Formosa Mine Superfund Site, Operable Unit 1

U.S. EPA, Region 10 – Seattle, Washington *January 2015*

Proposed Plan for Public Comment

Introduction

You are invited to comment on the U.S. Environmental Protection Agency (EPA) Formosa Mine Superfund Site OU1 Proposed Plan (OU1 Proposed Plan) to clean up surface and subsurface mine materials at the Formosa Mine **Superfund** Site (Site) located near Riddle, Oregon. Please send us your comments by February 5, 2015.

This OU1 Proposed Plan summarizes cleanup alternatives that were evaluated for surface and subsurface **mine materials** outside of the underground **mine workings** at the Site and identifies EPA's preferred alternative for managing those materials. *Exhibit 1* provides a list of primary topics and sections that are in the proposed plan.

OU1 stands for **Operable Unit 1** of the Site, which includes surface and subsurface mine materials, basically crushed rock. In a separate evaluation, EPA will develop a Proposed Plan for **Operable Unit 2** (OU2), which includes groundwater, surface water, and mine materials within the underground mine workings.

It is more effective for EPA to manage the site cleanup in two pieces for two main reasons. First, it is important to evaluate how the cleanup of OU1 affects the Site, including OU 2. Second, the U.S. Bureau of Land Management (BLM) will soon be conducting a Non-Time Critical Removal Action (NTCRA) on the Formosa 1 Adit, which discharges contaminated water from the mine into soil and groundwater at the headwaters of Upper Middle Creek. The removal action is intended to seal the **adit** and prevent the unrestricted flow of contaminated water to Middle Creek. After the groundwater level has stabilized, the effectiveness of the NTCRA will be evaluated in the OU2 remedial investigation.

The OU1 Proposed Plan describes the preferred alternative – a modified version of Alternative 3 presented and evaluated in the feasibility study. After considering public input and any new information presented, EPA may select the preferred cleanup alternative, modify it, select another, or develop other alternatives. EPA will document the selected action in a **Record of Decision (ROD)**.

The BLM, U.S. Geological Survey, and the Oregon Department of Environmental Quality (ODEQ) are supporting EPA in the investigation and cleanup, and will be involved in the selection of the final remedy.

Exhibit 1: Highlights of the OU1 Proposed Plan

The Superfund Process	Remedial Action Objectives and Preliminary Remediation Goals
Site Background	Summary of Remedial Alternatives
Site Characteristics	Comparative Evaluation of Alternatives
Conceptual Site Model	Description of the Preferred Alternative
Scope and Role of the Proposed Plan	Opportunities for Public Involvement
Summary of OU1 Investigation	Glossary/Useful Terms
Summary of Site Risks	Comments Sheet

To help you better understand this proposed plan, commonly used terms that appear in **BOLD** are defined in the Useful Terms section at the end of the document.

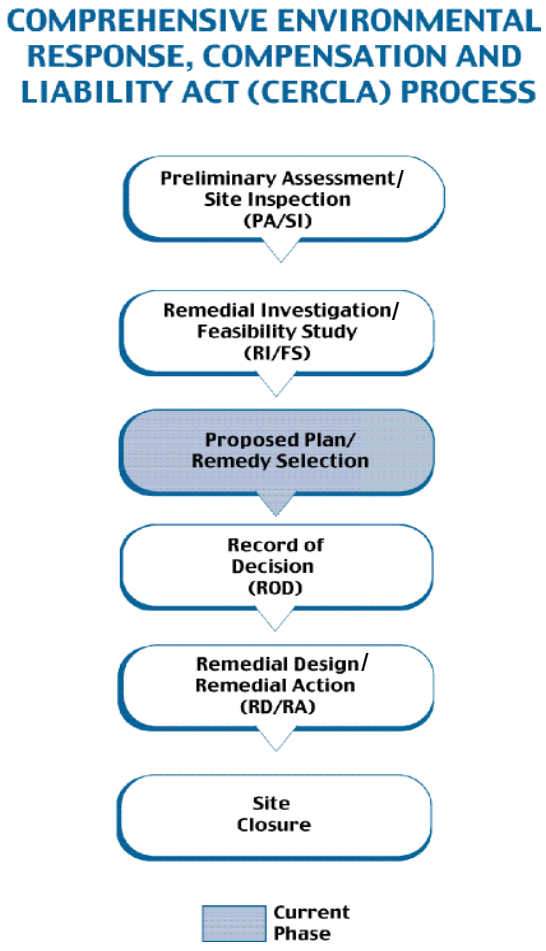
The Superfund Process

The **remedial investigation (RI)** for OU1**,** which characterizes the site conditions, determines the nature and extent of the surface and subsurface mine material at the site, and assesses risk to human health and the environment, was completed in January 2012. The **feasibility study (FS)** for OU1, which identifies, develops, screens, and evaluates remedial alternatives to address risks to human health and the environment from mine materials, was completed in January 2013. The OU2 baseline ecological risk assessment (BERA), completed in July 2014, documents the surface water conditions and the effects of **mining-influenced water**

on the aquatic environment downstream of the Formosa Mine.

After finalizing the RI/FS, a preferred alternative is presented to the public in a proposed plan (this document). The proposed plan briefly summarizes the alternatives studied in the detailed analysis phase of the FS and highlights the key factors that led to identifying the preferred alternative. The purpose of the proposed plan is to summarize the RI/FS information and provide the public with an opportunity to comment on the preferred alternative, as well as other alternatives that were considered. The proposed plan provides the public the opportunity to provide comments to EPA on the preferred alternative. Following receipt and evaluation of public comments, including final comment from the support agencies, EPA will select and document the remedial action in the ROD. *Exhibit 2* outlines the Superfund process.

Exhibit 2: CERCLA or Superfund Process



Site Background

The Formosa Mine Superfund Site is an abandoned mine located in southwest Oregon in Douglas County, approximately 25 miles south of Roseburg, Oregon, and 7 miles south of Riddle, Oregon.

The Site has been mined by several operators at various times during the past 80 years. Early exploration began in 1910, and historic underground **mining** occurred during the 1920s and 1930s. After decades with little activity, new exploration occurred in the 1980s. Modern mining was conducted by Formosa Exploration Inc. (FEI) from 1990 to 1993. Production of copper and zinc were the primary metals, with some gold and silver as a byproduct.

In 1993, onsite inspections by the Oregon Department of Geology and Mineral Industries (DOGAMI) revealed several violations of state permit requirements, and a subsequent notice of violation was issued to FEI. By August 1993, DOGAMI had issued a closure notice for failing to correct the problems identified in the notice of violation. After mine closure, FEI conducted reclamation from 1993 to 1994. Despite these reclamation efforts, preventing a release of chemicals from the surface mine materials was not successful.

In the late 1990s and early 2000s, ODEQ evaluated contamination remaining at the Site and replaced the aged **adit water diversion system** for the Formosa 1 and Silver Butte 1 adits built by FEI to prevent **mining-influenced water** discharge from directly flowing into surface water. In 2005, citizens petitioned EPA to consider adding the site to the **National Priorities List (NPL)**. In 2006, ODEQ completed emergency repairs on the adit water diversion system after a pipeline joint had become separated, which resulted in discharges of up to 48 gallons per minute of adit water to the ground surface near Upper Middle Creek. EPA added the Site to the NPL in 2007.

EPA conducted two separate emergency response actions in 2008 and 2009 to maintain and repair the adit water diversion system. BLM has maintained the adit water diversion system since 2009. EPA initiated the RI sampling in October 2009 and presented results in a final RI report in January 2012. EPA completed the FS the following year in January 2013.

Site Characteristics

The Site is located in Douglas County, Oregon on Silver Butte in the Coast Range of the Klamath Mountains at an approximate elevation of 3,700 feet. The 24-acre **primary mine disturbance area (PMDA)** is at the headwaters of several watershed drainages and surrounded by steep mountainous terrain. Two of these watershed drainages, Upper Middle Creek and South Fork Middle Creek, have been impacted by the release of mine materials and mine-related water from the Site. See *Exhibit 3,* a foldout map, at the end of this plan.

During mine reclamation by FEI, some of the surface mine materials were placed within an existing water storage lagoon, now called the **encapsulation mound,** which contains **tailings** and low-grade ore. Mounded low-grade ore and a manufactured clay layer with a soil cap cover the encapsulation mound. The material within the encapsulation mound is fully saturated. The encapsulation mound shows signs of overflow and erosional damage along with a poorly established vegetative cover, especially on the steep side slopes. The steep side slopes contain acid generating rocks, which are impacting groundwater and surface water, and prevent vegetation from growing on them.

The underground mine and associated underground mine entrances were constructed over various periods of operation and are inaccessible because the portals were sealed (backfilled) as part of reclamation in the 1990s. Mining-influenced water discharges from one underground mine entrance, the Formosa 1 Adit.

At locations where the adit water diversion system has discharged or leaked, soil and groundwater have been affected by mining-influenced water. The impacted soils and the encapsulation mound are included as part of OU1. The adit water discharge is being addressed by BLM through a NTCRA and is not part of the OU1 cleanup plan.

Approximately 234,000 cubic yards (CY) of OU1 mine materials are found within the PMDA. These materials are predominantly mixed piles of waste rock and construction rock although some tailings do exist in the encapsulation mound. Significant quantities of these wastes are found at all adits, on and beneath road surfaces, and in other areas disturbed by mining activities within the PMDA. Most of these materials are sources of contamination that pose a potential or actual release of hazardous substances and impact the ground and surface water quality at the site.

Conceptual Site Model

A conceptual site model was developed for the Site to show how contaminants enter the environment, how they are transported, and how humans and animals may be exposed. See *Exhibit 4,* a foldout figure, at the end of this plan. The model provides a framework to assess risks from contaminants, develop cleanup strategies, and determine contaminant source control requirements and methods to address unacceptable risks. The following information describes elements of the conceptual site model.

Current and Future Land Use

The site and surrounding land are within federal and private timber lands designated for timber harvest, mining, and recreational use (hiking, hunting, fishing). There are mining claims within the area, the closest being 1,500 feet northwest of the edge of the northern boundary of the PMDA. There are no residences within these lands nor would there be anticipated future residential development. The closest residence is 3.75 miles, as the crow flies, from the Site. Future land use is anticipated to remain as timber harvesting, mining, and recreational use. Designated Critical Habitat for Northern Spotted Owl is present in the vicinity of the Formosa Mine, but OU1 (PMDA) does not fall within the habitat. There are no other special habitat designations in this area. As part of the remedy selection process, EPA has completed notifications of Natural Resource Trustees, and government consultations were conducted regarding threatened or endangered species. A habitat survey for the Northern Spotted Owl was completed in 2014 by BLM for the Formosa Mine area and follow up, if needed, will continue in 2015.

How Acid Rock Drainage Is Created

The Formosa Mine exploited a natural deposit of rock that is enriched in metals and sulfide minerals (e.g., pyrite). The mining process brought broken rock containing ore to the surface. The ore was then crushed and processed to separate payable metals (e.g., copper), and waste mine materials were deposited on the surface and back in the mine workings. These waste mine materials, especially those that contain sulfide minerals (e.g., pyrite), generate **acid rock drainage** when exposed to water, oxygen, and bacteria. Mining-influenced water is a term used to describe acid rock drainage once it is generated and transported from the source. See *Exhibit 4*, a foldout figure, at the end of this plan for a diagram of the acid rock drainage and mining-influenced water process. The materials left on the

surface are exposed to rain and snowmelt and create mining-influenced water, which is very acidic and contains heavy metals.

OU1 mine materials, such as waste rock, tailings, and mixtures of waste rock with soils, are source materials for acid rock drainage generation and metals contamination. Cleanup of the OU1 mine material sources is the focus of this proposed plan and is intended to minimize effects to surface and groundwater at the site from these sources.

A major waste area called the encapsulation mound is a previous water containment pond that was used to dispose and contain tailings and mine waste when the mine closed. Tailings within the encapsulation mound are currently contained within a lined pond and submerged in water, which reduces the tailings exposure to oxygen and prevents the generation of acid rock drainage. However, the existing cover is not effective at preventing precipitation from infiltrating the mine wastes in the encapsulation mound, and the added water overflows from the pond and impacts groundwater and surface water.

How People and Wildlife Are Exposed to Contamination

Contamination can be carried from the Site by surface water, groundwater, and erosion. Migration of contaminants in surface water and groundwater will be addressed in OU2.

People near Formosa Mine, such as hikers or workers, may be exposed to OU1 contamination by dermal contact (touching), inhaling (breathing), or ingesting (eating) mine materials.

- Dermal (skin) contact (touching) can happen when chemicals from contaminated dust are absorbed through the skin.
- Incidental ingestion (eating) can happen when people, especially children, swallow soil that sticks to their hands during outdoor activities.
- Inhalation (breathing) of airborne soil particles can happen when contaminated dust is suspended in air by wind or mechanical disturbance.

Wildlife can be exposed by direct contact, ingesting and inhaling mine materials. Vegetation can uptake contamination through its root system, and growth can be inhibited by the lack of suitable soil. Fish and other aquatic life are exposed from leaching and erosion of mine materials into streams. Because the PMDA does not support the types or quantity of plants or wildlife sufficient for humans to eat, the **exposure** from eating vegetation or animals at the Site were not evaluated because the exposure was deemed insignificant. Aquatic life exposed to the mine materials (both soils and water) are adversely impacted.

Scope and Role of the Proposed Plan

Descriptions of OU1 and OU2

OU1 includes all surface and subsurface mine materials deposited outside of the underground mine workings. These materials are considered a major source of contamination to surface water and groundwater. The OU1 RI determined and documents the nature and extent of the surface and subsurface mine materials. The OU1 RI report also includes an initial evaluation of surface water and groundwater, which are components of OU2 to be further evaluated in the OU2 remedial investigation.

OU2 includes surface water, stream sediment, groundwater, underground workings, and adit water drainage. Actions for OU2 are being deferred to evaluate the impacts of addressing OU1 and the BLM NTCRA prior to proposing a cleanup approach for the water-related components of the Site.

Summary of OU1 Investigation

OU1 mine materials cover an area of approximately 25 acres and were characterized during the OU1 RI using a combination of field and laboratory characterization methods. Over 900 samples were analyzed by a field geochemical characterization procedure. Field data, such as rock composition, paste pH and x-ray fluorescence, provide additional information to evaluate the geochemistry and extent of OU1 mine materials. A subset of these samples was submitted for laboratory analysis for metals concentrations as well as acid base accounting and modified synthetic precipitation leaching procedure (used to determine the ability of the rocks to generate acidity and leach metals).

This information was used to determine the nature and extent of the OU1 mine materials. More specifically, the field and laboratory data were used to:

- Characterize the mine materials with respect to acid rock drainage generation potential and metal content

- Delineate the extent of OU1 mine materials
- Evaluate whether there are potentially recoverable quantities of precious metals in the mine materials
- Identify acid rock drainage generating rock outcrops
- Determine if OU1 mine materials pose unacceptable human health and ecological site risks

Exhibit 5 summarizes laboratory results for metals identified in the risk assessment as either a potential cancer risk to human health or adversely affecting aquatic resources.

Summary of Site Risks

Human health and ecological risk assessments estimate the health risks to people and the environment from exposure to mine materials either now or in the future. For EPA studies, "risk" is the possible harm to people or wildlife from exposure to chemicals. Two types of health risks for people are evaluated: the risks that can cause cancer and the risks that can cause other health effects. EPA evaluates only non-cancer risks to wildlife.

EPA uses the results of our risk assessment to determine if the contamination at a site poses an unacceptable risk to human health or the environment under CERCLA. The CERCLA regulations give us a range of risk numbers to use in deciding if federal cleanup is necessary. EPA established an "acceptable" extra cancer risk range, from 1 in 10,000 to 1 in 1,000,000 of developing cancer from exposure to a site contaminant over a person's lifetime.

For non-cancer health effects, EPA calculates a hazard quotient (HQ) or hazard index (HI) for both humans and wildlife. A hazard index is the sum of the hazard quotient for several chemicals that have the same or similar effects. The non-cancer hazard index has a threshold below which EPA does not expect any non-cancer health effects. If the HQ or HI is 1 or higher, it is possible that exposure to site contaminants could be a risk to humans or wildlife's health.

OU1 was divided into three exposure areas (EA) based on anticipated contaminant concentration levels. Potential human health and ecological risks associated with exposure to these three areas were evaluated during the OU1 RI:

- **EA-1:** This area covers the entire PMDA. These materials are a source of metal contamination, via leaching from precipitation, to groundwater and surface water. EA-1 does not pose unacceptable risks to human health but does result in unacceptable risk to aquatic ecological receptors as identified in the OU2 BERA. Cadmium, copper, and zinc are the chemicals of concern impacting aquatic organisms. Calculated risks to terrestrial receptors are identified but considered insignificant because of marginal habitat for exposure.
- **EA-2:** The soils located immediately downslope of mine materials in EA-1. This area was selected to determine if material beyond the PMDA posed unacceptable risks. EA-2 does not pose unacceptable risks to human health. Calculated risks to terrestrial receptors are identified but considered insignificant because of marginal habitat for exposure.
- **EA-3:** Areas that are visibly affected as a result of discharge from existing and former adit water diversion system pipeline and drainfields. Exposure to arsenic within mine materials at this EA results in cancer risk greater than the other EAs, but the extra risk is within EPA's acceptable range. Human exposure to groundwater is being addressed in OU2.
- **RI report.** Ecological exposure to surface water is evaluated in the OU2 BERA that documents the adverse effects of mine materials to aquatic wildlife. Potential effects to terrestrial wildlife are calculated in the OU1 RI and determined to be insignificant because exposure to metal contamination is limited by marginal habitat at the Formosa Mine Site.

Exhibit 5: Summary of Chemicals of Concern

Media	Number of Samples Used in Risk Assessment	Chemical Concentration Range (mg/kg)											
		Arsenic			Cadmium			Copper			Zinc		
		Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
EA-1 – Surface Soil	50	0.41 J	83	778 J	0.11	3	29.2	24.6	771	6,860 J	21.4	741	6,190 J
EA-1 – Subsurface Soil	42	0.56 J	61	603	0.1 J	5	51.2	4.1	917	8,400 J	18 J	1066	12,100 J
EA-2 – Surface Soil	11	1.03	8	23.47	0.56	1	1.76	34.23	163	306	99.03	211	408.33
EA-3 – Surface Soil	5	247	421	576	0.038J	0.19	0.28	268	362	491	63.7	148	211
Klamath Mountains	*	12			0.52			110			140		

Notes: 1 milligram per kilogram (mg/kg) is equal to 1 part per million (ppm).
Mean is the arithmetic mean of detected values
*Klamath Mountains regional values from ODEQ Fact Sheet *Background Levels of Metals in Soils for Cleanups* (March 2013)
Cadmium, Copper, and Zinc are aquatic chemicals of concern from the OU2 BERA.

Human Health Risks

Human health risks from exposure via inhalation, ingestion, and direct contact (dermal) to mine materials were evaluated for current and future workers, visitors, and offsite residents. The study included evaluation of exposure to offsite residents to dust caused by wind dispersion. Estimated cancer risks for all populations, both current and future, are within or below the EPA acceptable range of 1 in 10,000 to 1 in 1,000,000 over a person's lifetime. The maximum carcinogenic risk was 6 in 100,000 to an outdoor worker exposed to arsenic at EA-3, primarily through ingestion of soils. Current and future non-cancer risks were all less than a HI of 1, with the exception of a HI of 2 for future onsite construction worker at EA-1 from ingesting arsenic contaminated soils. However, the HI of 2 does not represent an actual risk because, when segregated by target organ, individual hazard quotients are all below the acceptable hazard benchmark of 1.0.

Ecological Terrestrial Risks

The ecological risk assessment identified chemicals of concern in surface and subsurface soils that occur at concentrations that may cause adverse effects to terrestrial wildlife (deer, birds, bugs) and vegetation. The chemicals of concern are presented below:

- **EA-1:** Arsenic (HQ of 6 for plants), cadmium (HQ of 14 for mammals), copper (HQ of 36 for birds), lead (HQ of 15 for birds), mercury (HQ of 33 for soil invertebrates), nickel (HQ of 5 for plants), selenium (HQ of 5 for plants), and zinc (HQ of 22 for birds)
- **EA-2**: Cadmium (HQ of 5 for mammals), copper (HQ of 11 for birds), manganese (HQ of 12 for plants), and zinc (HQ of 9 for birds)
- **EA-3**: Arsenic (HQ 23 for plants), copper (HQ of 13 for birds), and zinc (HQ of 3 for birds)

Because there is no foraging or nesting habitat within the PMDA, these risks are considered an overestimation of actual effects for terrestrial wildlife in the area. EPA determined cleanup solely to address these overestimated risks is not warranted. EPA is presenting them to be consistent with information in the OU1 RI.

Ecological Aquatic Risks

EPA completed the OU2 BERA in July 2014 that demonstrates the current risks to aquatic wildlife by releases from the mine. Although these risks cannot be attributed solely to the OU1 materials (soils), there is a reasonable expectation that soils are contributing to the adverse impacts identified in the OU2 BERA.

- **Middle Creek**: Cadmium (HQ of 57 for fish), copper (HQ of 58 for fish), zinc (HQ of 27 for fish); the cumulative HQ is 141.
- **South Fork Middle Creek**: Cadmium (HQ of 38 for fish), copper (HQ of 41 for fish), zinc (HQ of 23 for fish); the cumulative HQ is 102.

Remedial Action Objectives and Preliminary Remediation Goals

Remedial action objectives (RAOs) are identified in the feasibility study. The RAOs for this remedy are based principally on protection of ecological receptors and incidentally will provide protection for anticipated future use by people, primarily for recreational and commercial (logging) purposes. These objectives focus on contaminant source control to prevent further migration of metal contamination into surface water and groundwater. However, surface water and groundwater will be addressed under OU2 and not in this action.

The RAOs are:

1. Manage mine materials to minimize and control impacts to ecological receptor populations and communities, including individuals of threatened and endangered species from chemical migration. This objective is a source control objective and was established to protect terrestrial and aquatic receptors from mine materials. This objective will be met by successful revegetation of terrestrial areas, improvements of benthic macroinvertebrate communities in surface water, and reduced metal concentrations in groundwater. OU2 will fully address surface and groundwater and provide cleanup levels for those media.

2. Minimize the generation of acid rock drainage to reduce impacts to surface water and groundwater. This objective was established to improve conditions in surface water to support aquatic life habitat. This objective will be met by monitoring benthic macro invertebrate communities in surface water and monitoring the alluvial aquifer for reductions in **chemicals of concerns** (**COCs)** and reduced acidity. OU2 will fully address surface and groundwater and provide cleanup levels for those media.

RAO 1 and RAO 2 establish that mine materials will be managed to protect habitat and wildlife by reducing contaminated mine wastes from contributing metals to surface and groundwater via leaching or erosion. To achieve RAOs, mine materials will be distinguished from surrounding soil and rock during the OU1 cleanup. The extent of mine materials and area to be remediated were estimated during the OU1 RI and FS using information from drilling and trenching investigations. This area will be redefined during the design. Managing the mine materials will include processes such as removal, capping, isolation barriers, containment, and treatment.

Preliminary remediation goals (PRGs) are concentrations below which contaminants do not pose an unacceptable risk. For cancer risk, EPA has established an acceptable range of extra risk between 1 in 10,000 to 1 in 1,000,000 over a person's lifetime but prefers the acceptable extra cancer risk to be 1 in 1,000,000 or less. The goal of 1 in 1,000,000 for acceptable excess cancer risk is also consistent with Oregon Statute (ORS) 465.315(1)(b)(A).

As stated in the summary of site risks, cancer risk to humans from exposure to OU1 mine materials was determined to be acceptable.

Although risks to terrestrial wildlife were considered minimal because there are no foraging opportunities or habitat within the PMDA, there are calculated risks for terrestrial exposure that show if, or when, the area became habitat, there would be risk. Risks to aquatic wildlife in Middle Creek and South Fork Middle Creek have been evaluated for OU2 and have been determined to have adverse effects. Hazard quotients exceed 100 in Middle Creek and South Fork Middle Creek. This is demonstrated by fish and benthic macroinvertebrate surveys conducted for OU2 and exceedances of water quality standards. There are severe impacts on fish and benthic macroinvertebrates in streams adjacent and downgradient of the Site. OU1 mine materials are a significant source of contamination contributing to aquatic impacts. Reducing the contribution of metals from OU1 mine materials to surface waters will reduce the impacts to aquatic wildlife. EPA will monitor benthic macroinvertebrate communities and for the presence of fish in streams to assess the impacts of remedial actions at OU1. Monitoring levels of COCs in surface waters will also be conducted to assess improvement.

Summary of Remedial Alternatives

EPA identified a range of potential cleanup methods and technologies that protect human health and the environment and used them to develop remedial alternatives. The alternatives initially screened during the FS consist of varying combinations of those technologies to create remedy components (*Exhibit 6*).

The alternatives mainly differ in the use of various remedy components such as:

- Are the mine materials **covered** in place or excavated for disposal elsewhere?
- Are the tailings within the encapsulation mound submerged in place either with or without additives introduced for treatment, or are they excavated and treated for disposal elsewhere?
- Are excavated mine materials disposed of within a new facility constructed within the PMDA, a new facility constructed outside the PMDA but still on site, or at an existing offsite location?

Exhibit 6: Remedy Components Used in Remedial Alternatives

Remedy Component Used	Remedial Alternative					
	1	2	3	4	5	6
Five-year site reviews and monitoring	●	●	●	●	●	●
Institutional controls, community awareness activities, access controls		●	●	●	●	●
Partial in-place covering of mine materials		●	●			
Containment of tailings within encapsulation mound by submerging in place		●				
Treatment of tailings within encapsulation mound by submerging in place with the introduction of additives			●			
Excavation and treatment of tailings outside of encapsulation mound				●	●	●
Excavation and consolidation/disposal of mine materials within PMDA		●	●	●	●	
Excavation and consolidation/disposal of mine materials outside PMDA			●	●	●	●
Excavation and consolidation/disposal of mine materials at existing permitted facility					●	

Shaded alternative was eliminated from consideration prior to detailed analysis in FS.

Six alternatives, shown in *Exhibit 6,* were evaluated in the FS. Because Alternative 5 resulted in high costs and low implementability, it was screened out in the FS and is not discussed further in the OU1 Proposed Plan.

All alternatives utilize the same methods for identifying materials requiring remediation. Specific qualitative and quantitative criteria and field methods, such as mineral composition of the rock, paste pH, and x-ray fluorescence, were developed and used during the OU1 RI to delineate the extent of mine materials from surrounding soil and rock. The depth of the contaminated mine materials across this area were estimated during the OU1 RI using information gathered from drilling and trenching investigations. This information was used in the OU1 FS to determine the extent of mine materials requiring cleanup to meet RAOs. The field methods presented in the OU1 RI to define mine materials can be used as necessary during cleanup to determine that contaminated mine materials have been fully identified and adequately addressed to meet RAOs. Materials adjacent to stream headwaters and waste rock dumps, which are unstable and at significant depth, would be prioritized for excavation and subsequent containment.

Remedial Alternatives Retained for Detailed Analysis

With the exception of Alternative 1, which is required by CERCLA, the other alternatives are expected to be protective of human health and the environment by meeting the RAOs. The retained alternatives are also expected to comply with state and federal **applicable or relevant and appropriate requirements** (**ARARs**) as required by Superfund law. Final ARARs will be determined in the OU1 ROD.

Description of Alternatives

Alternative 1 – No Further Action

Estimated **Capital Costs**: $0
Estimated Total Operation and Maintenance (**O&M) Costs** (30 years): $0
Estimated Total **Periodic Costs** (30 years): $300,000
Estimated Total **Present Value Costs**: $115,000
Estimated Construction Timeframe: None
Estimated Time to Achieve RAOs: Will never comply with RAOs

Alternative 1 would leave mine materials at the Site (approximately 234,000 CY) in their current condition, and no additional cleanup action would be performed. Regulations governing the Superfund program require that the "no action" alternative be evaluated to establish an environmental baseline for comparison with other alternatives.

Five-year site reviews would be performed as required by law to evaluate whether the remedy is protective. Monitoring would only be performed as necessary to support the five-year site reviews. This alternative is not protective of human health or the environment and does not comply with ARARs and the RAOs**.**

Alternative 2 – In-Place Containment, Continued Submergence of Tailings within Encapsulation Mound, and Limited Excavation/Disposal of Mine Materials at Proposed Facility within PMDA

Estimated Capital Costs: $5,075,000
Estimated Total O&M Costs (30 years): $750,000
Estimated Total Periodic Costs (30 years): $330,000
Estimated Total Present Value Costs: $5,553,000
Estimated Construction Timeframe: 1 Year
Estimated Time to Achieve RAOs: Upon completion of remedial action

Alternative 2 includes in-place containment of the majority of highly acid-generating mine materials adjacent to creek headwaters and a combination of various covers to reduce the generation of acid rock drainage, including the encapsulation mound. The targeted mine materials for limited excavation would be from the east waste rock dumps adjacent to the encapsulation mound, illegal dump area, Formosa 1 Adit and Formosa 3 Adit waste rock dumps, mine materials along the upper side slopes of the encapsulation mound, and adit water diversion affected soils in EA-3. The specific qualitative and quantitative criteria and field methods described under the "Remedial Action Objectives and Remediation Goals" section would be used to identify contaminated mine materials to be covered and/or removed within these areas; a total of 234,00 CY are estimated to be addressed under this alternative. Approximately 72,000 CY would be excavated and placed at a proposed disposal facility within the PMDA located at the encapsulation mound, which would be capped with a manufactured cover layer and vegetation layer. A combination of manufactured cover layers, pavement covers, and exposure barriers would be implemented for remaining mine materials not targeted for excavation to reduce generation of acid rock drainage. Pavement covers would be constructed over mine materials within road alignments. Drainage would be provided to minimize infiltration and erosion.

Tailings within the encapsulation mound are currently contained within a lined pond and submerged in water, which reduces the tailings exposure to oxygen and prevents the generation of acid rock drainage. However,

the existing cover is not effective at preventing precipitation from infiltrating the mine wastes in the encapsulation mound. The encapsulation mound with the added mine materials would be capped with a manufactured cover layer while leaving the encapsulation mound contents submerged in place.

Excavated areas or areas disturbed during completion of the remedy would be regraded and seeded or covered in rocks/gravel. Roads removed during excavation would be re-constructed using clean native materials and road gravel.

Additional provisions of this alternative include:

- **Administrative controls**, consisting of institutional controls, community awareness activities, and access controls (fences and posted warnings), would protect covered areas and the disposal facility located at the encapsulation mound, as well as provide awareness of risks from potential exposure to mine materials.
- Long-term operation and maintenance (O&M) would preserve the integrity of covers and the proposed disposal facility within the PMDA. The State of Oregon will be responsible for long-term O&M once the remedy is operational and functional.
- Monitoring surface water and five-year site reviews would be performed to determine whether the remedy remains protective for human health and the environment.

Alternative 3 – Limited In-Place Containment, Chemically Reduced Submergence of Tailings within Encapsulation Mound, and Excavation/Disposal of Mine Materials at Proposed Facilities within and outside PMDA

Estimated Capital Costs: $8,878,000
Estimated Total O&M Costs (30 years): $553,000
Estimated Total Periodic Costs (30 years): $330,000
Estimated Total Present Value Costs: $9,275,000
Estimated Construction Timeframe: 2 Years
Estimated Time to Achieve RAOs: Upon completion of remedial action

Alternative 3 protects human health and the environment by excavating all OU1 mine materials except the encapsulation mound. The specific qualitative and quantitative criteria and field methods described under the "Remedial Action Objectives and Remediation Goals" section would be used to identify contaminated mine materials to be covered and/or removed within these areas; a total of 234,000 CY are estimated to be addressed under this alternative. Approximately 194,000 CY of mine materials would be excavated and capped for this alternative. The remaining 40,000 CY would be managed in place by either capping or capping and water diversion.

The removed materials would be placed in two disposal facilities, one within and one outside the PMDA. The proposed disposal facility within the PMDA would be constructed as described for Alternative 2.

The proposed disposal facility outside of the PMDA would be engineered and constructed to limit migration of contaminants. This disposal facility would cover the mine materials and control surface water run-on/runoff. Excavated areas or areas disturbed during completion of the remedy work would be reclaimed as described in Alternative 2.

Treatment of tailings within the encapsulation mound would be completed by leaving the tailings submerged in place and introducing additives, such as molasses, to initiate and enhance in-place biological treatment. The additives would increase the ability of natural bacteria to transform minerals into a less leachable form, thus, immobilizing them within the encapsulation mound.

Administrative controls, maintenance, monitoring, and five-year site reviews are the same as those described for Alternative 2. Additional access controls, such as fencing, and monitoring of covers and other facility features, would be implemented as required at the proposed disposal facility outside of the PMDA.

Alternative 4 – Excavation, Stabilization/Solidification of Tailings, and Disposal of Mine Materials at Proposed Facilities within and outside PMDA

Estimated Capital Costs: $10,010,000
Estimated Total O&M Costs (30 years): $553,000
Estimated Total Periodic Costs (30 years): $330,000
Estimated Total Present Value Costs: $10,407,000
Estimated Construction Timeframe: 2 Years
Estimated Time to Achieve RAOs: Upon completion of remedial action

Alternative 4 excavates and places all OU1 mine materials, including encapsulation mound tailings, at disposal facilities within and outside the PMDA. The proposed disposal facilities within and outside of the PMDA would be constructed as described for Alternative 3. The specific qualitative and quantitative criteria and field methods described under the "Remedial

Action Objectives and Remediation Goals" section would be used to identify contaminated mine materials to be covered and/or removed within these areas; a total of 234,000 CY are estimated to be addressed under this alternative. Tailings removed from the encapsulation mound would be dewatered and treated with an additive, such as Portland cement, to bind the contaminants and reduce further release of contamination. Excavated areas or areas disturbed during completion of the remedy work would be restored as described in Alternative 2. Administrative controls, maintenance, monitoring, and five-year site reviews would be the same as described for Alternative 3.

Alternative 6 – Excavation, Stabilization/Solidification of Tailings, and Disposal of Mine Materials at Proposed Facility outside PMDA

Estimated Capital Costs: $10,092,000
Estimated Total O&M Costs (30 years): $553,000
Estimated Total Periodic Costs (30 years): $330,000
Estimated Total Present Value Costs: $10,489,000
Estimated Construction Timeframe: 3 Years
Estimated Time to Achieve RAOs: Upon completion of remedial action

Alternatives 4 and 6 are similar except all excavated materials in Alternative 6 will be placed in a proposed disposal facility outside the PMDA. The proposed disposal facility outside of the PMDA would be engineered and constructed to limit migration of contaminants. This disposal facility would cover the mine materials and control surface water run-on/runoff. Excavated areas or areas disturbed during completion of the remedy work would be reclaimed as described in Alternative 2. Administrative controls, maintenance, monitoring, and five-year site reviews would be implemented as described for Alternative 3.

Comparative Evaluation of Alternatives

The federal Superfund law requires that alternatives be evaluated using the nine criteria described in *Exhibit 7*. These criteria are grouped into three categories: threshold, balancing, and modifying.

The preferred alternative (except No Further Action) must meet the two threshold criteria. The five balancing criteria weigh tradeoffs and are used to compare the alternatives; a low rating on one balancing criterion can be compensated by a high rating on another. The two modifying criteria consider public and state concerns and are not completed until after the public comment period.

Exhibit 7: Evaluation Criteria for Remedial Alternatives

Evaluation Criteria		
THRESHOLD CRITERIA	**Overall protection of human health and the environment**	Determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, access controls, containment, treatment, or other remedial actions.
	Compliance with ARARs	Evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that are ARARs or whether a waiver is justified.
BALANCING CRITERIA	**Long-term effectiveness and permanence**	Considers the ability of an alternative to maintain protection of human health and the environment over time.
	Reduction of toxicity, mobility, or volume through treatment	Evaluates an alternative's use of treatment to reduce (a) the harmful effects of principal contaminants, (b) the contaminant's ability to move in the environment, and (c) the amount of contamination remaining after remedy implementation.
	Short-term effectiveness	Considers the length of time needed to implement an alternative and the risk the alternative poses to workers, residents, and the environment during implementation.
	Implementability	Considers the technical and administrative feasibility of implementing the alternative, including factors such as the availability of materials and services.
	Cost	Includes estimated capital and annual operations and maintenance costs as well as present value cost. Present value cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent of actual cost.
MODIFYING CRITERIA	**State/Support agency acceptance**	Considers whether the state agrees with EPA's analyses and recommendations as described in the RI/FS and proposed plan.
	Community acceptance	Considers whether the local community agrees with EPA's analyses and preferred alternative. Comments received on the proposed plan are an important indicator of community acceptance.

The FS provides a detailed description of how the comparison of alternatives was made, but a general summary is included in this proposed plan.

Overall Protection of Human Health and the Environment

All of the alternatives, except Alternative 1, protect human health and the environment. Since Alternative 1 is not protective, it will not be discussed further.

Alternative 2 protects the environment by installing in-place covers for the majority of mine materials to reduce generation or acid rock drainage, with excavation and disposal of targeted mine materials at a proposed facility within the PMDA. Tailings would continue to be submerged within the covered encapsulation mound to limit acid rock drainage generation. Covering provides an exposure barrier to the mine materials and reduces the generation of acid rock drainage. However, mine materials still remain beneath covers across a large extent of OU1 and could pose risks if the covers are compromised.

Alternatives 3, 4, and 6 protect human health and the environment by excavating and disposing of mine materials at proposed disposal facilities. Long-term protection of human health and the environment is more certain than leaving mine materials in place. Alternatives 3, 4, and 6 would provide better protection than Alternative 2 because the disposal facility outside the PMDA could be sited, engineered, and constructed to limit the migration of contaminants. Alternative 3 treats submerged tailings using additives, such as molasses, to initiate in-place biological treatment, and Alternatives 4 and 6 treat tailings using solidification/stabilization prior to disposal to reduce further acid rock generation. However, the volume of tailings is small relative to the overall volume of mine materials.

Compliance with ARARs

Three key ARARs significantly affected EPA's evaluation of the remedial alternatives listed above:

1. The Oregon Hazardous Substance Remedial Action Rules (OAR 340-122-0115(2)(a)) define "acceptable risk level for human exposure to individual carcinogens" as a lifetime excess cancer risk of less than or equal to 1 per 1,000,000 (1 E-06) for an individual at an upper-bound exposure.

2. The Oregon Hazardous Substance Remedial Action Rules (OAR 340-122-0040(2)(c)) affect the development of the PRG for arsenic. Because of this rule, the determination of a PRG for arsenic is not solely based on the determination of risk but also whether that risk represents concentrations above background concentrations for the site.

3. The Oregon Revised Statute (ORS 459) governs the management of solid wastes at land disposal sites other than municipal solid waste landfills. Substantive requirements would be applicable for any management and disposal of mine materials in proposed facilities within or outside of the PMDA.

In general, Alternatives 2, 3, 4, and 6 are expected to comply with the chemical-, location-, and action-specific ARARs identified in the FS. No key ARARs significantly differ between these alternatives.

Long-term Effectiveness and Permanence

Alternative 2 provides long-term effectiveness and permanence primarily through in-place covering of mine materials with limited removal and disposal of targeted materials at a proposed disposal facility within the PMDA. Tailings would continue to be submerged within the covered encapsulation mound to limit acid rock drainage generation. Proper construction of the covers would limit direct exposure to mine materials by people, reduce infiltration of water, and prevent acid rock drainage generation and mining-influenced water migration, but the materials covered and left in place could pose risks if the covers ever deteriorate. Because mine materials would remain in place on steep slopes, long-term effectiveness and permanence is not as certain for alternatives that excavate contaminated mine materials and dispose of them in proposed facilities constructed with shallower slopes. The use of stability measures, such as retaining walls, may be needed to maintain slope stability.

Alternative 3 provides long-term effectiveness and permanence primarily through removal and disposal at proposed disposal facilities within and outside the PMDA. Disposal of mine materials at a location outside the PMDA increases effectiveness because it would be constructed with shallower slopes than are currently present at the site and would be engineered and constructed to limit the migration of contaminants. Alternative 3 also treats submerged tailings using additives to initiate in-place biological treatment and further reduce acid rock drainage generation. Alternative 4 is similar to Alternative 3 but includes removal and treatment (stabilization/solidification) of tailings outside of the encapsulation mound, which increases the long-term effectiveness and permanence of the remedy compared to alternatives without additional treatment.

Alternative 6 is similar to Alternative 4 with the exception that all mine materials would be disposed of at a proposed disposal facility outside the PMDA. The proposed disposal outside the PMDA could be designed to be fully contained and capable of collecting leachate for treatment and sited at a more environmentally favorable location than the PMDA to enhance permanence. The use of one disposal facility outside of the PMDA, coupled with the removal of all mine materials from the PMDA, would also increase long-term effectiveness by decreasing the environmental footprint (measured by surface area) of mine materials as compared to Alternative 4, making Alternative 6 the best alternative for long-term effectiveness and permanence.

All alternatives, with the exception of Alternative 6, include disposing of mine materials at a proposed disposal facility within the PMDA located at the encapsulation mound. Long-term stability of this location is not as certain as proposed facilities constructed with shallower slopes at other locations.

Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Alternatives 2, 3, 4, and 6 reduce toxicity, mobility, and volume through treatment of the tailings within the encapsulation mound. The tailings are a relatively small percentage of the volume of mine materials within OU1. In Alternative 2, tailings would continue to be submerged within the encapsulation mound under the new cover of the disposal facility within the PMDA, which reduces acid rock drainage generation. Alternative 3 would increase treatment of tailings through the introduction of additives to the tailings within the encapsulation mound to initiate in place biological treatment and further reduce acid rock drainage generation. These tailings would again be covered by the new cover of the disposal facility within the PMDA.

Under Alternatives 4 and 6, tailings would be treated by stabilization/solidification prior to disposal. Treatment would provide additional protection to groundwater from generation of acid rock drainage and migration of mining-influenced water from the tailings after disposal within a proposed facility outside of the PMDA. Water removed from the tailings would also be treated.

Short-term Effectiveness

Alternative 2 addresses short-term risks to workers, the community, and the environment primarily through in-place containment of mine materials. Limited excavation of mine materials and disposal at the proposed facility within the PMDA would require some disturbance of mine materials. While limited excavation of mine materials and construction of covers would involve surface disturbance of mine materials, short-term risks to workers would be prevented through the use of safety measures, such as personal protective equipment, dust suppression, and other best management practices. This alternative has the shortest construction duration compared to the other alternatives. However, trucks used to haul offsite materials, such as cover materials, as well as reclamation within the PMDA, increase short-term risks to the community. Transport and placement of borrow materials have potential environmental impacts from equipment emissions and disturbance of borrow locations. These factors affect overall short-term effectiveness.

Alternatives 3, 4, and 6 involve excavation of mine materials, which creates a greater short-term disturbance, and the construction of the proposed facility outside of the PMDA will increase the duration of construction. Hauling of mine materials to the proposed facility outside of the PMDA and additional construction materials to build the facility outside the PMDA increase truck traffic and related risks to workers and the community compared to Alternative 2. Potential environmental impacts include increased equipment emissions and disturbance of borrow location outside of PMDA. However the lower volume of borrow developed for covers and transported to the proposed disposal facilities for these alternatives as compared to Alternative 2 somewhat offsets the additional short-term risks from the transport and disposal of mine materials outside of the PMDA.

Alternatives 4 and 6 also increase short-term risks to workers and the community through the additional step of contact with the removed tailings within the encapsulation mound (a relatively small amount of OU1 mine materials) and truck traffic to bring in the stabilization agent for the solidification/stabilization treatment of the tailings.

Alternative 6 requires the most movement of and exposure to mine materials because this alternative involves transport of 234,000 cubic yards of material from the mine site to a disposal facility yet to be constructed outside of the PMDA. This would require nearly 11,000 trucks to travel on local roads. This significant increase of short-term risks to workers and the community results in lower short-term effectiveness than the other alternatives.

Implementability

Alternative 2 includes limited removal and disposal of targeted mine materials at a proposed facility within the PMDA. Construction of covers over the majority of in-place mine materials is a common practice and results in the shortest construction duration. Excavation of mine materials and placement of covers on steep slopes may require use of specialty equipment and practices to ensure worker safety. Alternatives 3 and 4 include the removal, transport, and disposal of larger volumes of mine materials, which is a common practice, but results in a longer construction period with more complicated coordination and uses more equipment to complete than Alternative 2. Alternative 6 includes transport of the largest quantities of mine materials for disposal at a proposed facility outside of the PMDA and has the longest construction period.

Alternative 2 uses disposal at a proposed facility entirely within the PMDA, which limits the need for administrative coordination with other agencies or selecting a suitable disposal facility location. Alternatives 3, 4, and 6 use disposal at a proposed facility outside the PMDA, which increases administrative coordination and difficulty in selecting a suitable disposal facility location. Alternatives 3 and 4 also require the use of disposal at two separate proposed disposal facility locations.

Alternatives 2, 3, 4, and 6 require importing outside construction resources such as asphalt (Alternative 2), Portland cement for solidification/stabilization (Alternatives 4 and 6), soil amendments, and cover materials. Uncontaminated borrow sources within or outside the PMDA would need to be identified. Excavation and covering of materials on steep slopes may require special equipment and worker safety practices as well as engineering measures to ensure stability. Maintaining institutional and access controls are not anticipated to be difficult. It is routine activity to maintain signage and fencing.

The introduction of additives, such as molasses to initiate in-place biological treatment in Alternative 3, would require the use of specialized operators, equipment, and material. Additional testing would be required to assess performance of stabilization/solidification practices in Alternatives 4 and 6 before full-scale application to maximize treatment. The amount of space needed to apply the stabilization/solidification material (Portland cement) and application of stabilization/solidification material would make this treatment approach more difficult to implement.

Alternative 2 would be the easiest to implement, and Alternatives 3, 4, and 6 have relatively similar implementability concerns due to increasing construction complexity and difficulties in selecting a disposal facility location outside of the PMDA.

Cost

The cost from lowest to highest is Alternative 2, 3, 4, and 6, respectively. The estimated present value cost of Alternative 2 (primarily in-place covers) is approximately half that of the most expensive alternative, Alternative 6 (full excavation and disposal). Differences in present value costs between alternatives are primarily due to the capital costs for each alternative.

Alternatives 3 and 4 differ in cost primarily because of the increase of mine materials volume excavated, transported, and disposed of outside of the PMDA in Alternative 4. The method of treatment for the tailings was also a factor in the difference between costs. Alternative 3 uses submergence of tailings with the addition of additives, such as molasses, to initiate in-place biological treatment, and Alternative 4 removes the tailings and treats via stabilization/solidification. Stabilization/solidification is a more costly approach to treatment than in-place biological treatment

Alternatives 4 and 6 are very close in cost. The increase in excavation and transportation costs for the additional mine material volume in Alternative 6 is offset by the lack of cost to build a second disposal facility (within the PMDA) as in Alternative 4.

State Acceptance

The State of Oregon (through ODEQ) has been consulted frequently throughout the remedial investigation, feasibility study process, and development of the preferred alternative. State acceptance will be evaluated after public comment period ends and will be described in the ROD for the site.

Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends and will be described in the ROD.

Description of the Preferred Alternative

The preferred alternative selected was Alternative 3, as presented in the feasibility study, with minor modifications as described here. The preferred alternative described in this plan may be modified based on new information or public comments. Consistent with the **National Oil and Hazardous Substances Pollution Contingency Plan (NCP)**, the remedial alternatives are developed sufficiently for evaluation against the threshold and balancing criteria and presented to the public. Additional design work and data collection will be required after selection of an alternative to refine the approach to implement the cleanup action.

The title of the preferred alternative (modified Alternative 3) is **Capping of Mine Materials, Continued Submergence of Tailings within Encapsulation Mound, and Excavation/Disposal of Targeted Mine Materials at Proposed Facilities inside PMDA and outside PMDA on FEI Property**. The preferred alternative would protect human health and the environment through the combination of targeted removals and in-place covering of OU1 mine materials.

Modifications from Alternative 3 for the preferred alternative include:

- The proposed disposal facility outside of the PMDA will be constructed on former FEI property close to the PMDA, possibly combining with the proposed disposal facility within the PMDA, to reduce impacts to the public and simplify the disposal facility location selection process.
- Continued submergence of tailings within encapsulation mound without additional treatment as described in Alternative 2.
- Excavation and consolidation of mine materials that directly affect the headwaters near the site or that are unstable on their current slope.
- Capping of mine materials not in close proximity to headwaters near the site and are stable on their current slopes.

Mine materials that are not in close proximity to impacted surface water, which have a relatively higher potential for long-term slope stability and a lower risk of contaminant release, will be capped in place. A combination of manufactured cover layers, pavement covers, and rock or vegetative covers would be used as the cover materials depending upon specific waste area characteristics. For example, roadbeds would receive a paved cover system and drainage controls to divert water from the underlying mine wastes.

Mine materials, which are stable on slopes but cannot be successfully capped with vegetative covers or manufactured covers, would receive a cover of inert rock to maintain slope stability and prevent erosion. Similarly, waste areas on slopes that have been excavated would receive a cover of inert rock.

The encapsulation mound and new repository would be capped with a manufactured cover to prevent infiltration of precipitation. Manufactured cover layers would be constructed on a limited basis in areas of mine materials outside proposed disposal facilities where conditions warrant (i.e., level areas and shallow slopes). Pavement covers would be constructed over mine materials within existing road alignments. Both pavement and manufactured cover layers are capable of preventing acid rock drainage generation.

Mine materials targeted for excavation and disposal directly impact the headwaters of the South Fork Middle Creek and Upper Middle Creek and/or affect the stability of the encapsulation mound. Identification of mine materials would be completed as described for Alternative 2. Approximately 139,000 CY of mine materials would be excavated for this alternative. This is 55,000 CY less than the targeted removal volume in the original Alternative 3 described in the FS. The non-excavated materials will be graded and or capped to limit infiltration and generation of acid rock drainage. The tailings would continue to be submerged within the encapsulation mound without additives as described in Alternative 2 since this approach has continued to be effective at limiting acid rock drainage generation.

The proposed disposal facilities within and outside the PMDA would largely be constructed as described in Alternative 3, with a few modifications. The overall profile of the disposal facility within the PMDA would be lowered to enhance stability and resistance to erosion from storm events, and the encapsulation mound area would be targeted for excavations to increase stability of the remaining mine materials on slopes.

The proposed disposal facility outside of the PMDA would be constructed on former FEI land in close proximity or adjacent to the PMDA. Construction of collection and storage facilities for leachate generated

from the proposed disposal facility outside of the PMDA (assumed to be leachate collection piping and an acid rock drainage storage tank), if needed, would be considered during design depending on the location-specific conditions. Treatment facilities would be addressed as part of acid rock drainage management and treatment conducted as part of OU2.

The location and extent of the proposed disposal facilities within and outside of the PMDA shown on *Exhibit 3* are conceptual. Evaluation during remedial design would determine if the facilities would be developed separately or combined for containment of excavated mine materials. Combining the facilities may result in a smaller environmental footprint and may have related benefits of reducing overall construction costs and O&M costs for a smaller footprint.

Excavated areas or areas disturbed during completion of the remedy work would be restored as described in Alternative 3. Administrative controls, maintenance, monitoring, and five-year site reviews would be implemented as described for Alternative 3.

A summary of how the alternative compares against the nine criteria is presented in *Exhibit 8*.

A summary of alternative costs is presented in *Exhibit 9*.

The preferred alternative was selected over other alternatives because:

1. It protects human health and the environment and complies with ARARs.
2. There are less significant impacts to the community and environment from truck traffic since disposal of mine materials is limited to the boundaries of former FEI property. This would reduce fuel costs and related engine emissions for transportation and minimize transportation-related safety issues.
3. The long-term effectiveness is greater because the disposal facility constructed within the PMDA is more stable as a result of improving the slopes and lowering the profile exposed to adverse weather.
4. The use of former FEI property lessens administrative activities such as acquiring property and meeting substantive permit requirements during selection and design of a disposal facility outside of the PMDA.
5. It simplifies development of borrow sources for proposed facility construction, cover, and reclamation materials due to use of former FEI property.
6. Location of the disposal facility within or close proximity to the PMDA would simplify future O&M activities because the facility would be adjacent to mine workings (addressed with OU2) that may also require O&M.

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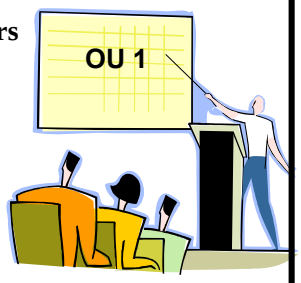
Opportunities for Public Involvement

Public Meeting

EPA will hold a public meeting to explain the OU1 Proposed Plan, the preferred cleanup alternative for the Formosa Mine Superfund Site, and all the alternatives presented in the feasibility study. We encourage you to attend. It's a great opportunity to learn more about the details.

Formosa Mine Superfund Site
Public Comment Meeting

January 20, 2015
6:30 to 9:00 pm
Riddle City Council Chambers
647 East First St.
Riddle, OR. 97469



If you like, you can provide your comment orally at the public meeting, and the meeting stenographer will record it.

Contacts

If you have questions or need additional information, please contact the following representatives:

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Written Comments and Extensions

The public comment period runs from January 6 to February 5, 2015. During that time, you may submit a comment in writing by mail, email, or at the public meeting. The mailing address for written comments is:

Christopher Cora
US EPA Region 10
1200 Sixth Ave., Suite 900,
Mailstop ECL - 115
Seattle, WA 98101
E-mail: cora.christopher@epa.gov

EPA will respond in writing to all significant public comments in a responsiveness summary. The responsiveness summary will be included as part of the record of decision for OU1.

Documents

Documents that provide the basis for selecting the final cleanup alternative will be available for viewing at:

Riddle Public Library
637 First St.
Riddle, OR 97469-0033
and

US EPA Region 10 Superfund Records Center
1200 6th Ave., 7th Floor
Seattle, WA 98101
(206) 553-4494*

** Please call for the most current information on office hours.*

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Glossary/Useful Terms

The following terms used in the Formosa Mine Superfund Site OU1 Proposed Plan are defined here to aid your understanding of this document:

- ***Access controls*** **–** Physical methods to discourage people from entering the site, including fencing and posting warning and informational signs.
- ***Acid rock drainage*** **–** A chemical process by which contaminants are released from rocks due to exposure to water and air. Outflow of acidic (low pH) water from abandoned metal mines caused by oxidation of rock sources.
- ***Adit*** **–** Underground mine entrances.
- ***Adit water diversion system*** **–** A system at the Formosa Mine Site that collects **mining-influenced water** discharging from the Formosa 1 and Silver Butte 1adits and diverts it from entering surface water.
- ***Administrative controls*** **–** A combination of **institutional controls**, community awareness activities, and **access controls**. Land use controls are generally used to protect remedy components, restrict access and use of contaminated areas, and provide awareness of risks from potential exposure to **mine materials**.
- ***Applicable or relevant and appropriate requirements (ARARs)*** **–** Any state or federal statutes or regulations that pertain to the protection of human health and the environment in addressing specific conditions (chemical, action, and location) or use of a particular cleanup technology at a **Superfund** site.
- ***Capital cost*** – The initial expenditure required to build or install the remedial action.
- ***Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)*** **–** A federal law enacted to clean up abandoned sites where there is a release or threat of release of a hazardous substance into the environment.
- ***Community awareness activities*** **–** Includes community education and outreach programs used to inform the community of potential risks associated with exposure to **mine materials** and how to prevent future risks.
- ***Chemical of concern (COCs)*** – Chemicals that pose unacceptable risk to humans, wildlife, or plants. For OU1, arsenic, cadmium, copper and zinc pose unacceptable risk to aquatic wildlife.
- ***Cap*** **–** An engineered cover that acts a barrier to prevent downward migration of water to mine materials or prevents exposure of humans and wildlife to mine materials. A **cover** is generally constructed in layers, such as pavement, manufactured materials, rock or soil, and may be covered with vegetation after it is completed.
- ***Encapsulation mound*** **–** An area at the Formosa Mine Site where acid-generating tailings and ore were enclosed in a lined and covered repository.
- ***Exposure*** **–** The path from sources of pollutants to people and animals.
- ***Feasibility study (FS)*** **–** A required process at a Superfund site to develop, screen, and evaluate various alternatives being considered for selection of a remedial action.
- ***Five-year site review*** **–** A periodic review required by **CERCLA** to make sure that the site cleanup continues to protect human health and the environment when contaminants remain on site.
- ***Institutional controls*** **–** Non engineered legal methods that help to discourage human contact with **mine materials** and encourage safe land uses and/or the integrity of a remedy. **Institutional controls** may be governmental controls (like zoning or permits), proprietary controls (like covenants, conditions, and restrictions), and informational devices (like deed notices).
- ***Mine materials*** **–** Media (such as waste rock, **tailings**, and soil) remaining after mining that contain contaminants that pose risks to humans and the environment.
- ***Mine workings*** **–** Tunnels or shafts related to the extraction of ore.
- ***Mining*** **–** Activities related to the extraction of ore from the earth that contains valuable minerals such as metals.

- ***Mining-influenced water*** **–** Water affected by mining activities that is potentially toxic to the environment, regardless of water pH.
- ***Monitoring*** **–** Information collected to help gauge the effectiveness of a cleanup action. Monitoring can be either by data collection or visual inspection.
- ***National Oil and Hazardous Substances Pollution Contingency Plan (NCP)*** **–**Federal regulations for responding to oil spills and hazardous substance releases.
- ***National Priorities List (NPL)*** **–** EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under **Superfund**. A site must be on the **NPL** to receive money for remedial action.
- ***Operable unit (OU)*** **–** Term for each of a number of separate activities undertaken as part of a Superfund site cleanup. An OU can be based on geography, media, or other characteristics that are used to manage the Superfund process.
- ***Operation and maintenance (O&M)*** **–** Activities conducted after a **Superfund** cleanup action is completed to ensure that the action is effective for the long term.
- ***O&M cost*** – The post-construction cost required to ensure the effectiveness of the remedial action.
- ***Periodic cost*** – Cost that occurs only once every few years, such as 5-year site reviews.
- ***Preliminary Remediation Goals (PRGs)*** **–** The average concentration below which a contaminant does not pose an unacceptable risk.
- ***Present value*** **–** The present value cost represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life. The present value analysis was performed on remedial alternatives using a 7 percent discount (interest) rate over the period of evaluation for each alternative.
- ***Primary Mine Disturbance Area (PMDA)*** **–** Portion of OU1 that has been impacted by surface deposition of mine materials because of mining-related activities.
- ***Record of Decision (ROD)*** **–** A formal decision document that describes the selected remedy for **CERCLA** sites. ***Remedial action objectives (RAOs)*** **–** Specific goals for protecting human health and the environment developed by evaluating **ARARs** and the results of the remedial investigation, including the risk assessment.
- ***Remedial investigation (RI)*** **–** A required study at **Superfund** sites that determines the nature and extent of contamination and assesses the risk to human health and the environment.
- ***Superfund*** **–** The common name for the **Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA)**, a federal law designed to clean up sites contaminated with hazardous materials.
- ***Tailings*** **–** Ground up mine materials left over after the valuable metals have been extracted out of the ore.

Exhibit 8. Key Considerations from Analysis of Preferred Alternative (Modified Alternative 3)

Evaluation Criteria		
THRESHOLD CRITERIA	**Overall protection of human health and the environment**	■ Acid generating mine materials at headwaters of creek areas, on steep or unstable slopes, and other targeted areas would be excavated and disposed of at proposed facilities within and outside the PMDA on FEI property. This would eliminate exposure of mine materials to the environment and significantly reduce migration of contamination for mine materials. ■ Overburden currently on top of the encapsulation mound would be removed and regraded to stabilize the proposed facility within the PMDA. ■ Tailings stored within the former water and tailings storage pond would continue to remain submerged under the new cover system at the encapsulation mound. Submergence would continue to mitigate acid rock drainage generation.
	Compliance with ARARs	■ The preferred alternative would be compliant with location-, action-, and chemical-specific ARARs.
BALANCING CRITERIA	**Long-term effectiveness and permanence**	■ Location of the proposed disposal facility or facilities on FEI property is on and/or adjacent to the PMDA, which simplifies future O&M activities. ■ Excavation and disposal of mine materials at proposed facilities within and outside PMDA would provide significant reduction of acid rock drainage generation and migration. ■ The tailings would continue to be submerged within the encapsulation mound under the new cover of the disposal facility within the PMDA. ■ The use of stability measures, such as geocells, retaining walls, or buttressing, will be used as needed to maintain stability due to excavation, disposal, and in-place covering of mine materials on steep slopes. Geotechnical monitoring will be used as needed to be conducted after construction.
	Reduction of toxicity, mobility, or volume through treatment	■ There is no reduction of toxicity, mobility, or volume through treatment for mine materials.
BALANCING CRITERIA	**Short-term effectiveness**	■ Location on FEI property would keep disposal activities within a localized area near the PMDA rather than over a larger area, thus, reducing traffic. ■ There would be minor impacts to the community under this alternative as truck traffic required for disposal of mine materials at the proposed facility outside of the PMDA on former FEI property would be contained within the boundaries of former FEI property. There could also be minor impacts to the environment during the implementation of the remedial action due to the use of heavy construction and hauling equipment and import of borrow, cover, and reclamation materials from within and outside the PMDA. ■ Use of fuel efficient and low emission equipment, careful selection and reclamation of borrow areas, and relatively short haul distance of excavated mine materials to disposal facility outside PMDA will be used, to the extent practicable, during design and remedial action to reduce environmental impacts. ■ The duration of remedial construction and implementation would be similar or less than Alternative 3 given the shorter distance to the disposal facility outside of the PMDA and smaller volume of material removed.

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Exhibit 8. Key Considerations from Analysis of Preferred Alternative (Modified Alternative 3) (continued)

	Implementability	■ Location on FEI property lessens administrative impacts during selection and design of a disposal facility outside of the PMDA. ■ Construction of the proposed disposal facility or facilities will consider the stability of steep slopes. ■ Transportation of excavated mine and borrow materials would be a relatively short distance and would reduce fuel usage. ■ Suitable rock and soil materials for proposed facility construction, cover construction, and reclamation would be required from within and outside the PMDA. The use of materials available within the former FEI property would simplify the development of suitable material at other locations.
	Cost	■ The estimated present value cost of the preferred alternative is assumed to be similar in magnitude to Alternative 3 ($9,275,000).
MODIFYING CRITERIA	**State/Support agency acceptance**	■ The State of Oregon (through ODEQ) has been consulted frequently throughout the remedial investigation, feasibility study process, and development of the preferred alternative. State acceptance will be evaluated after public comment period ends and will be described in the ROD for the site.
	Community acceptance	■ Community acceptance of the preferred alternative will be evaluated after the public comment period ends and will be described in the ROD.

Exhibit 9. Summary of Alternative Costs

Alternative	Est. Total Capital Costs	Est. Total O&M Costs (first 30 years)	Est. Total Periodic Costs (first 30 years)	Est. Construction Timeframe	Est. Total Alternative Cost (Present Value)
1	$0	$0	$300,000	None	$115,000
2	$5,075,000	$750,000	$330,000	1 Year	$5,553,000
3	$8,878,000	$553,000	$330,000	2 Years	$9,275,000
4	$10,010,000	$553,000	$330,000	2 Years	$10,407,000
6	$10,092,000	$553,000	$330,000	3 Years	$10,489,000

Note: The preferred alternative is a modification of Alternative 3 and is expected to have a similar magnitude of cost.
Definitions of cost terms can be found in the Glossary/Useful Terms list.

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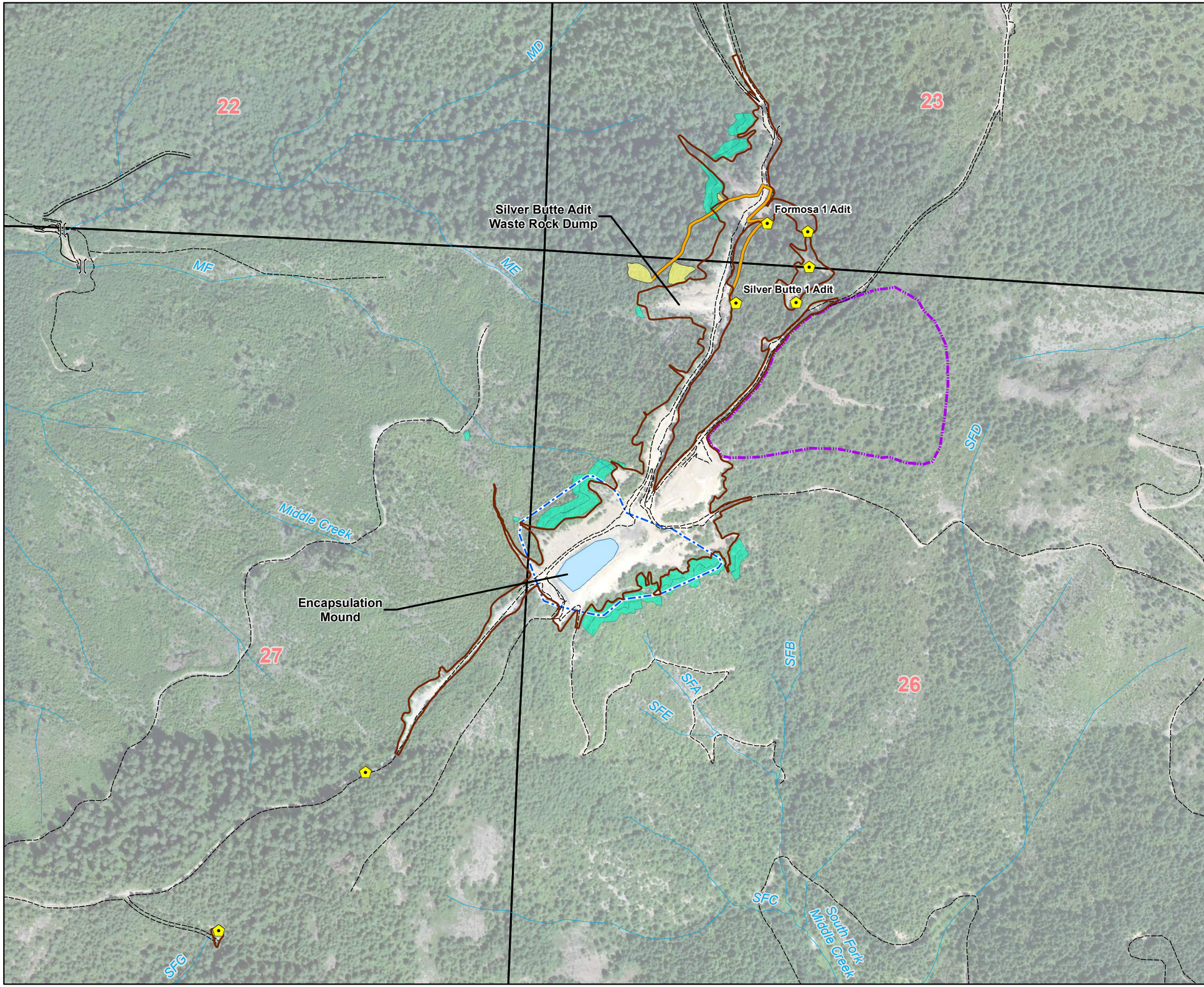

Legend

- Adit
- Culverts
- Adit Water Diversion System
- Roads
- Primary Mine Disturbance Area (EA-1)
- Downslope Soils (EA-2)
- Adit Drainage Affected Soil (EA-3)
- Approximate Extent of Proposed Facility within PMDA
- Approximate Extent of Proposed Facility Outside PMDA
- Former Water and Tailings Storage Pond
- Sections — 26 Section Number

Note(s):
1. The location and extent of the proposed disposal facilities within and outside of the PMDA are conceptual. Evaluation during remedial design would determine if the facilities would be developed separately or combined for containment of excavated mine materials.
2. "EA" = "Exposure Area"

0 250 500 1,000 Feet

Geographic Data Standards:
Projected Coordinate System:
NAD 1983 State Plane Oregon FIPS Zone 3602

N

Data Sources:
Bureau of Land Management:
2001 Hydrography
2005 Township, Range, and Topography
2010 ESRI World Imagery Service Layer

Exhibit 3

Site Map

Formosa Mine Superfund Site
Douglas County, Oregon

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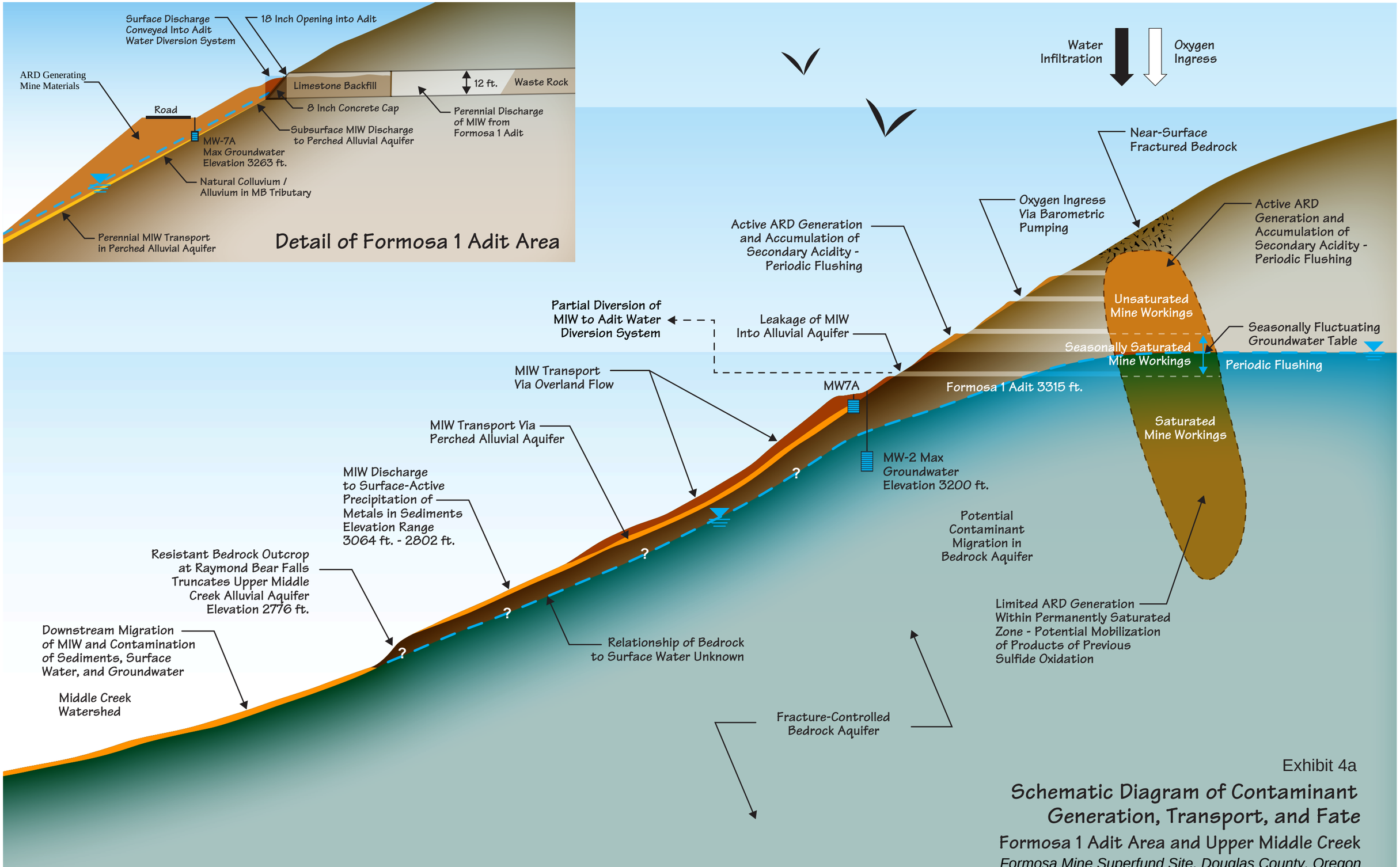

Exhibit 4a

Schematic Diagram of Contaminant Generation, Transport, and Fate

Formosa 1 Adit Area and Upper Middle Creek

Formosa Mine Superfund Site, Douglas County, Oregon

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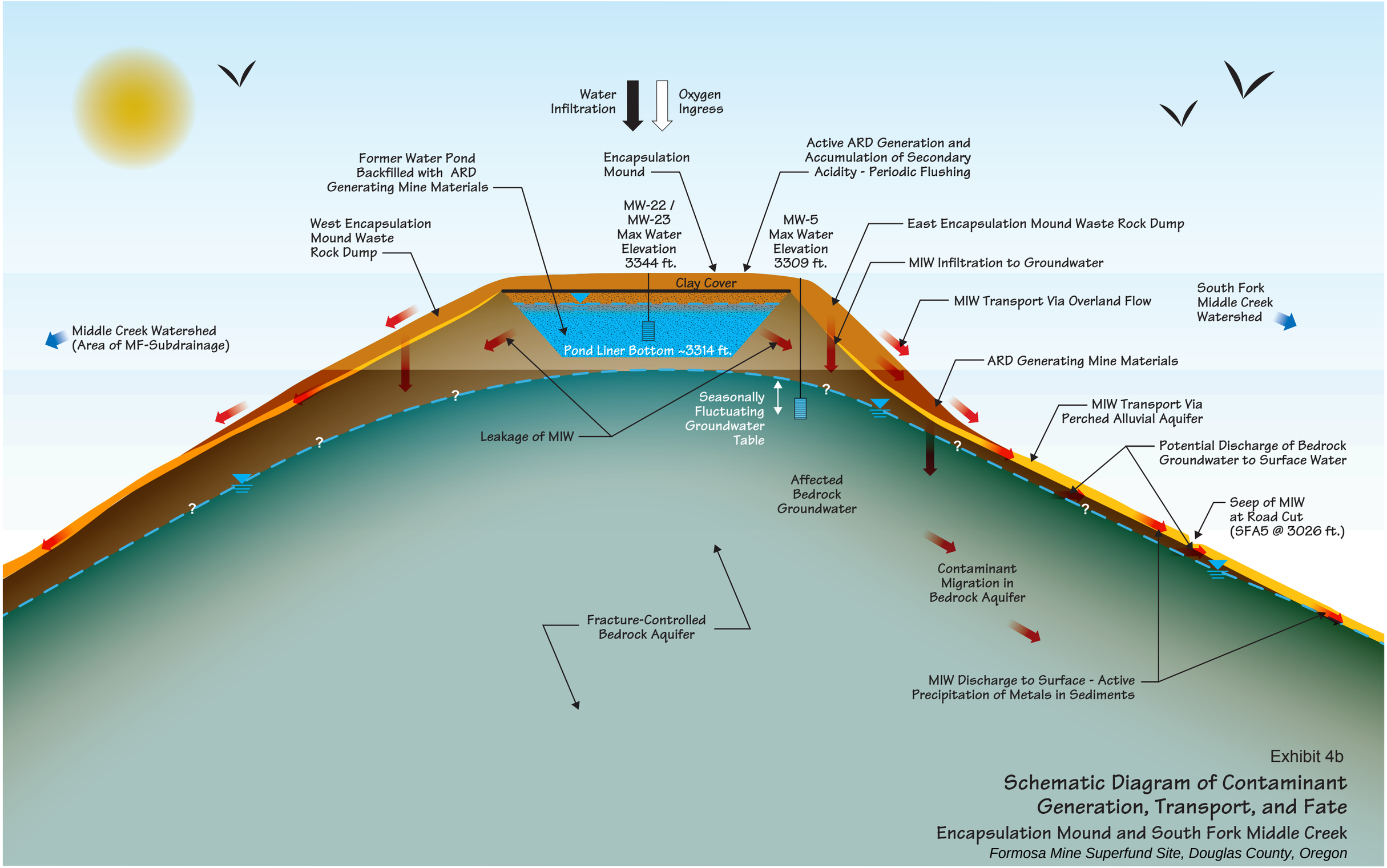

Exhibit 4b

Schematic Diagram of Contaminant Generation, Transport, and Fate

Encapsulation Mound and South Fork Middle Creek

Formosa Mine Superfund Site, Douglas County, Oregon

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COMMENT SHEET

Use this space to write your comments.

The EPA encourages you to submit written comments on the Formosa Mine Superfund Site OU1 Proposed Plan. You can use the form below to send written comments, or bring your comments to the public meeting. If you have questions about how to comment, please contact the EPA's Project Manager, Mr. Christopher Cora.

This form is provided for your convenience. Please mail this form or bring your comments to the public meeting. You may use additional sheets as needed. Comments by email can be sent to Cora.Christopher@epa.gov. Comments by mail must be postmarked no later than Thursday, February 5, 2015, to the address shown below:

Christopher Cora, Project Manager
US EPA Region 10
1200 Sixth Ave., Suite 900,
Mailstop ECL – 115
Seattle, WA 98101

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Comment Submitted by: _____

Address: _____

_____

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Return Address

affix postage here

Mr. Christopher Cora
US EPA Region 10
1200 Sixth Ave., Suite 900,
Mailstop ECL - 115
Seattle, WA 98101