or that bioaccumulate or bioconcentrate metals to a significant degree. Detailed information on the regional and Site ecology, sensitive environments, and RTE species is presented in the SI. Only rare and/or sensitive species are expected to be found at the Site; no threatened or endangered (i.e., protected) were observed or are expected at the Site (Table D4-1).

The predominant habitat in the vicinity of the Site is open ponderosa pine forest with a grassy/elk sedge understory. This habitat has been disturbed in close proximity to both mines and is now successional and weedy vegetation in these areas. Ochoco Creek flows adjacent to both mines and has a narrow riparian corridor. Scissors Creek is a tributary of Ochoco Creek that flows from an area of potential mine-related impacts separate from the Mayflower and Ochoco Mines. Scissors Creek enters Ochoco Creek approximately 200 meters downstream of the Mayflower Mine. Ochoco Creek flows into Ochoco Reservoir approximately 34 km (21 miles) downstream of the Site and then into the Crooked River downstream of Prineville, Oregon.

4.1.3 Conceptual Ecological Exposure Model

The CEEM (Figure 4-1) graphically depicts the sources of contamination, contaminant release and transport mechanisms, impacted exposure media, and exposure routes for ecological receptor types observed or expected at the Site. Based on current understanding of Site conditions, the potentially contaminated exposure media for ecological receptors include:

- Surface soil, wasterock, and tailings in the vicinity of the Site;
- Surface water in Ochoco Creek, Scissors Creek, and the Mayflower Adit drainage;
- Pore water within Ochoco and Scissors Creeks; and
- Sediment in Ochoco and Scissors Creeks.

Given these exposure media, the possible and likely ecological receptors include:

- Terrestrial plants and invertebrates exposed to COIs in soil, wasterock, and tailings;
- Terrestrial wildlife (including birds, mammals, and reptiles) exposed to COIs in soil, wasterock, tailings, surface water, pore water, and sediment;
- Aquatic life (including aquatic plants, benthic macroinvertebrates, fish, and amphibians) exposed to COIs in surface water, and pore water; and
- Benthic macroinvertebrates, birds, and mammals exposed to COIs in sediment.

4.1.4 Assessment Endpoints and Measures

Assessment endpoints and measures are developed based on the results of the problem formulation, are qualitative or quantitative expressions of the environmental values to be protected and, therefore, assessed in the ERA. As such, assessment endpoints link the ecological risk assessment and risk management processes by highlighting ecological aspects that are of concern to risk managers.

4.1.4.1 Assessment Endpoints

Within a screening level ERA, assessment endpoints are generalized to reflect the risk-based screening process and protective ecological risk-based screening concentrations (ERBSCs). The assessment endpoints for this ERA include:

- Protection of the reproduction and survival of plants, terrestrial invertebrates, birds, mammals, reptiles, and amphibians due to COIs in surface soil, wasterock, and tailings at the Site;
- Protection of the reproduction and survival of birds and mammals that may drink from Ochoco or Scissors Creeks;
- Aquatic life exposed to COIs in surface and pore water within adit drainage, Ochoco Creek, and Scissors Creeks;
- Protection of reproduction and survival of birds and mammals exposed via the aquatic/benthic food chain, to COIs in sediment within Ochoco and Scissors Creeks; and
- Protection of reproduction and survival of benthic macroinvertebrates exposed to COIs in sediment within Ochoco and Scissors Creeks.

4.1.4.2 Assessment Measures

Assessment measures are characteristics of the Site, selected ecological receptors, or ecosystem aspects that are measured through monitoring or sampling activities and then related qualitatively or quantitatively to the selected assessment endpoint(s) to determine whether an ecological effect is occurring. For this ERA, the assessment measures are comprised of the following:

- Measured concentrations in soil, wasterock, tailings, surface water, pore water, and sediment; and
- Readily-available ERBSCs.

4.2 ECOLOGICAL RISK-BASED SCREENING

Ecological risk-based screening begins with a list of COIs in the media of concern, determination of EPCs, and comparison of the EPCs to ERBSCs with consideration of exposure to multiple chemicals and media, reporting limit adequacy, and inordinate contribution of individual chemicals to the overall receptor group risk. The result is a list of Site-related chemicals or chemicals of potential ecological concern (COPECs) with the potential to pose risks to ecological receptors at the Site.

The initial screening was completed in Section 2.0. The chemicals retained as ecological COIs are presented in Table 4-1 below. The calculation of EPCs was described in Section 2.0. Generally, the ERBSCs used in the risk-based screening were screening level values (SLVs) provided by the ODEQ (ODEQ, 2001). When a SLV was not available for a given COI, then an alternative ERBSC was selected from peer-reviewed literature or a surrogate chemical ERBSC was substituted when appropriate. The ERBSCs and detailed screening results and ERBSCs are shown in Tables D4-2 through D4-6.

Table 4-1
Contaminants of Interest in Exposure Media

Surface Soil	Surface Water	Pore Water	Sediment
Aluminum	Aluminum	Aluminum	Aluminum
Antimony			Antimony
Arsenic III	Arsenic III		Arsenic III
Arsenic V	Arsenic V	Arsenic V	Arsenic V
Arsenic, total	Arsenic, total	Arsenic, total	Arsenic, total
		Barium	
Cadmium	Cadmium		Cadmium
Chromium III			
Chromium, Total			Chromium, Total
Cobalt			Cobalt
Copper			Copper
Iron		Iron	Iron
Lead			Lead
Manganese	Manganese	Manganese	Manganese
Mercury	Mercury	Mercury	Mercury
Mercury, Methyl		Mercury, Methyl	Mercury, Methyl
Nickel	Nickel		Nickel
Selenium			
Silver			Silver
Thallium			Thallium
Vanadium			Vanadium
Zinc	Zinc		Zinc

As per ODEQ guidance (2001), the EPCs for each medium were compared to the ERBSCs for each chemical and receptor group in each medium, resulting in chemical/receptor group-specific risk ratios (R_{ij} in Tables D4-2 through D4-5). These risk ratios were summed for all chemicals within a receptor group to obtain receptor group-specific risk ratios (R_j in Tables D4-2 through D4-5). The potential for bioaccumulation of each COI was assessed and the inordinate contribution of any given chemical to the overall receptor group risk was determined. Risk ratios greater than 1 were considered unacceptable and indicative of potential risks for protected ecological receptors (none were observed or are expected at the Site), aquatic life, and benthic macroinvertebrates. Risk ratios greater than 5 were considered unacceptable for other ecological receptors. The COIs for which potential ecological risks were indicated became COPECs for the Site.

The risk ratios for receptor groups exposed to COPECs in the exposure media are shown in Tables 4-2 through 4-5 below. Overall these results suggest a potential for the exposure of multiple ecological receptors to unacceptable concentrations of multiple COPECs in soil, wasterock, tailings, and sediment, and the exposure of aquatic life to very few COPECs in surface water and pore water.

Table 4-2. Chemicals of Potential Ecological Concern and Risk Ratios For Surface Soil, Wasterock, and Tailings

COPECs	Terrestrial Plants (R_{ij})	n*	Terrestrial Invertebrates (R_{ij})	n*	Birds (R_{ij})	n*	Mammals (R_{ij})	n*
Aluminum	**632**	4	**53**	4	**70**	4	**295**	4
Antimony	**84**	23	5	0	No ERBSC		**28**	21
Arsenic V	**146**	21	**24**	21	**146**	21	**50**	21
Total Arsenic	**71**	17	**21**	17	**30**	17	**28**	17
Cadmium	0.7	0	0.1	0	0.5	0	0.02	0
Chromium III	**62**	4	**155**	4	**15**	4	0.0002	0
Chromium, Total	**62**	5	**156**	5	**16**	5	0.2	0
Copper	1	0	2	0	0.6	0	0.3	0
Iron	**4787**	24	**239**	24	No ERBSC		No ERBSC	
Lead	**27**	30	3	0	**84**	30	0.3	0
Manganese	**23**	18	**114**	18	3	0	1	0
Mercury	5	0	**16**	39	1	0	0.02	0
Methyl Mercury	**50**	13	No ERBSC		4	0	0.03	0
Selenium	2	0	0.03	0	1	0	0.08	0
Silver	**100**	32	4	0	No ERBSC		No ERBSC	
Thallium	0.7	0	0.7	0	No ERBSC		0.7	0
Vanadium	**36**	1	No ERBSC		2	0	3	0
Zinc	**20**	25	5	0	**16**	25	0.05	0
Total Receptor Group Risk (R_j)	**6571**		**798**		**389**		**407**	

Bold = COPEC with risk ratio greater than acceptable levels (>5 for unprotected species; >1 for protected species - none are expected)
Non-bold = selected as COPECs for reasons other than exceedance of an ERBSC.
* n = number of exceedances of an ERBSC.

Table 4-3. Chemicals of Potential Ecological Concern and Risk Ratios For Surface Water

COPECs	Aquatic Life (R_{ij})	n*	Birds (R_{ij})	n*	Mammals (R_{ij})	n*
Aluminum	**3**	1	0.0003	0	0.03	0
Cadmium	0.2	0	Bioaccumulation		Bioaccumulation	
Manganese	**41**	1	0.0007	0	0.007	0
Zinc	**3**	1	0.004	0	0.0003	0
Total Receptor Group Risk (R_j)	**47**		0.005		0.04	

Bold = COPEC with risk ratio greater than acceptable levels (>1 for aquatic life, >5 for unprotected species).
Non-bold = selected as COPECs for reasons other than exceedance of an ERBSC.
* n = number of exceedances of an ERBSC.

Table 4-4. Chemicals of Potential Ecological Concern and Risk Ratios for Pore Water

COPECs	Aquatic Life (R_{ij})	n*	Birds (R_{ij})	n*	Mammals (R_{ij})	n*
Barium	**6**	1	0.0001	0	0.0006	0
Iron	**8**	1	No ERBSC		No ERBSC	
Manganese	**7**	1	0.0001	0	0.001	0
Methyl Mercury	No ERBSC		Bioaccumulation		Bioaccumulation	
Total Receptor Group Risk (R_j)	**22**		0.0007		0.01	

Bold = COPEC with risk ratio greater than acceptable levels (>1 for aquatic life; >5 for unprotected species).
Non-bold = selected as COPECs for reasons other than exceedance of an ERBSC.
* n = number of exceedances of an ERBSC.

Table 4-5
Chemicals of Potential Ecological Concern in Sediment

COPECs	Benthic Macroinvertebrates (R_{ij})	n*	Birds and Mammals (R_{ij})	n*
Aluminum	No ERBSC		No ERBSC	
Arsenic V	**12**	3	**17**	3
Total Arsenic	**12**	3	**17**	3
Cadmium	0.6	0	**113**	6
Total Chromium	**2**	3	0.01	0
Cobalt	No ERBSC		No ERBSC	
Copper	**2**	4	**7**	7
Iron	No ERBSC		No ERBSC	
Manganese	1	0	No ERBSC	
Mercury	**3**	1		
Methyl Mercury	No ERBSC		Bioaccumulation	
Nickel	**2**	6	0.1	0
Silver	0.1	0	No ERBSC	
Thallium	No ERBSC		Reporting Limit	
Vanadium	No ERBSC		No ERBSC	
Zinc	1	0	**41**	6
Total Receptor Group Risk (R_j)	**35**		**200**	

Bold = COPEC with risk ratio greater than acceptable levels (>1 for aquatic species; >5 for unprotected species).
Non-bold = selected as COPECs for reasons other than exceedance of an ERBSC.
* n = number of exceedances of an ERBSC.

4.3 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk description and uncertainty analysis. These are presented in the following sections.

4.3.1 Risk Description

Risk description involves examining the predicted risks in each medium to determine whether they are likely or artifacts of the risk assessment process.

4.3.1.1 Soil, Wasterock, and Tailings

The COPECs for soil, wasterock, and tailings were listed in Table 4.2. Every surface sample collected had at lease one exceedance of an ERBSC and maximum background concentrations. Many COPECs has multiple exceedances at multiple sample locations. This suggests that elevated concentrations of COPECs are present.

Cadmium, copper, selenium, and thallium were selected as COPECs but did not have EPCs that exceeded ERBSCs. Thallium was selected solely due to the lack of an ERBSC for birds exposed to COPECs in soil. However, the plant, terrestrial invertebrate, and mammal ERBSCs were not exceeded by detected thallium concentrations, thus, the data suggest impacts to birds are unlikely due to thallium. Cadmium, copper, and selenium were chosen as COPECs due solely to their potential to bioaccumulate. But the synthetic precipitation leaching procedure and toxicity characteristic leaching procedure results for cadmium and selenium both strongly suggest that these metals are bound to the soil, wasterock, and tailings particles, and thus, are not readily bioavailable, making it unlikely they will bioaccumulate to any significant degree in birds or mammals. Given these arguments, thallium, cadmium, and selenium are not considered to present a significant risk to ecological receptors.

Aluminum, arsenic V, and iron contributed an inordinate amount to the overall risk. While the aluminum risk ratios were quite high, only 4 of 38 sample stations had aluminum concentrations greater than those at background stations and the maximum detected concentration exceeded the maximum background concentration by a factor of only 1.2. Thus, aluminum is not considered to present a significant risk to ecological receptors.

In summary, given the multiple exceedances of ERBSCs by multiple chemicals at multiple stations, it seems likely that ecological risks will be posed by COPECs in soil, wasterock, and tailings. The most significant risk would be posed to plants and terrestrial invertebrates that inhabit the wasterock and tailings in the immediate vicinity of the Mayflower Mine. Mobile and wide-ranging wildlife species are unlikely to spend large amounts of time on or around the wasterock and tailings, and thus, are less likely to be impacted by the COPECs. Given the magnitude of the risk ratios and the number of sample locations where concentrations exceeded ERBSCs, the metals of most concern are antimony, arsenic V, total arsenic, chromium III, total chromium, copper, iron, lead, manganese, mercury, methyl mercury, silver, and zinc.

4.3.1.2 Surface Water

The COPECs for surface water were listed in Table 4-3. All of the exceedances of ERBSCs occurred at the adit drainage (SMM-AD1) and only for aquatic life. Cadmium was selected as a COPEC due to its potential to bioaccumulate and was also only detected at the adit drainage. The adit drainage extended approximately 60 meters from the adit along a gravel access road which may have been graveled with wasterock from the mine. This does suggest that mine-related chemicals may be present in adit water at elevated concentrations, but no aquatic life is present in the seep and it does not appear that the mine water is impacting Ochoco Creek because no elevated chemical concentrations were noted in Ochoco creek water. Given its only detection was in an area of minimal habitat, cadmium is not expected to bioaccumulate in the food chain. In addition, the detected concentration of aluminum (221 mg/L) was only 6 mg/L above the maximum background concentration, and is well within the range of background data variability. Given this information, ecological impacts are deemed unlikely due to COPECs in surface water.

4.3.1.3 Pore Water

The COPECs for pore water were listed above in Table 4-4. Barium, iron, and manganese were the only COPECs that exceeded both background concentrations and at lease one ERBSC. These exceedances were all at one station (OC-PW-4), just upstream of the Mayflower Mine. The exceedance of background factors for these three chemicals were 1.5, 120, and 1.2 for barium, iron, and manganese, respectively, but the exceedance factor for ERBSCs was less than 10 for all 3 COPECs. Overall, the ERA suggests there is a slight potential for pore water related ecological impacts posed to aquatic species exposed to primarily iron in pore water at OC-PW-4.

4.3.1.4 Sediment

The COPECs for sediment were listed above in Table 4-5. Every sediment station had at least one exceedance of an ERBSC. Several COPECs has multiple exceedances at multiple sample locations.

Aluminum, cobalt, iron, manganese, methyl mercury, silver, thallium, and vanadium were selected as a COPEC solely because of a lack of ERBSCs and thallium because of elevated detection limits. These COPECs exceeded maximum background concentrations by factors of 1.2, 1.4, 1.1, 1.7, 1.04, 2.4 (compared to background detection limits), and 1.1, respectively. One half of the thallium detection limit does not exceed the ERBSC.

Unacceptable risk ratios were calculated for cadmium, total chromium, total chromium, nickel, and zinc. However, these COPECs exceeded background concentrations by factors of 1.6, 1.2, 1.7, 1.5, and 1.9, respectively. Clearly, little impact is contributed by these COPECs in Ochoco Creek sediment and are not considered to contribute significantly to ecological impacts.

The remaining COPECs are arsenic V, total arsenic, and mercury. Mercury only exceeded its respective ERBSC for benthic macroinvertebrates at one station (OC-06). Therefore, arsenic V and total arsenic are the COPECs with the most potential for impacting ecological receptors, primarily at OC-05 and SC-02. The highest exceedances occur at SC-02. In addition, the benthic macroinvertebrate enumeration presented in the SI suggested a slight potential for impacts at SC-SS-2 in Scissors Creek and OC-SS-05 adjacent to the Mayflower Mine.

4.3.2 Ecological Hotspots

At the Mayflower Mine there were numerous ecological hotspots (concentration > 10 times the ERBSCs) in soil for antimony, arsenic V, lead, manganese, mercury, methyl mercury, silver, and zinc. The only hotspot at the Ochoco Mine was mercury at OM-WR1-2 and 7. The only ecological hotspot in surface water was for manganese at SMM-AD1. There were no pore water ecological hotspots.

In sediment, ecological hotspots were noted for arsenic V and total arsenic at SC-SS-2 and at OC-SS-5. This suggests that mine workings in the Scissors Creek watershed may be affecting the steam at SC-SS-2 and past activities at the Mayflower Mine may have resulted in mine-related chemicals entering Ochoco Creek.

4.3.3 Uncertainty Analysis

The uncertainty analysis lists the common uncertainties associated with ecological risk-based screening and assesses whether they are likely to over- or underestimate the potential for ecological risks to be realized at the Site. The primary uncertainties associated with this ecological risk-based screening and the impacts on the prediction of the potential for ecological risks are discussed below. This information is combined with that provided above in the risk description section to present conclusions and recommendations regarding ecological risks and the need for further investigation.

The risk-based screening assumes the receptors are constantly exposed to the chemical at a concentration equal to the EPC. While this may be true for immobile species such as plants and some terrestrial invertebrates, unless the contamination is widely and evenly spread, it is not realistic for wildlife species. Because the metals are primarily located around wasterock, tailings, and small centers of mining activity, the risks calculated above overestimate the actual risks posed to wildlife.

Similarly, the use of maximum detected concentration or 90UCL as the EPC is a conservative approach that is purposefully designed to result in some overestimation of the potential for ecological risks. Because of this, the risks predicted are likely to overestimate actual ecological risks at the Site.

Including a sample reporting limit screening is a conservative approach that includes COIs as COPECs when they are actually not-detected. Because the undetected COI is likely present at concentrations less than the reporting limit, possibly much less, including the COI as a COPEC result in an overestimation of the potential for ecological risks.

The lack of site specific bioavailability data does not allow for a formal assessment of risks due to some COPECs for upper trophic level receptors (i.e., birds and mammals). However, the fact that many metals

bind strongly to soil and sediment particles suggests that many of the metals may not be readily bioavailable. Given this evidence, risks due to the bioaccumulation of COPECs are likely overestimated.

Except for benthic macroinvertebrates and aquatic life, the ERBSCs used for this ERA are intended to be no-observed-adverse-effect-levels (NOAELs). Because actual ecological effects occur at an unknown concentration somewhere between the NOAEL and the LOAEL, simply exceeding an ERBSC does not necessarily indicate the potential for significant ecological effects. Thus, the use of NOAEL-based ERBSCs likely results in an overestimation of the potential for ecological risk.

The lack of ERBSCs for some receptors precludes the calculation of risk for those receptors. This may result in an underestimation of the potential for ecological risks. The use of a bioaccumulation screening is a conservative measure used to assess the potential for risks posed to upper trophic level ecological receptors when appropriate ERBSCS are missing.

Within this ERA, predictions are made regarding the significance of ecological exposures under current conditions at the Site. Overall, the risk-based screening is designed to overestimate the potential for ecological risks.

4.4 SUMMARY OF ECOLOGICAL RISKS

Elevated concentrations of several COPECs are present primarily in soil, wasterock, tailings, and sediment at the Site. It is likely that immobile receptors such as terrestrial plants and invertebrates are impacted within the boundaries of the Site, and more so at the larger Mayflower Mine where there were more exceedances of soil ERBSCs and more ecological hotspots identified. In addition, individual birds and mammals that consistently inhabit and/or forage from the Mayflower Mine may also be impacted due to the COPECs. Antimony, arsenic V, total arsenic, chromium III, total chromium, copper, iron, lead, manganese, mercury, methyl mercury, silver, and zinc are the soil COPECs contribute to unacceptable terrestrial ecological risks.

Aquatic life (i.e. aquatic plants, aquatic invertebrates, and resident fish), birds, and mammals are unlikely to be impacted due to COPECs within Ochoco Creek. Concentrations of some COPECs are significantly elevated in seep surface water, but ecological risks are not realized due to the limited size and nature of the drainage.

In sediment, arsenic V and total arsenic have the greatest potential to cause ecological impacts at OC-05 adjacent to Mayflower Mine and SC-02 in the Scissors Creek drainage. Given the results of the benthic macroinvertebrate survey which also suggested potential impacts at OC-SS-5 and SC-02, there is a weight of evidence suggesting that elevated concentrations of mine-related chemicals are impacting benthic macroinvertebrates. Given the relatively limited distribution of these elevated COPEC concentrations in sediments, impacts to bird and wildlife populations are considered unlikely.

5.0 CONCLUSIONS AND RECOMMENDATION

The risk assessment determined that there are no unacceptable human health risks from exposure to soil, wasterock, tailings, and sediment under the CTE exposure conditions. There is a potential for unacceptable risk for the RME exposure condition from ingestion and dermal contact with arsenic in soil, wasterock and tailings. A hotspot analysis determined that there are no hotspots at the Site. Under average exposure conditions no unacceptable risks are expected. A cleanup goal of 96.2 mg/kg (total arsenic) was developed for the Site based on average background concentrations of arsenic. Removal or capping of wasterock and tailings with higher concentrations of arsenic would eliminate some potential

pathways of exposure and therefore reduce potential intakes thus reducing potential adverse health impacts.

In this ERA, ecological impacts were predicted primarily for terrestrial plants and terrestrial invertebrates due to COPECs in soil, wasterock, and tailings. Ecological impacts were also predicted for benthic macroinvertebrates in Ochoco Creek adjacent to the Mayflower Mine and in the downstream portion of Scissors Creek. Overall, immobile or resident species inhabiting terrestrial and sediment habitats are the most likely species to be impacted. Further species-specific ecological assessment would be required to more accurately assess the potential for the predicted bird and mammal risks to be realized. The decision whether to complete more detailed ecological assessment should be made in coordination with any removal action planning to select the most cost-effective approach. Remediation, removal, or reduced receptor exposure to COPECs in soil, wasterock, and tailings, and sediment would be necessary to reduce the predicted impacts to ecological receptors. The total arsenic cleanup goal of 96.2 mg/kg recommended to reduce human health risks is expected to reduce the ecological impacts that were predicted for the Site to within acceptable levels.

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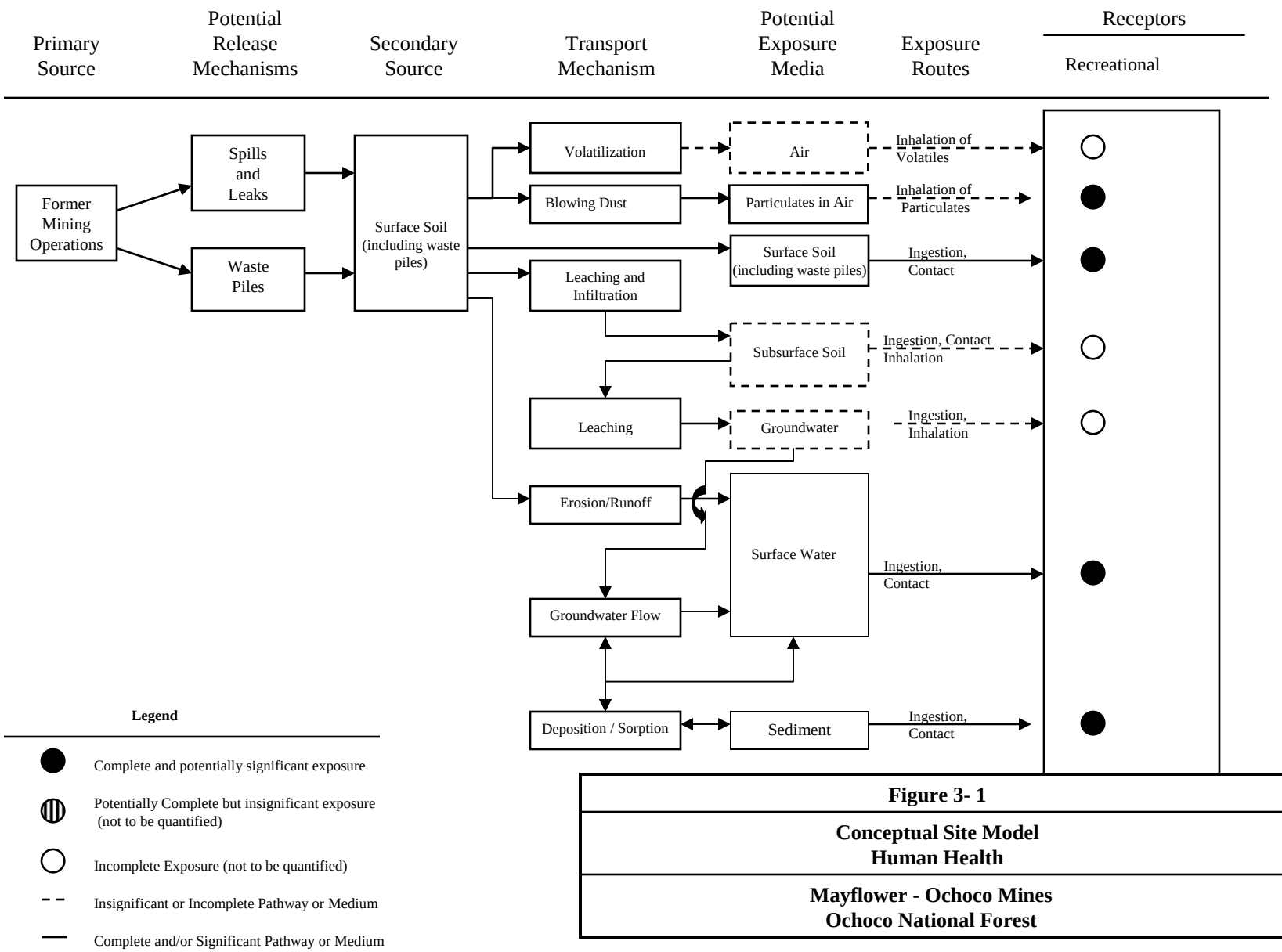


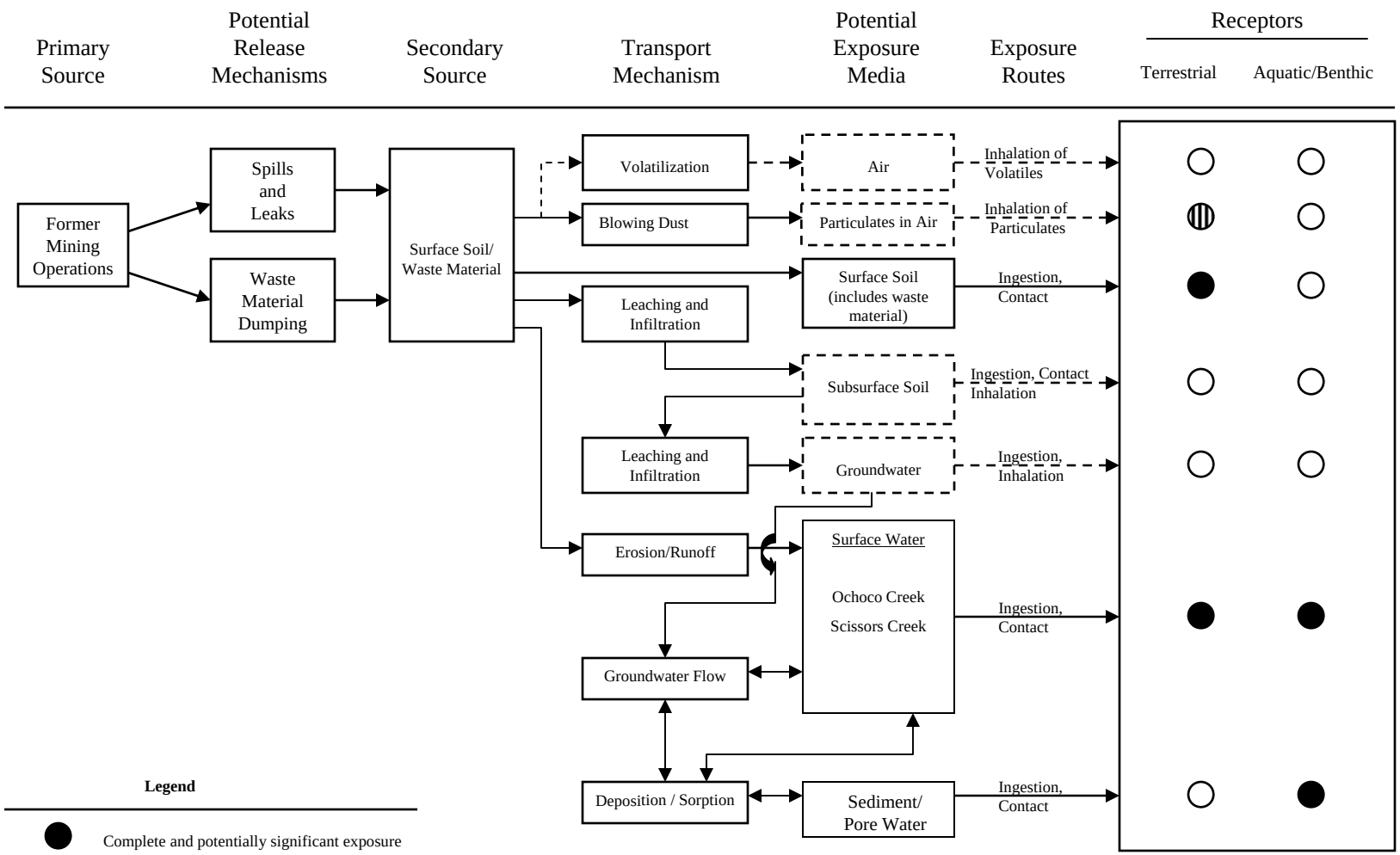
Legend

- Complete and potentially significant exposure
- Potentially Complete but insignificant exposure (not to be quantified)
- Incomplete Exposure (not to be quantified)
- Insignificant or Incomplete Pathway or Medium
- Complete and/or Significant Pathway or Medium

Figure 3- 1

Conceptual Site Model
Human Health

Mayflower - Ochoco Mines
Ochoco National Forest



Legend

- Complete and potentially significant exposure
- Potentially Complete but insignificant exposure (not to be quantified)
- Incomplete Exposure (not to be quantified)
- Insignificant or Incomplete Pathway or Medium
- Complete and/or Significant Pathway or Medium

Figure 4-1

Conceptual Ecological Exposure Model

Mayflower-Ochoco Mines
Ochoco National Forest
Crook County, Oregon