Addendum to the Supplemental Feasibility Study
Holden Mine Site
Chelan County, Washington

Prepared by
USDA Forest Service

In Cooperation with
US Environmental Protection Agency and
Washington State Department of Ecology

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FOREST SERVICE
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DEPARTMENT OF AGRICULTURE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

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ACRONYMS AND DEFINITIONS

ACS	Aquatic Conservation Strategy
Agencies	USDA Forest Service, acting with the US Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology)
AOC	Administrative Order on Consent
AOI	Area of Interest
AKART	All known, available, and reasonable methods of treatment, as referenced in the MTCA regulations [WAC 173-340-200 (within definition of “All practicable methods of treatment”) and WAC 173-340-720(8)(d)]. Note that other state regulations use AKART to refer to All Known, Available, and Reasonable Methods of Prevention, Control, and Treatment [WAC 173-201A-020], and this definition is also applicable to the Site.
APR	Agencies’ proposed remedy
ARAR	Applicable or Relevant and Appropriate Requirement
BLM	United States Department of the Interior, Bureau of Land Management.
BMP	Best Management Practice
CAA	Clean Air Act
CAP	Cleanup Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act [42 USC §§ 9601-9675]
CFR	Code of Federal Regulations
CPOC	Conditional Point of Compliance
CWA	Clean Water Act
cy	Cubic yards
DFFS	Draft Final Feasibility Study (URS 2004)
DRI	Draft Remedial Investigation report (Dames & Moore 1999)
DSO	Washington Department of Ecology Dam Safety Office
DSHH	The area down-slope from the Honeymoon Heights Waste Rock Piles
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
ERA	Ecological risk assessment

ACRONYMS AND DEFINITIONS (CONT.)

ESA	Endangered Species Act
ESD	Explanation of significant differences
Ferricrete	A cemented deposit of iron oxide precipitate that forms in stream channel sediments as a result of the release of iron sulfates and other hazardous substances.
FS	Feasibility Study. For the Holden Mine Site, the FS consists of several reports, letters, and other documents that are listed in Section 2 of this ASFS.
FSQV	Freshwater Sediment Quality Values
gpm	Gallons per minute
GRA	General response action
HAZWOPER	Hazardous waste operations and emergency response
HHRA	Human Health Risk Assessment
HHWRP	Honeymoon Heights Waste Rock Piles
HQ	Hazard Quotient
IDW	Investigation-derived wastes. Commonly IDW is used to refer to any waste materials (including soil and water) contaminated with hazardous substances that are generated during investigation or remediation of the Site.
LBI	Lutheran Bible Institute
LRMP	Wenatchee National Forest Land and Resource Management Plan
LWA	Lower West Area
MBTA	Migratory Bird Treaty Act
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goal
MGY	Million gallons per year
Mining Claims	Portions of public lands claimed for possession of locatable mineral deposits by locating and recording under established rules and pursuant to the 1872 Mining Law.
MNA	Monitored Natural Attenuation
MSHA	Mine Safety and Health Administration
MTCA	Model Toxics Control Act [RCW 70.105D.010-.921]
NCP	National Oil and Hazardous Substances Pollution Contingency Plan [40 CFR Part 300]

ACRONYMS AND DEFINITIONS (CONT.)

NFMA	National Forest Management Act
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPV	Net Present Values
NRDA	Natural Resource Damage Assessment
NRHP	National Register of Historic Places
NRRB	National Remedy Review Board
NTR	National Toxics Rule
NWFP	Pacific Northwest Forest Plan
NWQC	National Recommended Water Quality Criteria
O&M	Operations and Maintenance (also sometimes referred to as OMM, Operations, Maintenance and Monitoring)
PCB	Polychlorinated Biphenyl, a toxic chemical
PLP	Potentially liable party
Portal	Entrance to an underground mine. Holden Mine had eight portals (referred to as the 300-, 550-, 700-, 800-, 1000-, 1100-, and 1500-Level portals and the 1500-Level Ventilator Portal, some of which are now caved in). The 1500 Level portal is typically referred to as the Main Portal.
PPB	Partially penetrating barrier
PRG	Preliminary remediation goal
PRP	Potentially responsible party
RA	Remedial Action
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SEPA	State Environmental Policy Act [Chapter 43.21C RCW]

ACRONYMS AND DEFINITIONS (CONT.)

SFS	Supplemental Feasibility Study (Forest Service 2007c)
Site	Holden Mine Site
SMA	Shoreline Management Act
SPCC Plan	Spill Prevention, Control, and Countermeasure Plan
SWA	Surface Water Retention Area
Tailings	Fine-grained waste materials from an ore-processing operation
TBC	To be considered (criteria)
TCLP	Toxicity Characteristic Leaching Procedure
TEE	Terrestrial Ecological Evaluation
TP-1, TP-2, and TP-3	Tailings Pile 1, Tailings Pile 2, and Tailings Pile 3, respectively
TPH	Total Petroleum Hydrocarbons
USFWS	US Fish and Wildlife Service
UWA	Upper West Area
WAC	Washington Administrative Code
WARM	Washington Assessment and Ranking Method
Waste Rock	Rock with no commercial value that is removed from the earth during mining
WMA	Waste Management Area
WSDFW	Washington State Department of Fish and Wildlife

ADDENDUM TO THE SUPPLEMENTAL FEASIBILITY STUDY
HOLDEN MINE SITE
CHELAN COUNTY, WASHINGTON

EXECUTIVE SUMMARY

This document describes the evaluation of alternatives for cleanup at the Holden Mine (Site). This evaluation is being conducted by the USDA Forest Service (Forest Service) along with the Washington State Department of Ecology (Ecology) and the US Environmental Protection Agency (EPA) (collectively referred to as the Agencies), in consultation with the Confederated Tribes and Bands of the Yakama Nation.

Introduction

The Holden Mine is an inactive underground copper mine located in the Railroad Creek valley on the eastern slopes of the Cascade Mountains in Washington State, approximately 10 miles west of Lake Chelan. The Site is situated within the Wenatchee National Forest. Figure 1 shows the vicinity of the Site; Figures 2 and 3 shows adjacent land use and principal features of the former mine area of the Site.

Holden Mine operated from 1938 to 1957. The operation discarded more than 300,000 cubic yards of waste rock on the surface of the Site and produced roughly 10 million tons of tailings, most of which were discarded in three large piles directly adjacent to Railroad Creek. Holden Village, with approximately 60 year-round residents and 5,000 annual visitors, lies within the Site and is adjacent to the former mine.

The Agencies determined that past mining operations have caused adverse environmental impacts to groundwater and surface water. In addition, soils, waste rock, and tailings that remain on the Site contain hazardous substances that exceed criteria for protection of human health and terrestrial environmental receptors.

Chronology of the RI/FS Process

- In 1998, the Agencies entered into an Administrative Order on Consent/Agreed Order with Alumet Corporation (which subsequently merged into Intalco Aluminum Corporation) requiring investigation and cleanup of the Site.

- Between 1998 and 2004, Intalco conducted a remedial investigation and feasibility study (RI/FS) and prepared a Draft Remedial Investigation report and Draft Final Feasibility Study report (DFFS) evaluating a number of remedial alternatives (Dames & Moore 1999 and URS 2004, respectively).

- Upon review of the DFFS, the Agencies determined that none of the alternatives presented met the threshold requirements for remedy selection. Intalco and the Agencies subsequently developed additional remedial alternatives which were evaluated by the Agencies in a Supplemental Feasibility Study (SFS) (Forest Service 2007c). Based on the SFS, the Agencies prepared a draft Proposed Plan that identified Alternative 11 as the proposed cleanup action (Forest Service 2007d).

- Subsequently, Intalco proposed a new alternative, Alternative 13 (David E Jackson & Associates et al. 2007). However, the Agencies determined that there was insufficient information available to evaluate Alternative 13, and identified a number of data gaps (USDA OGC 2008).

- In 2008 and 2009, Intalco performed additional field investigations to address data gaps that the Agencies had identified. Based on the initial results of these investigations, Intalco revised Alternative 13, designating the new alternative as Alternative 13M. Intalco presented the results of the additional investigations, including an evaluation of Alternative 13M and Alternative 11, in the Draft Alternative 13M Evaluation Report (ERM and URS 2009a).

- Based on review of the Draft Alternative 13M Evaluation Report, the Agencies prepared this Addendum to the Supplemental Feasibility Study (ASFS) to address deficiencies with Alternative 13M and with the Draft Alternative 13M Evaluation Report. As part of preparing this ASFS, the Agencies developed a new alternative, Alternative 14, and also refined Alternative 11 (termed Alternative 11M) to reflect the additional data collected in 2008 and 2009.

Cleanup Alternatives Addressed in this ASFS

This ASFS evaluates three alternatives: Alternative 11M, Alternative 13M, and Alternative 14, described below.

Alternative 11M

The principal components of Alternative 11M are illustrated on Figure 12, following the main text of this report. Alternative 11M would address media impacted by hazardous substances as summarized below.

Soil

Under Alternative 11M, the tailings piles and the East and West Waste Rock Piles would be regraded to improve slope stability and capped with 2 feet of soil and a geomembrane. The Honeymoon Heights Waste Rock Piles would be consolidated onto the West Waste Rock Pile before it is capped.

Impacted soils from the former Mill, Lagoon, the Ventilator Portal Surface Water Retention Area, a portion of the Lower West Area, and a portion of the Ballfield Area would be consolidated into the tailings piles and capped; and impacted soils at the Maintenance Yard would be capped with a concrete or asphalt slab.

In situ treatment would be used to address impacted soils in Holden Village; a portion of the Ballfield Area; a portion of the Lower West Area; and the Wind-Blown Tailings Area.

Groundwater

Under Alternative 11M, contaminated groundwater that would otherwise enter Railroad Creek and Copper Creek from the mine portal, Honeymoon Heights seeps, Lower West Area, and Tailings Piles 1, 2, and 3 would be collected and treated. The DFFS found that it is not practicable to clean up groundwater in some portions of the Site within a reasonable restoration time frame, or to eliminate the tailings and waste rock piles as a continuing source of hazardous substances released to groundwater. Groundwater seep and base flow into Railroad Creek from the Lower West Area and tailings piles would be contained and collected using groundwater barrier wall technology and an associated collection system. The groundwater barrier wall would be fully penetrating (i.e., keyed into a lower, relatively impermeable layer of glacial till or bedrock). The Agencies propose waste management areas (WMAs) where the groundwater will be contained (containment is a prerequisite to establishing a WMA) as is further discussed in Section 2.5.

All collected groundwater and surface water would be treated using acid neutralization and precipitation to achieve proposed cleanup levels, in a treatment plant located downstream of Tailings Pile 3, on the north side of Railroad Creek. Alternative 11M would use a pump system to convey water into the treatment system. After dewatering, metal hydroxide sludge produced as a byproduct of water treatment would be disposed of in a limited purpose landfill constructed on the tailings piles in conformance with state standards. Treated water would be discharged into Railroad Creek.

Alternative 11M also includes hydraulic bulkheads installed in the mine to control the rate of groundwater discharging from the Main Portal. Air restrictors would be installed within open portals to reduce oxygen transport through the mine to slow the release of hazardous substances in the Main Portal drainage.

Groundwater at and in the vicinity of the former mine is not currently used as a source of drinking water for residents and visitors who get their drinking water from Copper Creek upstream of the Site. But groundwater is used as a source of drinking water at Lucerne, which is downgradient of the former mine.[1] Alternative 11M includes institutional controls to prevent the potential future use of groundwater that exceeds human health risk-based criteria as a drinking water source within the WMA. Groundwater outside of the WMAs is expected to achieve drinking water criteria within a reasonable restoration time frame after implementation of the remedy.

Surface Water

The three tailings piles would be regraded (prior to capping) to move the edges of the piles back from Railroad and Copper Creeks and to construct toe buttresses to reduce the risk of future slope failures releasing wastes into the creeks.

The Copper Creek channel would also be modified under Alternative 11M to constrain future channel migrations that could erode the tailings. The Copper Creek Diversion would be placed into a lined channel or culvert from the hydroelectric plant to Railroad Creek to avoid seepage through tailings in this area.

Upgradient water diversion swales or French drains would be constructed south of the tailings and waste rock piles to reduce the amount of clean water run-on that would otherwise contact the tailings and waste rock materials.

[1] Lucerne is considered to be part of the Site, since hazardous substances in Railroad Creek that exceed proposed cleanup levels extend all the way to Lake Chelan.

Sediment

Alternative 11M includes removal of ferricrete from Railroad Creek and monitoring sediment in Railroad Creek and in Lake Chelan (at the Lucerne Bar) to determine whether additional sediment cleanup actions are required following the elimination of the sources of hazardous substances.

Alternative 13M

The principal components of Alternative 13M are illustrated on Figure 13. Alternative 13M would address media impacted by hazardous substances as summarized below.

Soil

Under Alternative 13M, the tailings pile side slopes would be regraded for stability, including construction of a stabilizing buttress. A cover, consisting of 6 inches of soil, gravel, and wood slash would be placed on the top surfaces of the tailings piles and 8 to 12 inches of soil and gravel would be placed on the tailings pile side slopes.

The former Mill Building superstructure would be demolished and contaminated materials remaining on the former Mill Building foundation would be removed and/or covered.

The East and West Waste Rock Pile side slopes would be regraded for stability and the excess rock generated from the regrading actions would be relocated onto the former Mill Building foundation and Tailings Pile 1. A vegetated soil cover that is 6 inches thick on the top surface and 8 to 12 inches thick on the side slopes would be placed on the waste rock piles.

Contaminated soils associated with the Surface Water Retention Area and Lagoon would be excavated and placed in a permanent, on-site disposal facility. Contaminated soils in the Maintenance Yard would be covered with a concrete slab or an impermeable liner and gravel.

Soil in other areas of the site that exceed proposed cleanup levels (i.e., the Ballfield Area, Lower West Area, Wind-Blown Tailings Area, and Honeymoon Heights) would be monitored based on Intalco's assertion that remediation would occur naturally over time (referred to as natural restoration). Alternative 13M does not include any cleanup actions for these areas, other than institutional controls.

Groundwater

Under Alternative 13M, contaminated groundwater that would otherwise enter Railroad Creek from the Lower West Area and Tailings Pile 1 would be contained in a WMA and collected using a fully penetrating groundwater barrier and collection system. The collected water would be conveyed to a treatment facility located east of Tailings Pile 3.

Railroad Creek would be diverted, beginning near the middle of the northern side of Tailings Pile 1 and extending east (downstream) to a point to rejoin the original channel about 1200 feet east of Tailings Pile 3. Along the northwest side of Tailings Pile 2, the former creek channel would collect groundwater impacted by seepage from the western portion of Tailings Pile 2, and convey that water to a treatment system east of Tailings Pile 3.

Groundwater impacted by seepage from Tailings Pile 3 and the remainder of Tailings Pile 2 would not be contained or collected, but instead would flow eastward unchecked. The Draft Alternative 13M Evaluation Report (ERM and URS 2009a) asserted that the groundwater quality data obtained in 2008-2009 were evidence of natural attenuation that was protective of Railroad Creek, and eliminated the need for groundwater containment and collection east of Tailings Pile 3. Intalco also stated that "...if after an extended period of monitoring ARARs are not achieved at the CPOC(s) downstream of the terminus of the realigned creek channel, contingent actions would be evaluated under Alternative 13M."[2]

The Honeymoon Heights seeps and the Main Portal drainage would be collected and treated with acid neutralization and precipitation in a treatment facility constructed in the Lagoon area of the Lower West Area.

Hydraulic bulkheads would be installed in the mine to control and equalize the rate of groundwater discharging from the Main Portal. Air restrictors would be installed within open portals to reduce oxygen transport through the mine to slow the release of hazardous substances in the Main Portal drainage.

Alternative 13M also includes institutional controls to prevent groundwater that exceeds human health risk-based criteria from being used as drinking water in the future.

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[2] ARARs refer to applicable or relevant and appropriate requirements. See Section 2.2 for additional discussion.

Surface Water

As described in the preceding subsection, Railroad Creek would be realigned. This would move the creek away from most of the tailings piles and minimize the potential for erosion of tailings into the creek. Additional grading and stabilization of the tailings piles would also be performed to prevent the potential for erosion of tailings into the creek.

Under Alternative 13M, the Copper Creek channel would be modified to constrain future channel migrations that could erode the tailings. The Copper Creek Diversion would be placed into a lined channel or culvert from the hydroelectric plant to Railroad Creek to avoid seepage through tailings in this area.

Upgradient water diversion swales or French drains would be constructed south of the tailings and waste rock piles to reduce the amount of clean water run-on that would otherwise contact the tailings and waste rock materials.

Sediment

Ferricrete and other sediments in the reach of Railroad Creek that would be relocated would be effectively isolated by relocation of Railroad Creek. Intalco did not address whether floc containing hazardous substances related to iron-rich seepage from the tailings piles would continue to form in Railroad Creek downstream of the relocated portion.

Alternative 14

The principal components of Alternative 14 are illustrated on Figure 14. Alternative 14 would address media impacted by the release of hazardous substances as summarized below.

Soil

Under Alternative 14, the tailings piles and the East and West Waste Rock Piles would be regraded and buttressed to improve slope stability and capped to protect human and terrestrial ecological receptors. The caps would be designed to satisfy performance standards for landfill closure [WAC 173-350-400(3)(e)(i)].

Soils exceeding proposed cleanup levels at the former Mill, Lagoon, a portion of the Lower West Area, a portion of the Ballfield Area, and the Surface Water Retention Area would be consolidated into the tailings piles prior to capping, and soils exceeding proposed cleanup criteria in the Maintenance Yard would be covered with a concrete or asphalt slab.

In situ treatment would be used for impacted soils in Holden Village; the remainder of the Lower West Area and the Ballfield Area; the Wind-Blown Tailings Area; and on Honeymoon Heights.

Groundwater

Alternative 14 is similar to Alternatives 11M and 13M in the west portion of the Site. Alternative 14 includes a groundwater containment barrier wall and collection system around a WMA comprised of the Lower West Area and Tailings Pile 1. Alternative 14 includes collection and treatment of seeps SP-12 and SP-23 downslope of Honeymoon Heights (Figure 5).

Alternative 14 would include a barrier wall and collection system to contain and collect groundwater for treatment downgradient of Tailings Piles 2 and 3. This component may be modified or eliminated as a contingent part of the remedy in the event that Intalco is able to demonstrate that an alternate cleanup approach of groundwater impacted by Tailings Piles 2 and 3, such as monitored natural attenuation, would satisfy ARARs and be protective of Railroad Creek. Such a change may constitute a significant change to the selected remedy and would require documentation of the basis for the change.

The barrier and collection system would be located along the downgradient edge of the WMAs between the tailings piles and Railroad Creek, including the section of the creek that is relocated. The groundwater barrier wall would be fully penetrating (i.e., keyed into a lower, relatively impermeable layer of glacial till or bedrock).

All collected groundwater and surface water would be treated using acid neutralization and precipitation to achieve proposed cleanup levels using two treatment facilities, as proposed for Alternative 13M. Sludge produced as a byproduct of water treatment would be disposed of in a limited purpose landfill constructed on the tailings piles in conformance with state standards. Treated water would be discharged into Railroad Creek.

Alternative 14 includes hydraulic bulkheads installed in the mine to control the rate of groundwater discharging from the Main Portal. Air restrictors would be installed within open portals to reduce oxygen transport through the mine to slow the release of hazardous substances in the Main Portal drainage.

Alternative 14 also includes groundwater monitoring to determine the extent of groundwater collection in the area where the Honeymoon Heights seeps exceed proposed cleanup levels.

Alternative 14 includes institutional controls to prevent the potential future use of groundwater that exceeds human health risk-based criteria as a drinking water source.

Like Alternative 11M, Alternative 14 includes institutional controls to prevent potential future use of groundwater that exceeded human health-based cleanup levels, as a drinking water source within the WMAs. Groundwater outside of the WMAs is expected to achieve drinking water cleanup levels within a reasonable restoration time frame.

Surface Water

As described for Alternative 13M, Railroad Creek would be realigned. This would move the creek away from most of the tailings piles and minimize the potential for erosion of tailings into the creek. Additional grading and stabilization of the tailings piles would also be performed to reduce the potential for erosion of tailings into the creek.

The Copper Creek channel would be modified under Alternative 14 to constrain future channel migrations that could erode the tailings. The Copper Creek Diversion would be placed into a lined channel or culvert from the hydroelectric plant to Railroad Creek to avoid seepage through tailings in this area.

Upgradient water diversion swales or French drains would be constructed south of the tailings and waste rock piles to reduce the amount of clean water run-on that would otherwise contact the tailings and waste rock materials.

Sediment

Alternative 14 includes relocation of Railroad Creek so that the reach known to be impacted by existing ferricrete would be isolated from the rest of the creek and would not pose a risk to aquatic life. Alternative 14 would prevent release of hazardous substances into stream sediments through source controls across the Site. As described in Section 1.2.2.4 of the SFS (see also Forest Service 2003), the Agencies do not consider existing sediment concentrations to be severe enough to require an active sediment cleanup, other than elimination of the ferricrete from aquatic habitat. Finally, Alternative 14 includes monitoring to determine whether additional sediment actions are needed in the future.

Comparative Analysis of Alternatives 11M, 13M, and 14

The threshold requirements under CERCLA and MTCA require that a remedy protects human health and the environment, and complies with ARARs. MTCA also requires that remedies comply with cleanup standards and provide for compliance monitoring.

CERCLA Criteria

Under CERCLA, the threshold criteria for remedy selection are protection of human health and the environment, and compliance with ARARs. Alternatives 11M, 13M, and 14 are compared to these criteria in Section 6 of the text of this report, as summarized below.

Protection of Human Health and the Environment

Alternatives 11M, 13M, and 14 would each be protective of human health. Table 3 (following the main text of this report) shows areas of the Site with soil concentrations that exceed human health criteria. Alternatives 11M and 14 would also be protective of the environment, but Alternative 13M would not.

Protection of Human Health

Under Alternative 14, risks to humans from soils (including tailings and waste rock) in the Tailings Piles, East and West Waste Rock Piles, Mill, Lagoon, Maintenance Yard, a portion of the Lower West Area, and the Surface Water Retention Area would be addressed by capping the material in place or consolidating and capping it to reduce infiltration and prevent exposure via direct contact. Risks from materials in the remainder of the Lower West Area, Honeymoon Heights Waste Rock Piles, and the impacted areas downslope of Honeymoon Heights Waste Rock Piles (DSHH) would be addressed through *in situ* treatment and institutional controls such as signage and administrative access restrictions. Potential future use of impacted groundwater and surface water for drinking would be restricted by institutional controls. In addition, resident and visitor safety would be addressed through physical mine access restrictions.

Alternatives 11M and 13M would protect human health in the same manner as Alternative 14 for parts of the Site. However, under Alternative 13M, Intalco did not propose any action other than institutional controls to protect human health in the Honeymoon Heights Waste Rock Piles and the DSHH, and only limited cleanup (associated with treatment plant construction) in the Lower West Area. Under Alternative 11M, exposure to waste rock at Honeymoon Heights and

DSHH would be addressed by consolidating the waste rock and impacted soils into the tailings piles and capping instead of relying on *in situ* treatment and institutional controls.

Beyond the WMAs under Alternatives 11M and 14, groundwater is expected to meet drinking water cleanup levels within a reasonable restoration time frame. (Surface water currently meets drinking water criteria at the Site.)

Protection of the Environment

Terrestrial Environment. Under Alternative 14, risks to terrestrial organisms from soil (including tailings and waste rock) at the Tailings Piles, East and West Waste Rock Piles, Mill, Lagoon, Maintenance Yard, a portion of the Lowest West Area, a portion of the Ballfield Area, and the Surface Water Retention Area would be addressed by excavation (consolidation) and/or capping the impacted soils to prevent exposure. Risks to terrestrial receptors in other areas (such as the remainder of the Lower West Area, remainder of the Ballfield Area, Holden Village, the Windblown Tailings Area, etc.) would be addressed by *in situ* treatment and possible future removal, capping, or treatment.

Under Alternative 11M, risks to terrestrial organisms from soil would be accomplished in a manner similar to Alternative 14, except that under Alternative 11M, exposure to waste rock at Honeymoon Heights and the DSHH would be addressed by moving the material to the tailings piles and capping it instead of by *in situ* treatment.[3]

Alternative 13M would address the terrestrial environment in a manner similar to Alternative 14 for some portions of the Site. However, Alternative 13M would not fully protect the terrestrial environment because it would not address risks from soil in the Lower West Area, Ballfield Area, Honeymoon Heights, Holden Village, most of the Lower West Area, and the Wind-Blown Tailings Area.

Aquatic Environment. Under Alternatives 14 and 11M, groundwater (including base flow, seeps and the mine drainage) would be intercepted and treated before being discharged to surface water in order to protect aquatic organisms from hazardous substances discharging to surface water via groundwater.

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[3] At the time that Alternative 11 was originally developed, Intalco had not characterized the area downslope of the Honeymoon Heights Waste Rock Piles. Since information developed in 2008-2009 indicates that soils in this area have concentrations that exceed both human health and ecological protection criteria, the Agencies assume that these downslope areas could be remediated as part of removing the Honeymoon Heights Waste Rock Piles, in the event that Alternative 11M is selected.

Alternative 13M would only intercept and treat groundwater from some parts of the Site before it enters surface water. Alternative 13M would allow hazardous substances from Tailings Piles 2 and 3 to enter groundwater and flow down valley unchecked, and to enter surface water at unknown locations and at unknown concentrations. It has not been demonstrated that Alternative 13M would fully protect the aquatic environment from groundwater discharging to surface water at the site.

Under Alternative 14, risks to aquatic organisms from ferricrete would be addressed by rerouting Railroad Creek; sediment in Railroad Creek and Lake Chelan would be monitored to confirm that risks remain low and decrease over time. Under Alternative 11M, ferricrete would be physically removed from Railroad Creek, instead of being addressed as part of stream relocation as proposed in Alternative 14. In addition, sediment in Railroad Creek and Lake Chelan would be monitored to confirm that risks remain low and decrease over time. Under Alternative 13M, risks to aquatic organisms from ferricrete would be addressed in the same manner as under Alternative 14.

All three alternatives would protect aquatic organisms in Railroad Creek from exposure to hazardous substances due to erosion of the tailings piles. Under Alternatives 14 and 13M, the creek would be rerouted away from the tailings piles. Under Alternative 11M, the toes of the tailings piles would be pulled back away from the creek.

Compliance with ARARs

Applicable or relevant and appropriate requirements (ARARs) are described in Appendix F and in Section 2.3 of the SFS. Details of how each alternative summarized below complies with specific ARARs are discussed in Sections 6.2.1.2, 6.2.2.2, and 6.2.3.2 of the main text of this ASFS.

Surface Water ARARs

Under Alternatives 14 and 11M, implementation of cleanup actions is expected to result in achievement of proposed surface water cleanup levels for protection of aquatic life in Railroad Creek, the Copper Creek Diversion, and other surface waters. Alternatives 11M and 14 are both expected to meet chemical-specific ARARs for surface water. Surface water already meets ARARs for protection of human health at the Site.

Under Alternative 13M, there is considerable uncertainty about whether proposed surface water cleanup levels based on protection of aquatic life would be met throughout Railroad Creek downstream from Tailings Piles 2 and 3, because of uncontrolled discharge of groundwater from Tailings Piles 2 and 3 to surface water. Alternative 13M may not meet chemical-specific ARARs for surface water.

Groundwater ARARs

Under Alternatives 14 and 11M, groundwater exceeding proposed cleanup levels would be contained within the Site in WMAs where groundwater would be collected and treated. Alternatives 11M and 14 are both expected to meet chemical-specific ARARs for groundwater within a reasonable restoration time frame, except within the WMAs where an ARAR waiver may be necessary under CERCLA, because it is technically impracticable to clean up groundwater to achieve ARARs within the WMAs.

Under Alternative 13M, Intalco asserts that drinking water ARARs would be addressed through institutional controls but, under CERCLA, ARARs must either be met or waived. Intalco's description of Alternative 13M did not include establishment of any WMAs. Institutional controls would be implemented to limit exposure to contaminated groundwater. Groundwater discharging from Tailings Piles 2 and 3 would not be contained, and may continue to enter Railroad Creek above concentrations that are protective of aquatic life. Protection of aquatic life is a designated beneficial use for groundwater at the Site, as discussed in Section 1.2.1.2 of the SFS. Without a barrier wall, there is uncertainty about whether proposed cleanup levels based on protection of surface water would be met in groundwater before it enters Railroad Creek downstream of Tailings Piles 2 and 3. However, as discussed herein, the barrier wall design could be modified, or the barrier wall may not need to be constructed if Intalco can demonstrate that some other alternative component(s) will result in compliance. Such a demonstration would rely on monitoring data that show groundwater concentrations would be protective of aquatic life and comply with ARARs without the barrier wall. Under MTCA, Alternative 13M also does not constitute all known, available, and reasonable methods of treatment (AKART) because of the lack of containment; therefore, Alternative 13M is not eligible for a conditional point of compliance for groundwater.[4]

[4] AKART refers to all known, available, and reasonable methods of treatment. Note that other state regulations use AKART to refer to all known, available, and reasonable methods of prevention, control, and treatment, and this definition is also applicable to the Site.

Soil ARARs

Under Alternatives 14 and 11M, soil exceeding proposed cleanup levels would be addressed through a combination of removal, containment, institutional controls, *in situ* treatment, and monitoring. Alternatives 11M and 14 are both expected to meet chemical-specific ARARs for soil.

Alternative 13M does not address soil contamination in the Honeymoon Heights Waste Rock Piles, DSHH, Holden Village, portions of the Lower West Area, Wind-Blown Tailings Area and the Ballfield Area, thus Alternative 13M would not satisfy chemical-specific ARARs for soils.

Sediment ARARs

Under Alternatives 14 and 13M, ferricrete in Railroad Creek would be isolated as a result of stream relocation. Ferricrete would be removed under Alternative 11M.

Remediation under Alternative 11M and 14 would include preventing all discharges of iron-rich groundwater from the tailings piles, which would eliminate formation of floc that contains hazardous substances in Railroad Creek. Under both alternatives, sediment in Railroad Creek downstream from Tailings Piles 2 and 3 and in Lake Chelan at the Lucerne Bar would be monitored to confirm that risks to benthic macroinvertebrates remain low and decrease over time with continued natural deposition of clean sediment. These actions are expected to comply with ARARs.

Under Alternative 13M, ferricrete in Railroad Creek would be isolated as part of relocating the stream channel; however, groundwater containing elevated concentrations of dissolved iron from Tailings Piles 2 and 3 would still continue to flow into Railroad Creek and it is not clear if floc would continue to be formed. Alternative 13M may not comply with ARARs.

Action- and Location-Specific ARARs

Each alternative includes some actions that, in the short term, may not meet the Forest Plan Standards and Guidelines without requiring mitigation, and may possibly warrant amendment of the Forest Plan. However, the Agencies anticipate that Alternatives 14, 11M, and 13M would satisfy the Forest Plan Standards and Guidelines in the long term, and would also satisfy other potential action- and location-specific ARARs. Adverse impacts of the cleanup action, such as destruction of habitat to construct remedy components, disturbance of habitat (especially for threatened and endangered species) during construction, visual quality, air quality, and other impacts that are not compliant with the Forest Plan will need to be addressed through mitigation, and possibly an Amendment to the Forest Plan or an ARAR waiver, with the intent of satisfying Forest Plan requirements as soon as, and to the extent, practicable. In the event that the selected remedy would produce adverse impacts that could not be addressed through mitigation or a combination of mitigation and an Amendment to the Forest Plan, it would then be possible to apply an ARAR waiver to portions of the Forest Plan, but it would not be known if this is necessary until the time of the ROD or possibly during or after remedial design (RD), in which case the ARAR waiver would need to be documented with an ESD or ROD amendment.

Monitoring during and after implementation would be used to assess compliance, as required under both CERCLA and MTCA. Final ARARs will be identified by the Agencies for the selected remedy at the time of the ROD.

Summary of CERCLA Threshold Criteria

As summarized in the preceding paragraphs, Alternatives 11M and 14 satisfy the CERCLA criteria for selection of a permanent cleanup action, but Alternative 13M does not.

Primary Balancing Criteria

Alternatives 11M and 14 are further compared under the primary balancing criteria as summarized in this section. Under CERCLA, only alternatives that meet the CERCLA threshold criteria for selecting a final remedy are typically carried forward and compared using the primary balancing criteria. Alternatives 11M and 14 both satisfy the threshold criteria for selection of a remedy under CERCLA, but Alternative 13M does not. Thus, comparisons including Alternative 13M are not summarized in this section.[5]

Alternatives 11M and 14 differ in their ability to satisfy some of the primary balancing criteria. The following summary focuses on the key differences between Alternatives 11M and 14 and explains why, overall, Alternative 14 provides a better balance among the criteria, and is the better alternative.

The main advantages of Alternative 11M over Alternative 14 are as follows:

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[5] Although Alternative 13M does not meet the threshold criteria, it is also carried forward in the primary balancing criteria discussion in Section 6 of this report for completeness and to better compare and understand the three alternatives.

- Alternative 11M would quickly achieve soil cleanup at the Honeymoon Heights Waste Rock Piles and the DSHH, but at the cost of eliminating existing, minimally impacted habitat in the DSHH, and causing long-term habitat damage in the estimated 70-acre area downslope of the Honeymoon Heights access road needed to remove the waste rock and impacted soils. Alternative 14 uses *in situ* treatment, which could take several years to achieve protection from the hazardous substances, but without the long-term damage associated with removal of the waste rock and impacted soils.

- Alternative 11M would more effectively address human health risks from exposure to waste rock at Honeymoon Heights and soils in the DSHH. Alternative 11M involves removal and capping of impacted materials to prevent visitor exposure to these materials. Alternative 14 would, instead, establish administrative restrictions and warnings to limit human contact with impacted waste rock and soil.

- Alternative 11M preserves wetland habitat, which is relatively rare in the Railroad Creek valley, by locating the water treatment plant in an upland area north of Railroad Creek. Alternative 14 involves locating the treatment system in the wetland east of Tailings Pile 3. Alternative 14 would require mitigation for the loss of the wetland and the riparian forest impacted by creek relocation by establishing or improving wetland and riparian forest habitat.

The main advantages of Alternative 14 over Alternative 11M are as follows:

- Alternative 14 avoids long-term, potentially permanent habitat loss in the vicinity of the Honeymoon Heights Waste Rock Piles, the DSHH area, and for construction of the access road to accomplish removal on Honeymoon Heights. Alternative 14 would, therefore, avoid long-term, possibly permanent habitat degradation to an estimated 70 acres downslope of the Honeymoon Heights access road and waste rock piles, caused by changes in drainage and instability. Unlike Alternative 11M, Alternative 14 uses *in situ* treatment of soils in these areas that would not require heavy equipment access or involve soil disturbance.

- The water treatment system under Alternative 14 would be easier to maintain and would be less susceptible to mechanical failure (that would potentially result in exceedances of surface water quality standards), because the Alternative 14 system does not rely on electrically driven pumps to convey water to the treatment system.

- Assuming use of diesel generators for electric power, Alternative 14 would involve less long-term risk of fuel spills because it relies on gravity flow rather than pumping all the groundwater collected for treatment. Conversely, Alternative 11M does rely on pumping and would require substantial electrical power, possibly supplied by a diesel generator. The fuel would need to be loaded, unloaded, and transported to the site via barge and truck.[6]

- Alternative 14 involves less risk of tailings releases to surface water during construction than Alternative 11M. Unlike Alternative 11M, Alternative 14 does not involve regrading and excavation immediately adjacent to Railroad Creek to relocate the toe of the tailings piles.

- Alternative 14 involves less risk of sedimentation or bentonite/cement release to surface water during construction because barrier walls would not be constructed immediately adjacent to Railroad and Copper Creeks as they would under Alternative 11M.

- The soil caps used on the tailings piles and East and West Waste Rock Piles would be easier to maintain and repair than the membrane liner systems used in Alternative 11M.

- Alternative 14 would cost less than Alternative 11M, primarily because it does not involve a geomembrane as part of the cap for tailings and waste rock piles and removal of the Honeymoon Heights Waste Rock Piles and impacted soils in the DSHH.

The advantages to terrestrial organisms of removing waste rock and soil at Honeymoon Heights under Alternative 11M would be outweighed by the disadvantages of the accompanying long-term destruction of habitat. Similarly, the advantage of removing the waste rock and soil to limit human exposure to hazardous substances would be outweighed by the accompanying long-term destruction of terrestrial habitat, especially in light of the expected effectiveness of institutional controls to control human exposure.

The loss of the wetland east of Tailings Pile 3 under Alternative 14 would be outweighed by the benefits of using a low-energy water treatment system. The low-energy system would be easier to maintain than the system proposed for Alternative 11M, would be less likely to fail (potentially resulting in exceedances

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[6] Risks related to fuel use would be reduced for all Alternatives if a hydroelectric source of power is successfully developed as desired.

of surface water quality standards), and would not rely as heavily on a diesel generator, along with its associated impacts to air quality and risk of fuel spills (if diesel generators are used as a source of power).[7] The disadvantage of wetland loss under Alternative 14 would be further offset by required mitigation measures that would establish and/or improve wetland habitat elsewhere in the Lake Chelan drainage.

The other advantages of Alternative 14 that offset those of Alternative 11M include a reduced risk of tailings, bentonite/cement, or sediment releases to surface water during construction; easier maintenance and repair of the tailings and waste rock caps; and lower overall lifecycle cost.

Alternatives 14 and 11M both satisfy the threshold criteria under CERCLA; however, Alternative 14 satisfies the primary balancing criteria to a greater degree than does Alternative 11M. The Agencies believe that the advantages of Alternative 11M are more than offset by the advantages of Alternative 14. As described in the preceding paragraphs, the Agencies conclude, that overall, Alternative 14 satisfies the CERCLA remedy selection criteria better than Alternative 11M does, and, therefore, conclude that Alternative 14 is the better alternative.

MTCA Requirements

Under MTCA, the Threshold Requirements for remedy selection include:

- Protect human health and the environment.
- Comply with cleanup standards.
- Comply with applicable state and federal laws.
- Provide for compliance monitoring.

Alternatives 11M, 13M, and 14 are compared to these criteria in Section 6 of this report. The requirement that a proposed remedy protect human health and the environment was summarized above, as was the requirement that a proposed remedy comply with state and federal laws (ARARs). Alternatives 11M, 13M, and 14 are compared to the other two MTCA Threshold Requirements in Section 6 of this report, as summarized below.

Alternatives 11M and 14 would comply with cleanup standards under MTCA. Under both of these alternatives, contaminated groundwater would be

[7] The Agencies have expressed a preference for hydroelectric power to avoid negative environmental consequences of the use of diesel fuel consistent with EPA policies (TBCs) and the Forest Plan (ARAR).

contained and treated before entering surface water. Groundwater downstream from the groundwater containment that might enter surface water would be expected to meet proposed cleanup levels at a conditional point of compliance along the groundwater-surface water interface of Railroad Creek. Alternatives 11M and 14 satisfy the requirements for Ecology to approve a conditional point of compliance for groundwater.

Alternative 13M would not comply with cleanup standards. Under MTCA, for a cleanup action to qualify for a groundwater conditional point of compliance, groundwater discharges must receive all known available and reasonable methods of treatment (AKART) before release to surface water. Alternative 13M does not constitute AKART, because it does not include containment of groundwater downstream of Tailings Piles 2 and 3. As a result, Ecology would not approve a conditional point of compliance along the groundwater-surface water interface of Railroad Creek for Alternative 13M and, therefore, this alternative would not satisfy cleanup standards under MTCA.

Alternatives 11M, 13M, and 14 would all be able to provide for compliance monitoring as part of a Sampling and Analysis Plan developed during remedial design and approved by the Agencies. All three alternatives would be able to satisfy this MTCA requirement.

As summarized in the preceding paragraphs, Alternatives 11M and 14 satisfy the MTCA threshold requirements for selection of a permanent cleanup action, but Alternative 13M does not. Alternative 14 satisfies the MTCA other requirements to a greater degree than does Alternative 11M, for reasons similar to those summarized previously under the CERCLA primary balancing criteria and detailed in Section 6 of this report. The Agencies conclude that Alternative 14 satisfies the MTCA remedy selection criteria better overall than does Alternative 11M and, therefore, conclude that Alternative 14 is the better alternative.

ADDENDUM TO THE SUPPLEMENTAL FEASIBILITY STUDY
HOLDEN MINE SITE
CHELAN COUNTY, WASHINGTON

1. INTRODUCTION

This document (titled Addendum to the Supplemental Feasibility Study, or ASFS) describes the Agencies' evaluation of alternatives to develop a proposed plan for cleanup action at the Holden Mine (Site). The evaluation of alternatives was accomplished to meet the requirements of the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 117(a) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) 40 CFR § 300.430(f)(2), and Washington's Model Toxics Control Act (MTCA), Chapter 70.105D RCW, and Chapter 173-340 WAC. The USDA Forest Service (Forest Service), along with the Washington State Department of Ecology (Ecology) and the US Environmental Protection Agency (EPA) have cleanup authority for the Site, and are collectively referred to as the Agencies. The Agencies, in consultation with the Confederated Tribes and Bands of the Yakama Nation, have undertaken a process to evaluate alternatives for cleanup action based on the remedial investigation and feasibility study (RI/FS) documents, including this document, that are listed in Section 2.

The Holden Mine is an inactive hard rock mine located in the Railroad Creek valley on the eastern slopes of the Cascade Mountains in Washington State, approximately 10 miles upstream (west) of Lake Chelan. The Site includes the Holden Mine and all areas impacted by hazardous substances associated with it. The Site is situated within the Wenatchee National Forest and is surrounded on three sides by the Glacier Peak Wilderness. Figure 1 shows the vicinity of the Site; Figures 2 and 3 shows adjacent land use and principal features of the former mine area of the Site.[8] All the figures and tables are presented following the main text of this document.

Holden Mine was an underground copper mine that was operated by the Howe Sound Mining Company (Howe Sound) from 1938 to 1957. The Agencies have determined that the past mining operations at the Site have resulted in an ongoing release of hazardous substances from the Site, and an appropriate response action is required under both federal and state law.

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[8] Except for the privately owned land shown on Figure 3, all other portions of the Site and adjacent areas are managed by the Forest Service in conformance with the Land and Resource Management Plan (LRMP) for Wenatchee National Forest (Forest Service 1990 as amended by the Northwest Forest Plan (NWFP 1994), and subsequent amendments of the NWFP 2001, 2004, and 2007).

There are adverse water quality impacts in groundwater beneath the Site, in seeps discharging to Railroad Creek, and in the surface waters of Railroad Creek and the Copper Creek Diversion. Elevated concentrations of hazardous substances have reduced populations of fish and aquatic macroinvertebrates in Railroad Creek adjacent to and downstream of the mine. Groundwater and soils (including mine tailings and waste rock[9]) have concentrations of hazardous substances that exceed criteria for protection of human health and terrestrial environmental receptors. Without a complete cleanup action, the release of hazardous substances will continue for hundreds of years.

In 1993, the Agencies identified Alumet Corporation (a successor in interest to Howe Sound) as a potentially responsible party (PRP) for the Holden Mine cleanup action, under CERCLA.[10] On April 11, 1998, Alumet and the Agencies entered into an Administrative Order on Consent/Agreed Order (AOC) to conduct a remedial investigation and feasibility study (RI/FS) for cleanup of the Site.[11] Alumet completed a Draft Remedial Investigation (DRI) report (Dames & Moore 1999). Alumet Corporation subsequently merged into Intalco Aluminum Corporation and is hereafter referred to as Intalco. Intalco prepared a Draft Final Feasibility Study (DFFS, URS 2004). The DFFS described eight proposed remedial alternatives, as well as variations on several of these.

The Agencies reviewed the DFFS and found it was deficient (Forest Service 2007a). The Agencies determined that none of the alternatives presented in the DFFS would meet the threshold requirements[12] for a final remedy under CERCLA

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[9] The Agencies consider soils at the Site to include tailings and waste rock, consistent with WAC 173-340-200.

[10] Alumet was also named as a potentially liable person (PLP) under MTCA.

[11] 1998 Holden Mine Site Administrative Order on Consent/Agreed Order for Remedial Investigation/Feasibility Study between Alumet Corporation (now Intalco) and the Agencies, USDA Forest Service Docket No. 06-97-01.

[12] The threshold requirements are the criteria specified in CERCLA [40 CFR 300.430(f)(1)(i)(A)] and MTCA [WAC 173-340-360(2)(a)] that must be satisfied for a remedial alternative to be selected as the final cleanup remedy for a site. The CERCLA threshold criteria for remedy selection are: 1) overall protection of human health and the environment; and 2) compliance with applicable or relevant and appropriate requirements (ARARs), except when an ARAR is waived, as allowed under 40 CFR § 300.430(f)(1)(ii)(C).

- Applicable requirements mean those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at the CERCLA site. Under CERCLA, only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable [40 CFR § 300.5].
- Relevant and appropriate requirements mean those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the

or MTCA. Subsequently, both Intalco and the Agencies developed additional remedial alternatives that were designated as Alternatives 9, 10, 11, and 12.[13] These alternatives were described and evaluated in the Supplemental Feasibility Study (SFS, Forest Service 2007c). The Agencies prepared the SFS to address the deficiencies of the DFFS, as provided for in Paragraph 36 of the AOC.

The Agencies prepared a draft Proposed Plan that was not released to the public, which identified Alternative 11 as the Preferred Alternative for the Site (Forest Service 2007d) whereupon Intalco proposed a variation on Alternative 5c presented in the DFFS, which it designated as Alternative 13 (David E Jackson & Associates et al. 2007).

Intalco proposed extensive studies to evaluate components of Alternative 13 and potential modifications to it (Intalco 2007a and b; and 2008a, b, and c). After initial review of Alternative 13 and Intalco's proposals, the Agencies determined that there was insufficient information available to evaluate Alternative 13 or its potential modifications. The Agencies identified additional information that was needed for this evaluation in eight specific areas (USDA OGC 2008) and Intalco agreed to obtain this information (Intalco 2008d).

Intalco subsequently developed a series of work plans that were reviewed and commented on by the Agencies. Fieldwork was accomplished in 2008 and 2009. Intalco briefed the Agencies in a series of technical meetings and teleconferences about the studies that Intalco conducted in 2008 and 2009. During this evaluation process, Intalco modified Alternative 13 and referred to the modified alternative as Alternative 13M. Intalco produced the report titled Draft Alternative 13M Evaluation Report (ERM and URS 2009a) on August 14, 2009.

The Agencies reviewed and commented on Intalco's Draft Alternative 13M Evaluation Report and related documents (Forest Service 2010a). The Agencies evaluated Alternative 13M relative to other alternatives as described below in this document. The Agencies prepared this ASFS to supplement the SFS, and

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CERCLA site that their use is well-suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate [40 CFR § 300.5]. Applicable, or relevant and appropriate requirements are similarly defined under MTCA [WAC 173-340-710]. The threshold requirements for selecting a cleanup remedy under MTCA include that the remedy: 1) protect human health and the environment; 2) comply with cleanup standards; 3) comply with applicable state and federal laws; and 4) provide for compliance monitoring. The threshold requirements are further described in Sections 4.1.2 and 4.1.5.1 of the SFS.

[13] Alternative 12 is the No Action Alternative, which is required to be evaluated under both CERCLA and MTCA.

developed Alternative 14 to address certain deficiencies of Alternative 13M and in the Draft Alternative 13M Evaluation Report (related to protection of surface water and remediating soils to achieve soil cleanup standards), as provided for in Paragraph 36 of the AOC.

This ASFS modifies the Draft Alternative 13M Evaluation Report by:

- Presenting relevant information not included in the Draft Alternative 13M Evaluation Report;
- Restating the remedial action objectives (RAOs);
- Describing three remedial alternatives, including two new alternatives and one (Alternative 11M) that has been modified since the SFS; and
- Evaluating the three additional remedial alternatives.

Detailed discussions of these items are included in this ASFS.

The three remedial alternatives evaluated herein are Alternative 11M (i.e., a modification of Alternative 11, as discussed below), Alternative 13M, and Alternative 14. The Agencies evaluated Alternative 12, the No Action Alternative, in the SFS and found that it did not satisfy the threshold requirements for remedy selection. As a result, Alternative 12 is not considered further in this document.

Alternative 11 was the only alternative evaluated in 2007 that met the CERCLA and MTCA threshold requirements for selection of a permanent cleanup action. Alternative 11 included provisions for completion of an ecological risk assessment during remedial design to provide the basis for soil cleanup in some areas of the Site. Subsequent to completion of the SFS, Intalco completed an ecological risk assessment (ERM 2008 and 2009a), referred to as the Terrestrial Ecological Evaluation (TEE). The Agencies have modified Alternative 11 herein to include the results of the TEE, and the modified alternative is referred to as Alternative 11M.

Alternative 13M was proposed by Intalco as the result of its 2008-2009 analysis, as described above.

Alternative 14 was developed by the Agencies to include components of both Alternatives 11M and 13M.

This document describes the process used by the Agencies to evaluate Alternatives 11M, 13M and 14, based on information presented in the SFS, as well as new information developed in 2008-2009. The Agencies evaluated the degree to which these alternatives satisfy the requirements for remedy selection.

1.1 Purpose and Organization

This document is an update to the SFS (Forest Service 2007c) to consider additional information developed after completion of the SFS. The SFS describes the regulatory history of the Site and evaluation of remedial measures proposed by both Intalco and the Agencies to that point.

This document compares Alternatives 11M, 13M, and 14 using the CERCLA and MTCA criteria for remedy selection to provide the evaluations necessary to identify the preferred alternative in the Proposed Plan for public comment.

Following this introduction (Section 1), subsequent chapters of this report address:

- Section 2 - The regulatory process for remedy selection;
- Section 3 - Summary of proposed cleanup levels and exceedances across the Site;
- Section 4 - Cleanup components;
- Section 5 - Cleanup action alternatives considered; and
- Section 6 - Detailed analysis of Alternatives 11M, 13M and 14.

References are presented in Section 7, followed by tables and figures. Additional information is presented in six Appendices. Appendix A discusses estimated costs for Alternatives 11M, 13M and 14; Appendix B discusses *in situ* treatment of soil to reduce bioavailability and mobility of hazardous substances; Appendix C describes performance objectives for caps to isolate hazardous substances from the environment; Appendix D discusses the MTCA practicability analysis used to develop the groundwater barrier component of Alternative 14; Appendix E presents the derivation of terrestrial ecological risk-based soil cleanup levels; and Appendix F presents potential ARARs and TBC criteria for the Site.[14]

[14] TBCs refer to "to be considered" information that are non-promulgated criteria, advisories, guidance, and proposed standards issued by federal, state, or tribal governments. TBCs are not ARARs but are meant to complement the use of ARARs as discussed further in Section 2.2.

1.2 Background Information

The former mine area of the Site includes tailings piles, a former mill building and adjacent waste rock piles, and the Main Portal, covering about 125 acres. The Site also includes the portion of the Railroad Creek drainage impacted by historical mining that extends downstream from the former mine to Lake Chelan; Holden Village; outlying areas such as Honeymoon Heights; and a depositional area of wind-blown tailings. These features are described in Section 1.2 of the SFS and Section 1.3 below. Figure 3 shows principal Site features, and Figure 5 shows sampling locations near the former mine operations.

As described in sections 1.2 and 2.0 through 2.5 of the SFS, the Agencies determined that the past mining operations at the Site have resulted in an ongoing release of hazardous substances from the Site. The enclosed Table 1 presents a summary of the primary constituents of concern for the Site. Table 2 summarizes the areas of the Site where groundwater concentrations exceed Drinking Water criteria, and Table 3 summarizes areas of the Site with soil concentrations that exceed human health criteria.

Tables 4, 6, 8, and 11 present regulatory benchmarks (ARARs and TBCs) and background concentrations (where available) for surface water, drinking water, soils, and sediments. Proposed cleanup levels for the Site have been developed as discussed in Section 2.4 of the SFS and Section 2.4 of this report. Table 1 presents proposed cleanup levels for the constituents of concern for various media.

Concentrations of constituents of concern for surface water, groundwater, soils, and sediments at the Site are summarized in Tables 5, 7, 10, and 12.

1.3 Description of Areas of Interest

The Site is described in detail in Section 2 of the DRI (Dames & Moore 1999), and Section 1.2.1 of the SFS. Physical descriptions are provided below for particular areas of interest (AOIs) where soil cleanup is discussed later in this report. The locations of these AOIs are shown on Figure 3.

1.3.1 Tailings Piles 1, 2, and 3

Tailings at the Site occur in three main piles (identified as Tailing Piles 1, 2, and 3) located along the south side of Railroad Creek, and are dispersed in other disturbed areas such as the area referred to as the east portion of the Lower West Area (Lower West Area-East), as described below. The three main piles, which range in height up to about 120 feet above the creek, are estimated to contain approximately 8.5 million tons of tailings covering an area of about 90 acres.[15]

1.3.2 East and West Waste Rock Piles

The East and West Waste Rock Piles consist of an estimated 307,000 cubic yards (cy) of waste rock that covers about 8 acres, and range in height up to about 165 feet.

1.3.3 Honeymoon Heights Waste Rock Piles

The Honeymoon Heights Waste Rock Piles consist of five discrete piles totaling about 49,000 cubic yards, and covering an area of about 5 acres. The Honeymoon Heights Waste Rock Piles are located between about elevations 3800 to 4600 feet across a relatively steep north-facing slope that varies from about 50 percent (2H:1V) to 200 percent (1H:2V).

The Honeymoon Heights Waste Rock Piles are located on private land, except possibly a small portion of the 1100-level Waste Rock Pile that may be located on National Forest System land. The piles are located in an area that is biologically important as functional riparian habitat (Figure 4).

1.3.4 TEE Areas Downslope from the Honeymoon Heights Waste Rock Piles

The TEE described an AOI consisting of a total of about 3 acres of riparian forest habitat directly downslope from the Honeymoon Heights Waste Rock Piles associated with the 300-, 550-, 700-, 800-, and 1100-level portals. The largest of these areas (collectively referred to as DSHH), as defined by the TEE, are shown on Figure 3. Like the Honeymoon Heights Waste Rock Piles, the DSHH are located on a relatively steep north-facing slope.

The DSHH are on private land in an area that is biologically important as functional riparian habitat (Figure 4).

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[15] Intalco reported the tailings area to be about 90 acres in the DRI, and subsequently revised their estimate to about 70 acres in subsequent documents. The Agencies' own estimate is closer to 90 acres than 70, but the actual figure likely depends on whether the areas of dispersed tailings west of Tailings Pile 1 (i.e., in the area around the Copper Creek Diversion), and elsewhere along the margins of the main piles are considered to be part of the main piles.

1.3.5 Ballfield Area

The former miner's village baseball field (ballfield) covers about a half-acre located several hundred feet east of the edge of the Glacier Peak Wilderness Area (Figures 3 and 5). Sampling in 2008 for the TEE extended over an area of about 8 acres (i.e., Ballfield Area), as shown on Figure 5, Sheet 1. The Ballfield Area is primarily on National Forest System land, although a small portion (~15 percent) of the ballfield is on patented land owned by Holden Village.

1.3.6 Holden Village

Holden Village currently includes about 25 buildings, with roads and landscaped areas. This former miner's village covers an area of about 11 acres (Figure 3). Holden Village, Inc. has operated since 1961 as an interdenominational religious retreat under a Special Use Permit issued by the Forest Service. All of the buildings in the village are located on National Forest System land. Approximately 60 adults and children live at Holden Village year-round. In addition, approximately 5,000 to 6,000 people visit the facility each year, with each person staying an average of 2 to 7 days.

1.3.7 Lower West Area

The Lower West Area covers an area of about 15 acres located south of Railroad Creek and west of Tailings Pile 1. The Lower West Area is roughly bisected by a road running south from the vehicle bridge over Railroad Creek to the Holden Village Maintenance Yard. (Figure 3) An ephemeral pond, referred to as the Lagoon, is located along this road and is considered as a separate AOI, as discussed below.

1.3.8 Lagoon Area

The Lagoon was reportedly excavated as a surface water management facility during mine operations, and may also have been used for temporary storage of tailings slurry that was pumped to the tailings piles or perhaps for backfilling portions of the underground mine. The Lagoon covers an area of about one acre, and contains visible accumulations of tailings.

1.3.9 Wind-Blown Tailings Area

The Wind-Blown Tailings Area extends over an area of about 77 acres located north and east of Tailings Piles 2 and 3. This area is mostly coniferous forest, with a strip of riparian wetland habitat along Railroad Creek. The Wind-Blown Tailings Area has intermittent visible accumulations of tailings. A portion of this area nearest to the creek was clear cut in the early 1960s, and subsequently became reforested. Other areas were selectively harvested and have residual old growth structure. The remainder has not been logged and has well-established native vegetation.

1.3.10 Maintenance Yard

The Maintenance Yard is an area of about 1 acre where Howe Sound and, subsequently, Holden Village performed equipment maintenance (Figure 3). The surface of the Maintenance Yard is densely compacted gravelly soil with little or no existing vegetation.

1.3.11 Former Mill Building

The former Mill Building is located between the East and West Waste Rock Piles, and extends over an area of about 2 acres. The ground surface is largely covered by concrete slabs and walls, along with debris and remnants of the steel superstructure. The dilapidated condition of the former Mill Building did not allow safe access during the RI to fully characterize potential hazardous substances.

1.3.12 Ventilator Portal Surface Water Retention Area

This area is apparently a former water detention pond that is located downslope of the 1500-level ventilator portal (Figure 3). The Surface Water Retention Area pond is an excavation with a perimeter berm, which extends over less than a half-acre. There are tailings in the soils within the former pond footprint.

1.3.13 Lucerne-Holden Road

In September 2009, the Forest Service found an April 24, 1940, memorandum from the District Ranger, W. O. Shambaugh (Forest Service 1940), indicating that the Howe Sound Company was proceeding with plans to resurface the road between Lucerne and Holden. The memorandum stated that the contractor for the job would install a rock crusher on the "waste dump at the mine" to obtain material for the resurfacing. Subsequent file searches by the Forest Service to date have been unsuccessful in determining whether this plan was actually implemented. Pending further investigation, the Agencies assume that waste rock may have been used for resurfacing the Lucerne-Holden Road and may be a source of contamination within the Site.

2. REGULATORY PROCESS FOR REMEDY SELECTION

Site characterization information, data, and regulatory and technical analyses that are used for remedy selection decision making are presented in the Remedial Investigation and Feasibility Study (RI/FS) and other documents in the Administrative Record for the Site.

The Remedial Investigation (RI) for the Holden Mine is presented in the following documents:

- Dames & Moore 1999. Draft Final Remedial Investigation Report, Holden Mine Site. Prepared for Alumet Inc. by Dames & Moore. Seattle, Washington, July 28, 1999.

- Forest Service 2002. Letter from Norman F. Day to Dave Jackson, Finalization of the Holden Mine Remedial Investigation Report. February 8, 2002.

The Feasibility Study (FS) for the Holden Mine consists of the following documents:

- URS 2004. Draft Final Feasibility Study. February 19, 2004.

- URS 2005. Alternative 9 Description and Focused CERCLA-MTCA Feasibility Evaluation, Holden Mine Site, Chelan County, Washington, November 18, 2005.

- Forest Service 2007a. Agencies' Comments on the Draft Final Feasibility Study. August 31, 2007.

- Forest Service 2007b. Agencies' Comments on Intalco's Alternative 9 Description. August 31, 2007.

- Forest Service 2007c. Supplemental Feasibility Study. September 2007.

- ERM and URS 2009a. Draft Alternative 13M Evaluation Report. August 14, 2009.

- Forest Service 2010a. Agencies' Comments on Intalco's August 14, 2009 Alternative 13M Evaluation Report and related documents. March 30, 2010.

- Forest Service 2010b. Addendum to the Supplemental Feasibility Study, Holden Mine, Chelan County, Washington. March 30, 2010.

The RI provides information about the Site that is used to assess the need for and scope of needed remedial action. The FS provides information on a range of remedial alternatives and includes evaluations needed to formulate a Proposed Plan. The Proposed Plan identifies the "preferred alternative." Following public and stakeholder review and input on the Proposed Plan, the Agencies select and document a remedy in a Record of Decision (ROD). The ROD then forms the basis for remedial design (RD) and subsequent remedy construction, termed remedial action (RA). The FS information supports the remedy selection process.

This ASFS, which is the last document in the list of citations above, explains the process by which the Agencies identified the cleanup components that will be presented in the Proposed Plan, after considering the information in all of the other documents listed above.

2.1 Site Risks

Remedial action is needed to address risks to human health and the environment resulting from the release of hazardous substances at the Site.

Site risks related to groundwater, surface water, and sediment are described in the SFS and USFWS (2007). New data obtained in 2008-2009 provide a more current perspective than data that were presented in the SFS, which were largely based on the DRI.

2.1.1 Human Health Risks

Humans that could potentially be exposed to hazardous substances at the Site include Holden Village residents and visitors, other visitors to the National Forest, workers during implementation of the remedy, and Agency personnel.

The Agencies have identified the following potential human health risks that exist at the Site:

1. Groundwater at the Site has hazardous substance concentrations that exceed drinking water standards for aluminum, cadmium, copper, lead, and zinc (see Table 2). Surface water at the Site does not exceed drinking water criteria.

2. Some soils at the Site exceed proposed soil cleanup levels for protection of human health for direct contact with arsenic, cadmium, copper, lead, zinc, gasoline- and diesel-range hydrocarbons, and heavy oil-range hydrocarbons (see Table 3).

3. Soils in some portions of the Site also exceed human health criteria for protection of groundwater for arsenic, cadmium, copper, mercury, selenium, silver, thallium, zinc, and the same hydrocarbons listed above (see Table 3).

In its supplemental human health risk evaluation of the tailings piles and waste rock piles (Appendix F of ERM and URS 2009a) Intalco concluded that hazardous substances in these specific areas would not pose unacceptable risks to certain receptors, namely recreational visitors and construction workers. This evaluation did not address other areas of the Site or evaluate other potential pathways and receptors such as drinking water and residential use. The Agencies do not accept some of Intalco's findings that were presented in Appendix F, see Forest Service (2010a).

2.1.2 Ecological Risks

Data collected for the TEE (ERM 2008 and ERM 2009a) provide the basis for a more specific assessment of risks to terrestrial ecological receptors than was previously available. Based on the analyses presented in the DRI (Dames & Moore 1999); Forest Service 2004; USFWS 2004, 2005, and 2007; the SFS; and the Agencies' development of cleanup levels protective of terrestrial ecological receptors (presented in Section 2.4.1 and Appendix E) the following ecological risks exist at the Site:

- The DRI reported that toxicity risks for trout exist in surface water at the Site, predominantly from dissolved copper, based on Hazard Quotients (HQ) for dissolved copper in surface water samples that ranged from 20 to 30.[16]

- US Fish and Wildlife Service (USFWS) toxicity reviews for the Site determined that surface water concentrations of cadmium, copper, zinc, and aluminum exceed levels known to be toxic to salmonids, based on published scientific studies cited in USFWS (2004 and 2005). Iron concentrations in surface water at the Site also have adverse effects on both salmonids and benthic macroinvertebrates (USFWS 2005). See also USFWS (2007).

- Toxicity risks for benthic invertebrates may exist in the Site's aquatic environment from aluminum, cadmium, chromium, copper, iron, and zinc in Railroad Creek and/or Lucerne Bar sediment. Concentrations of these

[16] The HQ is the ratio of estimated exposure level to a chemical from a site to the estimated exposure level at which no adverse health effects are likely to occur, such that values greater than one may be of concern. Within this document, calculated HQ values are reported to one significant figure as suggested by EPA (2004).

constituents exceed levels that may cause adverse effects to benthic organisms (see Tables 11 and 12).

- The Agencies calculated HQs for constituents of concern in soil at each area of interest (AOI) for each of three terrestrial receptors: plants, soil invertebrates, and wildlife. HQs were calculated by dividing constituent concentrations (presented in Table 10) by site-specific, risk-based screening values for each of the three receptors (presented in Appendix E). A summary of the HQs for each AOI is presented in Table 14. The west portion of the Lower West Area-West had no HQs greater than 1. Among the other areas of interest, relatively low HQs were calculated for the following areas:

    - The Ballfield Area (HQ of 2 for soil invertebrates from copper);

    - The Wind-Blown Tailings (HQ of 3 for plants from molybdenum); and

    - Holden Village (HQs of 3 and 4 for plants and wildlife, respectively, from aluminum; and HQs of 2 for plants and invertebrates from copper and invertebrates from zinc).

Significantly greater HQs were calculated for all other areas of interest, ranging from 40 to greater than 100. Aluminum, copper, thallium, and zinc were typically associated with the highest HQs in these areas. In addition, HQs of 10 and 60 were calculated for soil invertebrates from petroleum hydrocarbons at the Lagoon and Maintenance Yard, respectively.

There is also a significant risk that future tailings pile slope failures could produce a mass release of reactive tailings into Railroad Creek. The tailings are not chemically inert. Release of tailings into the creek due to slope failures would increase concentrations of hazardous substances and could cause increased toxicity to aquatic organisms above present conditions.

2.2 Potential Applicable or Relevant and Appropriate Requirements

Potential applicable or relevant and appropriate requirements (ARARs) are defined in the NCP (40 CFR Part 300). “Applicable” requirements are those cleanup standards and other environmental protection requirements promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. While not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, “relevant and appropriate” requirements address problems or situations sufficiently similar to those encountered at the Site that their use is well suited to the Site. ARARs are potential or preliminary until finalized by the lead agency in a Record of Decision (ROD).

ARARs fall into three broad categories, based on the manner in which they are applied: chemical-, action-, and location-specific.

- Chemical-specific ARARs include requirements that regulate the release to, or presence in, the environment of materials with certain chemical or physical characteristics, or containing specified chemical compounds. The requirements are usually either health- or risk-based numerical values or methodologies that establish the acceptable amount or concentration of a chemical that may remain in or be discharged to the environment.

- Action-specific ARARs set performance, design, or similar controls or restrictions on particular kinds of activities related to the management of hazardous substances, pollutants, or contaminants. The need to follow these ARARs depends on the particular remedial action selected for implementation, and indicate how, or to what level, the alternative must achieve the requirements. For example, the National Pollutant Discharge Elimination System (NPDES) discharge requirements are an action-specific ARAR when the remedy includes a groundwater treatment facility that discharges treated effluent to surface water. In general, only the substantive requirements of an ARAR need to be implemented at the Site.

- Location-specific ARARs are restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. They relate to the geographic or physical position of the Site. Remedial actions may be restricted or precluded depending on the location or characteristics of the Site and the requirements that apply to it. Location-specific ARARs may apply to actions in natural or man-made features. Examples of natural site features include wetlands and floodplains. An example of a man-made feature is an archaeological site. Also, since the Site is located within the Glacier Peak Wilderness Area Class 1 Airshed, specific air quality ARARS need to be addressed under the Clean Air Act (42 USC § 7401 et. Seq.; 40 CFR Part 50) and related regulations.[17]

[17] These air quality regulations are frequently considered to be action-specific ARARs since they may be triggered by specific actions such as the potential for generation of fugitive dust during tailings regrading. However, the Clean Air Act and related ARARs are also location-specific due to the location of the Holden Site adjacent to the Wilderness Area, and,

"To be considered" materials (TBCs) are non-promulgated criteria, advisories, guidance, and proposed standards issued by federal, state, or tribal governments that, although not legally enforceable, may be helpful in establishing protective cleanup levels and developing, evaluating, or implementing remedy alternatives. TBCs are not ARARs but are meant to complement the use of ARARs. If no ARARs address a particular chemical or situation, or if existing ARARs do not provide adequate information, TBCs are available for use in developing remedial alternatives.

Preliminary ARARs and TBCs are presented in Appendix F. Potential ARARs and TBCs that were not previously identified in the SFS are summarized below.

- **National Emissions Standards for Hazardous Air Pollutants (NESHAP) - Asbestos, 40 CFR Part 61, Subpart M.** Demolition or removal of any asbestos-containing materials in the former Mill Building must comply with NESHAP requirements.

- **Roadless Area Conservation Rule 2001 [66 Fed. Reg. 3244, January 12, 2001].** This rule limits road construction, reconstruction, and timber harvest in inventoried roadless areas because they have the greatest likelihood of altering and fragmenting landscapes, resulting in immediate, long-term loss of roadless area values and characteristics. This rule is potentially applicable to permanent roads and temporary construction roads in the vicinity of the Site.

- **Dam Safety Chapter 173-175 WAC.** This regulation provides for the comprehensive regulation and supervision of dams in order to reasonably secure safety to life and property and is potentially relevant and appropriate to the tailings piles (i.e., former tailings impoundments) at the Site.

- **Dam Safety Guidelines Part 4- Dam Design and Construction (Department of Ecology, Publication 92-55d, July 1993).** Guidelines developed by the Washington Department of Ecology Dam Safety Office (DSO) as required under WAC 173-175-050 are a potential TBC based on DSO jurisdictional interpretations regarding the tailings piles at the Site.

- **Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration, OSWER Directive 9283.** This Directive provides a compilation of some key existing EPA groundwater policies to assist EPA Regions in

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therefore, must meet both the National Ambient Air Quality Standards and the Prevention of Significant Deterioration and Visibility Regulations.

making groundwater restoration decisions pursuant to CERCLA and the NCP. It addresses the following:

- Whether CERCLA remedial action is warranted
- Appropriate role of institutional controls (ICs)
- Groundwater classification and beneficial use policy
- Remedial action cleanup levels
- Groundwater point of compliance

■ The Agencies have identified EPA guidance on native plants and invasive species as potential TBCs.[18] This guidance includes:

- **Revegetating Landfills and Waste Containment Areas Fact Sheet, EPA 542-F-06-001,** (http://www.epa.gov/tio/download/remed/revegetating_fact_sheet.pdf);
- **Frequently Asked Questions About Ecological Revitalization of Superfund Sites, EPA 542-F-06-002,** (http://www.cluin.org/download/remed/542f06002.pdf); and
- **Ecological Revitalization and Attractive Nuisance Issues EPA 542-F-06-003,** (http://www.epa.gov/tio/download/remed/542f06003.pdf).

■ **Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, and Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance, October 5, 2009.** Executive Order 13423 sets goals in the areas of energy efficiency, acquisition, renewable energy, toxics reductions, recycling, renewable energy, sustainable buildings, electronics stewardship, fleets, and water conservation. In addition the order requires more widespread use of Environmental Management Systems as the framework in which to manage and continually improve these sustainable practices.

Executive Order 13514 expands on the energy reduction and environmental performance requirements for Federal agencies identified in Executive Order

[18] Note that the Forest Plan (Forest Service 1990, and subsequent amendments) that was identified as a potential ARAR in the SFS, also addresses requirements for use of native vegetation and control of invasive species.

13423 and requires federal agencies to make reductions in greenhouse gas emissions a priority for federal agencies. Executive Order 13514 states that the federal government must lead by example in increasing energy efficiency, reducing greenhouse gas emissions, etc. In addition, the following green remediation policy statements may be TBCs:

- **Superfund Green Remediation Strategy, Office of Superfund Remediation and Technology Innovation, August 2009.** Sets out the plans of the Superfund Remedial Program to reduce greenhouse gas (GHG) emissions and other negative environmental impacts that might occur during remediation of a hazardous waste site.

- **Incorporating Sustainable Practices into Remediation of Contaminated Sites, April, 2008, EPA 542-R-08-002.** Outlines the principles of green remediation and describes opportunities to reduce the footprint of cleanup activities throughout the life of a project.

- **EPA's Principles for Greener Cleanups, August 27, 2009.** Sets forth the goal to evaluate cleanup actions comprehensively to ensure protection of human health and the environment and to reduce the environmental footprint of cleanup activities, to the maximum extent possible.

- **EPA Region 10's Clean and Green Policy, August 13, 2009.** EPA Region 10's Clean and Green Policy applies to all Superfund cleanups, including those performed by Potentially Responsible Parties (PRPs). The Policy encourages cleanup practices that, among other things, employ 100 percent use of renewable energy, and energy conservation and efficiency approaches including EnergyStar equipment; and use of cleaner fuels and diesel emissions controls.

Final ARARs and TBCs will be determined in the ROD.

2.3 Proposed Remedial Action Objectives and Cleanup Requirements

CERCLA provides for the establishment of Remedial Action Objectives (RAOs) that specify "contaminants and media of concern, potential exposure pathways and remediation goals," 40 CFR § 300.430(e)(2)(i). The remediation goals (and thus the RAOs) are to be modified as more information becomes available; final remedial goals are determined in the ROD.

The Agencies presented RAOs in Section 2.5 of the SFS. The Agencies have subsequently revised the RAOs as provided in 40 CFR § 300.430(e)(2)(i), as shown below.

1. Reduce surface water concentrations of hazardous substances to levels that are protective of aquatic life and comply with ARARs in Railroad Creek and other surface waters.

2. Eliminate adverse effects of ferricrete to aquatic life in Railroad Creek and monitor sediment quality to determine whether any further action is needed to protect aquatic life and comply with ARARs.

3. Prevent migration of hazardous substances above cleanup levels in groundwater (including the mine portal discharge) from on-site WMAs to protect aquatic life and comply with ARARs.

4. Reduce exposure to hazardous substances in soils (including tailings and other wastes) to protect terrestrial organisms and comply with ARARs. Prevent future releases of tailings and other wastes into surface water to protect aquatic receptors from hazardous substances.

5. Protect human health and comply with ARARs by reducing human exposure to hazardous substances in soils and other wastes, and in groundwater as a drinking water resource.

6. Implement the remedial action in a manner that complies with ARARs and protects human health and the environment, including the Holden Village residential community during and after construction.[19]

The Agencies consider the proposed cleanup levels and points of compliance for groundwater, surface water, and sediment, as presented in Section 2.4 of the SFS, are adequate for remedial decision making.[20] The need for future sediment

[19] The Agencies understand that Holden Village, Inc. has concerns for the viability of its operations in the event that remedial construction results in substantial curtailment of the Village's normal activities for more than two consecutive years, or a second curtailment within five years of the first construction period. Intalco will propose a construction schedule, subject to Agency approval, that will evaluate the feasibility and timing of conducting the work sequentially or concurrently. Intalco has already indicated a willingness to accomplish some work ahead of, or following, the period of major construction, and the Agencies believe this approach will mitigate impacts on Holden Village. While the Agencies do not expect that it will be necessary for Holden Village to suspend operations during remedial construction, the Agencies understand a large construction project does not lend itself to the usual expected Holden Village experience. Through review, input, and approval of remedial design, the Agencies are prepared to assist Holden Village to mitigate impacts of construction to the extent possible. The Agencies will also take into account Holden Village's request for a five-year gap between the conclusion of the first phase of construction and the initiation of any second phase, as is reflected in the Preferred Alternative.

[20] The only changes to the proposed cleanup levels for groundwater and surface water in this document compared to those presented in the SFS are for aquatic life protection criteria, which have calculated values based on surface water

cleanup actions will be determined from monitoring after implementing other remedial actions, as discussed in the SFS.

Proposed soil cleanup levels differ from those presented in the SFS based on the Agencies' analysis of information obtained from Intalco's TEE and other information, as described below.

2.4 Development of Proposed Soil Cleanup Levels

As defined in WAC 173-340-700(3), a cleanup level is the concentration of a hazardous substance that is protective of human health and the environment under specified exposure conditions and taking into account background concentrations. In accordance with this definition, the Agencies' approach for establishing soil cleanup levels involved three steps for each constituent of concern at each AOI: 1) establishing terrestrial ecological risk-based levels; 2) establishing human health risk-based levels; and 3) establishing background levels.[21] The proposed soil cleanup level for each constituent of concern at each AOI, is the lower of the ecological or human health based level, or the natural background level, if it is higher.[22] Proposed soil cleanup levels for each AOI are presented in Table 1.

2.4.1 Terrestrial Ecological Risk-Based Levels

Ecology developed the terrestrial ecological risk-based levels used by the Agencies in establishing proposed soil cleanup levels. Ecology developed separate levels for plants, soil invertebrates, and wildlife for each AOI.

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hardness (e.g. copper and zinc). Recent analysis of surface water samples collected in 2008 and 2009, combined with samples collected previously, led to revision of the background hardness used for calculation of these parameters, as discussed in Hart Crowser, 2009.

[21] MTCA requires that soil cleanup levels for protection of terrestrial receptors be based on a terrestrial ecological evaluation, except for sites that meet specific exclusion criteria (WAC 173-340-7491). Neither the Site as a whole, nor any individual area of interest, meets the requirement for an exclusion under this regulation.

[22] Separate soil cleanup levels were developed for each AOI to account for different soil chemistry, contaminant bioavailability, and anticipated exposure pathways. For the purpose of determining cleanup levels, samples from Tailings Piles 1, 2, and 3 were grouped together because the tailings piles contain the same type of soil-like waste material, derived from a common source. Samples from the East and West Waste Rock Piles were grouped together because these piles contain the same type of waste material, derived from a common source. The Honeymoon Heights Waste Rock Piles could arguably be considered as having a different geologic origin since these waste rock piles likely come from a different area within the mine than the waste rock in the main East and West Waste Rock Piles. The eastern portion of the Lower West Area was considered separately from the western portion of the Lower West Area because it is a highly disturbed area with extensive tailings contamination and limited native vegetation, whereas the western portion of the LOWER WEST AREA is a moderately disturbed area with extensive, relatively mature native vegetation.

Development of these levels took into account Site-specific information that was presented in the draft TEE (ERM 2009a), additional literature studies supporting alternative toxicity reference values (TRVs) that were submitted to the Agencies by Intalco (ERM 2009b and ERM 2009c), EPA soil screening levels (EPA Eco-SSLs), and MTCA Environmental Indicator Soil Concentrations (EISCs). Ecology's development of terrestrial ecological risk-based values is presented in Appendix E. Terrestrial ecological risk-based levels (representing the lowest value for each of the three receptors) are shown in Table 9.

2.4.2 Human Health Risk-Based Levels

Human health risk-based levels used by the Agencies in establishing proposed soil cleanup levels are, except for lead, MTCA Method B cleanup levels for unrestricted land use. These values represent the lower of the non-carcinogenic and carcinogenic levels calculated using Equations 740-1 and 740-2 (ingestion only) and 740-4 and 740-5 (ingestion and dermal contact) presented in WAC 173-340-740(3). The human health risk-based level for lead is the MTCA Method A cleanup level which is based on preventing unacceptable blood lead concentrations. Human health risk-based soil levels are presented in Table 8.

2.4.3 Background Levels

Soil background levels used by the Agencies in establishing proposed cleanup levels are the Site-specific background concentrations for the riparian and mixed conifer background areas presented in Table 7-2 of the draft TEE Report (ERM 2009a). These levels were determined in accordance with MTCA methodology (WAC 173-340-709). Background levels associated with the riparian background area are applicable to the Lower West Area, Lagoon, and DSHH. Background levels associated with the mixed conifer background area (BGMC) are applicable to all other AOIs. Background soil sample locations are shown on Sheet 3 of Figure 5 and background levels are summarized in Table 8.

2.4.4 Proposed Soil Cleanup Levels

As described in Section 2.4, the proposed soil cleanup level, for each constituent of concern at each AOI, is the lower of the ecological or human health-based level, or the natural background level, if it is higher. Ecological risk-based levels are presented in Table 9; human health and background levels are presented in Table 8. Table 1 summarizes the proposed soil cleanup levels for those constituents whose concentrations exceed background levels.

2.5 Development of Proposed Groundwater and Surface Water Cleanup Standards

Proposed cleanup levels for surface water and groundwater are presented in Table 1, based on the discussion in Section 2.4 of the SFS and Tables 4 and 6 in the SFS.

CERCLA and the NCP expect that groundwater should be returned to its beneficial uses within a reasonable timeframe whenever practicable. When restoration of groundwater is not practicable, it is necessary to prevent further migration of the plume and to prevent exposure to the contaminated groundwater [40 CFR 300.430(a)(1)(iii)(F)]. The NCP provides that groundwater cleanup levels should generally be attained throughout the contaminated plume. However, the NCP recognizes that groundwater may remain contaminated within a WMA, and groundwater cleanup levels attained at and beyond the edge of the WMA (55 Fed. Reg. 8753, and 53 Fed. Reg. 51426). Even within a WMA, however, under CERCLA, ARARs must be attained or waived.

The DFFS found that it is not practicable to clean up groundwater in some portions of the Site within a reasonable restoration time frame. As a result, some alternatives for the proposed remedy include designation of WMAs, and institutional controls to prevent groundwater from becoming a future source of drinking water within the WMA. Figure 11 shows the approximate boundary of potential WMAs at the Site that are anticipated to be long-term continuing sources of groundwater contamination due to wastes left in place following completion of the remedy under all of the alternatives being considered.[23]

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[23] The proposed WMAs would encompass the three main tailings piles, East and West Waste Rock Piles, the Honeymoon Heights Waste Rock Piles, and the Lower West Area. Waste materials in these areas will be a continuing source of groundwater contamination for tens to hundreds of years. The DFFS found it was not practical to treat or remove the tailings and waste rock piles (for example by disposal in the underground mine), thus it is necessary to designate the tailings and waste rock piles as WMAs. The Lower West Area is also identified as a WMA since hand auger explorations accomplished for the TEE found significant deposits of mine tailings over an extended area. The reported depth of tailings was more than 3 feet at the exploration location designated LWA-09; more than 2 feet at location LWA-13; 2.5 feet at location LWA-14; and more than 2 feet at LWA-16 (see Tables 2 and 4, ERM 2008). Although Alternatives 11M and 14 include consolidation of these materials to the extent possible into the main tailings piles during cleanup, this is not expected to be completely effective in all locations within the Lower West Area. In the locations just noted, the tailings were mantled with surficial soils (apparently native soil fill) and, in some cases, forest duff. Even if removal were completely effective, previous modeling (the batch flush model discussed in Appendix A of the SFS) suggests that natural attenuation alone following elimination of the sources of hazardous substances would require tens to hundreds of years to reduce groundwater concentrations to aquatic protection levels. Although the tailings in the Lower West Area are different from the specific sources of hazardous substances addressed in the batch flush model in the SFS, the Agencies

2.6 Points of Compliance

The proposed cleanup action is intended, in part, to improve soil and water quality to meet proposed cleanup levels at the designated points of compliance for the Site. Points of compliance for soil, surface water, and groundwater have been determined under CERCLA and/or MTCA, as discussed in Section 4.1.1.3 of the SFS, and are summarized in Table 13.[24]

The preamble to the proposed rule of the NCP discusses points of compliance under CERCLA (53 Fed. Reg. 51440). In cases where the ARAR itself does not specify where the requirement should be attained, generally, EPA's policy is to attain ARARs and TBCs to ensure protection at all points of potential exposure. This is true whether the ARAR pertains to contaminant levels or to performance or design standards. This means that any waste left in place should either be brought to levels that allow for unrestricted use and unlimited exposure or managed according to performance or design specifications.

In addition, if groundwater that is a current or potential source of drinking water is contaminated above protective levels (e.g., for drinking water aquifers, contamination exceeds Federal or State MCLs or non-zero MCLGs), a remedial action under CERCLA should seek to restore that aquifer to beneficial use (e.g., drinking water standards) wherever practicable. If active measures are not technically practicable or there is some other basis to waive the ARAR, exposure to the waste must be controlled through legally enforceable institutional means to ensure protectiveness.

In addition to being a potential source of drinking water, a beneficial use of groundwater at the Site is recharge to surface water to support aquatic life. Groundwater discharging through seeps, springs, or base flow that adversely impacts surface water must be managed for surface water protection.

Both CERCLA and MTCA seek to restore groundwater quality wherever practicable. CERCLA requires consideration of the state's stream classification for protection of site-specific uses that could be impacted by groundwater discharging into the surface water.[25] At a minimum, this includes preventing

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expect a similar time frame would be needed to achieve cleanup of the Lower West Area due to natural attenuation following source removal.

[24] Points of compliance would also be developed to satisfy potential ARARs in the event that any future sediment cleanup is determined to be needed.

[25] In this case, the State of Washington regulations [WAC 173-201A-200 and -600] require protection of Railroad and Copper Creek's designated beneficial uses. Per WAC 173-201A-600, the following are the designated beneficial uses of

receptors in the creeks from being exposed to groundwater that exceeds aquatic life protection criteria and drinking water standards by controlling hazardous substances before they enter the surface water (see the NCP preamble [55 FR 8713]).

Under MTCA, soil points of compliance are established separately for human exposure via direct contact, the protection of groundwater, and the protection of terrestrial ecological receptors [WAC 173-340-740]. The point of compliance for soil based on human exposure via direct contact is from the surface of the soil to 15 feet below the ground surface. Capping and/or institutional controls at various locations at the Site would prevent excavation and other activities and thus, would eliminate the direct contact exposure pathway for humans. For terrestrial ecological receptors, the point of compliance will be the biologically active zone, which is assumed to extend to a depth of 6 feet, or a site-specific depth based on a demonstration that an alternative depth is appropriate per WAC 173-340-7490(4)(a). Soil cleanup to protect groundwater is required wherever soils exceed criteria and are not within a groundwater containment area [WAC 173-340-740(1)(d)].

For surface water, the point of compliance is the point or points where the release enters the surface waters, unless Ecology has authorized a mixing zone [WAC 173-340-730(6)]. MTCA does not allow a mixing zone for groundwater discharges into surface water [WAC 173-340-720(8)(d)(i)(C)].

MTCA requires the point of compliance for groundwater be throughout the Site, from the uppermost level of the saturated zone to the lowest depth that could potentially be affected. MTCA requires that groundwater cleanup levels be attained in all groundwater from the point of compliance to the outer boundary of the hazardous substance plume [WAC 173-340-720(8)]. MTCA allows a conditional point of compliance for groundwater for limited circumstances where it is not practicable to meet the cleanup level throughout the site within a reasonable restoration time frame. MTCA requires that the conditional point of compliance shall be as close as practicable to the source, and may be established no further than in surface water as close as technically possible to the point(s) where groundwater flows into the surface water, provided certain conditions are satisfied [WAC 173-340-720(8)(d)(i)].

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surface water (i.e., Railroad and Copper Creeks) at the Site (use categories in parentheses): aquatic life (salmonid spawning, rearing, migration, and core summer habitat), recreation (extraordinary primary contact), water supply (domestic, industrial, agricultural, and stock watering), and miscellaneous (wildlife habitat, harvesting, commerce and navigation, boating, and aesthetic values).

3. SUMMARY OF PROPOSED CLEANUP LEVELS AND EXCEEDANCES ACROSS THE SITE

CERCLA requires that remediation goals be developed to satisfy remedial action objectives (RAOs) for contaminants and media of concern, and potential exposure pathways. The remediation goals are initially developed based on readily available information, such as potential chemical-specific ARARs, and may subsequently be modified as more information becomes available [40 CFR § 300.430(e)(2)(i)].

State of Washington regulations [Chapter 173-340 WAC] set forth various ways to determine the appropriate cleanup standards for surface water, groundwater, soil, and sediment. The proposed cleanup levels for Site groundwater, surface water, soil, and sediment for protection of human health and the environment are based on potential chemical-specific ARARs, background concentrations, and analysis of TEE data to assess risk-based cleanup requirements for soils.

The “proposed cleanup levels” for the Site, as used in this document, are the same as “preliminary remediation goals” as used in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 CFR § 300.430(e)(2)(i)] and in some CERCLA guidance documents. The proposed cleanup levels will apply to exposure pathways determined to be complete and significant by the Agencies. Results of the human health risk assessment and the ecological risk assessment (i.e., TEE) are summarized below. Final remediation goals and cleanup levels will be described in the ROD.

Where the background concentration is greater than the potential ARAR-based or calculated risk-based proposed cleanup level, the background concentration becomes the proposed cleanup level for that constituent of concern [WAC 173-340-700(6)(d)]. Background concentrations for surface water and soil compared to the numerical values for potential ARARs are presented in Tables 4 and 8, respectively. Background concentrations have not been determined at this Site for groundwater or sediment.

3.1 Summary of Proposed Cleanup Levels and Exceedances for Groundwater, Surface Water and Sediment

Proposed cleanup levels for groundwater, surface water, and sediment were identified in Section 2.5 of the SFS. Proposed cleanup levels have changed only slightly from those identified in the SFS for surface water protection, due to new background hardness data collected in 2008 and 2009. State and federal drinking water criteria and proposed cleanup levels for sediment that were presented in the SFS have not changed.

Proposed cleanup levels for each constituent of concern, as derived from the potential ARAR concentrations and available background concentrations, are presented in Table 4 for surface water, Table 6 for groundwater, and Table 11 for sediment.

Proposed cleanup levels for groundwater are based on protection of surface water. Potential beneficial uses of groundwater include both drinking water and recharge to surface water for which a designated beneficial use is aquatic life habitat. Table 6 shows drinking water quality criteria that are applicable to groundwater. In some areas of the Site water from Railroad Creek infiltrates into the ground, referred to as a losing condition. However, the Agencies are of the opinion that all groundwater at the Site eventually discharges to surface water. The aquatic life protection criteria are the basis for the proposed groundwater cleanup levels presented in Table 1 because the aquatic life protection criteria are more stringent than the drinking water standards.

Table 5 lists areas of the Site where surface water concentrations exceed proposed cleanup levels, and Table 7 lists areas of the Site where groundwater concentrations exceed proposed cleanup levels.

Figures 6 and 10 show areas of the Site where groundwater and surface water exceed proposed cleanup levels.

The DFFS found that the discharge of groundwater containing hazardous substances (including base flow, seeps, and drainage from the mine portal) was the primary source of hazardous substances in surface water at the Site. Intalco (ERM and URS 2009a) has suggested that containment and collection of groundwater to protect surface water is only needed in gaining reaches (i.e., where groundwater base flow enters the creek) of Railroad Creek, and not in losing reaches (i.e., where water in the creek seeps into the ground). The approximate extent of gaining and losing reaches adjacent to the Lower West Area and the tailings piles is shown on Sheets 1 and 2 of Figure 7, and Figure 8 shows the gaining and losing reaches east of Tailings Pile 3. Based on limited observations, Intalco conjectured that groundwater likely does not enter Railroad Creek above proposed cleanup levels, east of Tailings Pile 3 (ERM and URS 2009). However, groundwater above proposed cleanup levels has been found in several wells east of the Tailings Pile 3 and preliminary observations indicate both gaining and losing conditions along Railroad Creek east of Tailings Pile 3, as indicated on Figure 8.

Intalco has also suggested that observations over time indicate concentrations of hazardous substances are decreasing in groundwater downstream of the tailings piles. While this may be true for some wells, there is considerable scatter in some of the data as indicated on Figure 9. A statistically robust monitoring program would be needed to support natural attenuation as a possible part of the remedy.

3.2 Summary of Proposed Cleanup Levels and Exceedances for Soils

Proposed cleanup levels for soils were identified in Section 2.5 of the SFS. However, new proposed soil cleanup levels have been developed as part of the Agencies' evaluation of Alternatives 13M and 14, as discussed herein.

Soil concentrations of more than a dozen hazardous substances and petroleum hydrocarbons exceed state criteria for protection of human health from dermal contact and/or soil ingestion, groundwater, surface water, and/or site-specific risk-based soil criteria for protection of terrestrial organisms.

The SFS identified preliminary soil cleanup levels based on the MTCA Table 749-3 default screening levels for protection of terrestrial receptors, and required an ecological risk assessment (i.e., TEE) to be completed during remedial design to determine final soil cleanup levels. Intalco prepared a TEE as part of developing Alternative 13M and used the results to propose what it referred to as preliminary Ecological Indicator Soil Concentrations (EISCs). These EISCs are presented in Appendix I of the draft Alternative 13M report. These EISCs were intended to form the basis for site-specific soil cleanup levels; however, EISCs were not developed for all constituents of concern at all areas of interest. In addition, EISCs for a number of constituents were based on default toxicity reference values (TRVs) that Intalco proposed to supersede subsequent to the issuance of Appendix I of the Alternative 13M report (ERM 2009b and ERM 2009c). For these reasons, the Agencies rejected the EISC values presented in Appendix I of the Alternative 13M report (Ecology 2010a). The Agencies used the data from the TEE, along with Intalco's proposed revised TRVs (plus the Agencies' evaluation and modifications to these proposed TRVs) to develop proposed site-specific soil cleanup levels, as described in Appendix E. The ecological risk-based soil concentrations protective of terrestrial receptors are presented in Table 9.

The following sections summarize the constituents of concern and exceedances of proposed soil cleanup levels, including HQ values for terrestrial receptors, in each of the AOIs described in Section 1.3. Table 10 shows areas of the Site that have soils with hazardous substance concentrations that exceed proposed cleanup levels, and Table 14 shows HQs for terrestrial receptors at each AOI.

3.2.1 Tailings Piles 1, 2, and 3

The tailings piles have concentrations of cadmium and copper that exceed human health-based criteria for protection of groundwater; concentrations of various hazardous substances that produce HQs greater than 1 for plants and soil invertebrates; and cadmium, copper, thallium, and zinc HQs ranging from 4 to 40 for wildlife species.

3.2.2 East and West Waste Rock Piles

Waste rock in these two piles has concentrations of cadmium and copper that exceed human health-based criteria for protection of groundwater; concentrations of various hazardous substances that produce HQ values greater than 1 for plants and soil invertebrates; and barium, chromium, copper, lead, molybdenum, thallium, and zinc HQ values ranging from 2 to 60 for wildlife species.

3.2.3 Honeymoon Heights Waste Rock Piles

The waste rock in these piles has concentrations of copper and mercury that exceed human health-based criteria for protection of groundwater, and concentrations of lead that exceed criteria for direct contact and/or injection. The waste rock also has concentrations of various hazardous substances that produce HQ values greater than 1 for plants and soil invertebrates; and barium, copper, lead, molybdenum, silver, and thallium HQs ranging from 2 to more than 100 for wildlife species.

3.2.4 TEE Areas Downslope from the Honeymoon Heights Waste Rock Piles (DSHH)

The DSHH have concentrations of arsenic, cadmium, and copper that exceed human health-based criteria for protection of groundwater and concentrations of arsenic that exceed criteria for direct contact and/or ingestion. Concentrations of various hazardous substances produce HQ values greater than 1 for plants and soil invertebrates; and aluminum, barium, copper, and thallium HQs ranging from 2 to 70 for wildlife species.

3.2.5 Ballfield Area

Soil at this AOI does not exceed human-health based criteria. Concentrations of copper in soil produce an HQ value of 2 for soil invertebrates.

3.2.6 Holden Village

Soil at Holden Village does not exceed human health-based criteria. Soils do produce HQs of 3 to 4 for plants and wildlife from aluminum; and HQs of 2 for plants and invertebrates from copper and invertebrates from zinc.

3.2.7 Lower West Area

Soils in the Lower West Area-East have concentrations of arsenic, cadmium, copper, and lead that exceed human health direct contact and ingestion criteria; and concentrations of arsenic, cadmium, and copper that exceed human health-based criteria for protection of groundwater. Soils in this area also have HQs for plants, soil invertebrates, and wildlife species for several constituents ranging from 2 to more than 100.

Soils in the Lower West Area-West (west of the road to the Maintenance Yard and excluding the Lagoon), have concentrations of arsenic that exceed human health direct contact and ingestion criteria and health-based criteria for protection of groundwater. Soils in this area do not have HQs greater than one for terrestrial ecological receptors.

3.2.8 Lagoon Area

Soils within the Lagoon have concentrations of cadmium, copper, silver, thallium, and zinc that exceed human health-based criteria for protection of groundwater. Soils in the Lagoon also have concentrations of cadmium, copper, lead, and zinc that exceed criteria for direct contact and/or ingestion. Soils in this area also have HQs for a number of constituents (including petroleum hydrocarbons) of 3 to over 100 for plants, soil invertebrates, and wildlife species.

3.2.9 Wind-Blown Tailings Area

Soils within the Wind-Blown Tailings Area do not exceed human health-based criteria. Soils do produce an HQ of 3 for plants from molybdenum.

3.2.10 Maintenance Yard

Soils at the Maintenance Yard have concentrations of arsenic, copper, lead, and petroleum hydrocarbons that exceed human health risk-based criteria for direct contact/ingestion and concentrations of arsenic, cadmium, copper, and petroleum hydrocarbons that exceed health-based criteria for protection of groundwater. Soil in this area also has HQs for a number of constituents (including petroleum hydrocarbons) of 2 to over 100 for plants, soil invertebrates, and wildlife species.

3.2.11 Former Mill Building

Soils in the former Mill Building area have not been characterized due to safety concerns associated with the derelict structure, but will need to be characterized during remedial action. Sources of contamination within the former Mill Building likely include unprocessed ore, mineral concentrates (processing residuals), and mineral salts present on the surface and in abandoned equipment. The presence of potential hazardous substances is inferred from groundwater seeps from the mill area that have concentrations of several hazardous substances above proposed cleanup levels.

3.2.12 Ventilator Portal Surface Water Retention Area

Soils within the Ventilator Portal Surface Water Retention Area exceed human-health based criteria for protection of groundwater for cadmium and copper. Soils in this area also have HQs for aluminum, barium, copper, and zinc of 2 to over 100 for plants, soil invertebrates, and wildlife species.

3.2.13 Lucerne - Holden Road

Soils along the Lucerne-Holden Road have not been characterized to date, but will need to be characterized during remedial action.

4. CLEANUP COMPONENTS

Cleanup alternatives for surface water and soils, including mine tailings and waste rock, were evaluated in Section 4.3.1.1 of the SFS, and have been further evaluated as described in this ASFS. Section 4.3.1.1 of the SFS also discussed cleanup of groundwater and sediment; these cleanup components are referred to herein but have not been further evaluated in this ASFS.

The approach for cleanup of surface water identified in the DFFS screening process, and carried through the SFS, is source control. This includes containment and treatment of groundwater above proposed cleanup levels that discharges into surface water, as well as preventing the release of contaminated soils (including tailings and waste rock) into surface water. The alternatives for control of groundwater differ on the location of barriers and collection components to prevent groundwater containing hazardous substances from migrating and from discharging into surface water.

Potential approaches to soil cleanup were evaluated to select the most appropriate alternative for each AOI, considering existing land use and physical constraints, such as topography, that affect the feasibility of the alternatives in different areas. The potential soil cleanup approaches that were considered are listed below:

- Consolidation, to reduce the volume of impacted soils and the extent of the area impacted.

- Stabilization, to prevent future releases due to geologic processes such as erosion or mass wasting.

- Capping, to reduce or prevent infiltration, and to prevent direct contact with humans or ecological receptors. The extent of capping should be limited by consolidation of impacted materials, so as to reduce the footprint of the cap that would thereafter need to be monitored and maintained.

- *In situ* treatment to reduce mobility and bioavailability of hazardous substances.

- Downgradient barriers to protect surface water and groundwater.

Different approaches for soil cleanup may be appropriate for different areas of the Site, depending on the nature and extent of contamination, habitat values, and physical constraints such as topography. Regulatory considerations are discussed below; the feasibility of implementing these alternatives for specific AOIs is discussed in Section 5.2.

Institutional controls are part of essentially all other remedial components, for diverse reasons, e.g., to prevent direct contact with hazardous substances that present a risk to human health; prevent ground-disturbing activities that would result in the spread of hazardous substances; protect the integrity of caps; protect and assure performance of the groundwater containment, collection and treatment system(s); assure operation, maintenance and monitoring of other remedy components; and to prevent human exposure to groundwater that exceeds drinking water standards within WMAs. Specific institutional controls are described conceptually in Section 4.2 for some AOIs; final requirements for institutional controls will be determined at the time the ROD is prepared.

4.1 Regulatory Considerations

Selection of a remedy needs to satisfy requirements of both CERCLA (40 CFR § 300.430) and MTCA (WAC 173-340-360). However, in some parts of the Site, some potential remedial actions could result in more environmental harm than benefit. Federal and state laws differ in their approach to selecting remedial components in order to avoid adverse impacts that might be caused by the cleanup. These differences are explained in Sections 4.1.1 and 4.1.2.

4.1.1 CERCLA Requirements

During remedy selection under CERCLA, the assessment of short-term impacts of alternatives includes consideration of:

> *Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation. . .* [40 CFR 300.430(e)(9)(iii)(E)(3)].

CERCLA guidance (EPA 1999, OSWER Directive 9285.7-28P pages 6 and 7) further clarifies and expands this concept by explicitly advising that some contaminated areas may be better left unremediated if the cleanup would cause greater ecological harm:

> *Will the cleanup cause more ecological harm than the current site contamination?*
>
> *Whether or not to clean up a site based on ecological risk can be a difficult decision at some sites. When evaluating remedial alternatives, the NCP highlights the importance of considering both the short-term and long-term effects of the various alternatives, including the no action alternative, in determining which ones 'adequately protect human health and the environment.' Even though an ecological risk assessment may demonstrate that adverse ecological effects have occurred or are expected to occur, it may not be in the best interest of the overall environment to actively remediate the site. At some sites, especially those that have rare or very sensitive habitats, removal or in situ treatment of the contamination may cause more long-term ecological harm (often due to wide spread physical destruction of habitat) than leaving it in place. Conversely, leaving persistent and/or bioaccumulative contaminants in place where they may serve as a continuing source of substantial exposure, may also not be appropriate.*
>
> *The likelihood of the response alternatives to achieve success and the time frame for a biological community to fully recover should be considered in remedy selection. Although most receptors and habitats can recover from physical disturbances, risk managers*

should carefully weigh both the short- and long-term ecological effects of active remediation alternatives and passive alternatives when selecting a final response. This does not imply that there is a preference for passive remediation; all reasonable alternatives should be considered. For example, the resilience and high productivity of many aquatic communities allows for aggressive remediation, whereas the removal of bottomland hardwood forest communities in an area in which they cannot be restored due to water management considerations may argue heavily against extensive action in all but the most highly contaminated areas.

The evaluation of ecological effects resulting from implementing various alternatives should be discussed in the Feasibility Study or the Engineering Evaluation/Cost Analysis and should include input from the ecological risk assessor and the federal and/or state trustees responsible for the resources that may be impacted by the response.

CERCLA provides for an ARAR waiver and selection of a remedy that does not attain an ARAR if the administrative record supports a finding that compliance at a given site or portion of a site will result in greater risk to human health and the environment than alternative options. [See 42 U.S.C. § 121(d)(4)(B).]

4.1.2 MTCA and SEPA Requirements

MTCA allows consideration of the environmental impact of the cleanup action itself as part of a disproportionate cost analysis to determine whether a cleanup action is permanent to the maximum extent practicable (WAC 173-340-360(3)(f)(i)). This includes consideration of the risks to the environment associated with construction and implementation of an alternative and the overall improvement of environmental quality resulting from the alternative. However, unlike CERCLA, MTCA regulations, policy, and guidance do not explicitly allow final cleanup actions that do not meet cleanup standards if meeting such standards would cause greater ecological harm than benefit.

The State Environmental Policy Act (SEPA) (Chapter 43.21C RCW), provides Ecology with substantive authority, subject to certain provisions, to modify a proposed cleanup action to mitigate adverse environmental impacts (RCW 43.21C.060; WAC 197-11-660); (RCW 43.21C.036; WAC 197-11-250).

A proposed cleanup action that includes components that would cause more ecological harm (e.g., permanent habitat destruction) than the threat posed by existing site contamination should be conditioned to avoid such harm. As such, Ecology expects that under its adopted SEPA policies (see WAC 173-802-110) it would condition the cleanup action such that those components of the action would be mitigated to eliminate the undue adverse impacts.

4.2 Identification of Cleanup Components for Specific AOIs

This section discusses cleanup components for specific areas of the Site considering topographic, land use, and other factors that potentially constrain selection of remedial measures.

Potential cleanup approaches were assessed for each AOI to determine how best to achieve proposed cleanup levels, as discussed below. The comparison of potential alternative approaches was done in compliance with the MTCA requirements for selecting cleanup actions [WAC 173-340-360(2)], including those to determine whether the alternatives are permanent to the maximum extent practicable [WAC 173-340-360(3)]. The analysis is also intended to inform Ecology's consideration under SEPA, WAC 197-11-660, and WAC 173-802-110.

4.2.1 Tailings Piles 1, 2, and 3

Cleanup of the tailings piles can be accomplished by a combination of approaches that include consolidation, capping, downgradient barriers to contain impacted groundwater, and institutional controls.

- Consolidation is a reasonable part of cleanup in order to relocate areas of the tailings that are thin or intermittent, to within the main tailings pile footprint, prior to construction of a cap.

- Capping is needed to reduce infiltration, prevent direct contact, prevent dispersion of the tailings by erosion, and to satisfy the performance requirements for closure of limited purpose landfills [WAC 173-350-400(3)(e)(i)] and other ARARs. The tailings pile slopes will need to be regraded prior to capping to assure long-term stability.

- Downgradient barriers to contain groundwater impacted by releases from the tailings piles (and other portions of the Site) is needed as part of cleanup since it is not practicable to clean up all such impacted groundwater, or to prevent ongoing releases from the tailings piles to groundwater, as discussed in Section 4.1.1.3.1 of the SFS.

- Finally, institutional controls are needed as part of the cleanup action to protect integrity of the cap; to protect and assure performance of the groundwater containment, collection, and treatment system; and to prevent human exposure to groundwater that exceeds drinking water standards due to releases from the tailings piles and other areas of the Site.

Alternative 11M includes a cap for the tailings piles that would meet the presumptive final closure cover requirements for limited purpose landfills [WAC 173-350-400(3)(e)(ii)]. This cap would consist of a minimum of two feet of earthen material and a minimum 30-mil-thick geomembrane. For Alternative 13M, Intalco proposed to place a cover consisting of 6-inches of "soil/gravel and wood slash" on the top surface of the tailings piles, and 8- to 12-inches of "soil/gravel" on the tailings pile side slopes, but did not explain the basis for this proposed cover.[26] Appendix C summarizes the performance requirements for limited purpose landfill covers [WAC 173-350-400(3)(e)(i)], which the Agencies believe can be met for the tailings pile cap, with less cost than the presumptive cover requirements.[27]

Alternative 11M includes regrading to move the toe of the tailings piles away from Railroad Creek and to provide room for construction of a groundwater barrier and collection system. Alternative 11M also includes a soil buttress to improve seismic stability of the regraded tailings piles slopes, based on geotechnical analysis of data collected by Intalco in 2008-2009.[28]

Intalco proposed relocating a portion of Railroad Creek to allow construction of a groundwater barrier and collection system for Alternative 13M, to avoid the need to move the toe of the tailings piles away from Railroad Creek, as depicted on Figure 13 of this ASFS.[29] Intalco has suggested the extent of the groundwater

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[26] Intalco subsequently provided another proposed cover consisting of twelve inches of soil, or soil and amended tailings (URS 2010a).

[27] For the purpose of remedy selection, the Agencies expect that a 2-foot-thick soil cap may meet the performance requirements for a final tailings pile cover, as discussed in Appendix C, and have used this assumption to evaluate Alternative 14. Final determination of the type of soil, thickness, and other details, such as erosion prevention and control of run-on and runoff, will be made during remedial design. An important consideration that will need to be addressed is the requirement that the cap be capable of sustaining native communities, including both vegetation and wildlife.

[28] Intalco's seismic liquefaction and slope stability analyses determined that a toe buttress is needed to provide stability of the tailings pile slopes for both Alternatives 11 and 13M. However, the Agencies found that Intalco did not use a consistent approach or assumptions in evaluating the buttress for these two alternatives, and have revised Intalco's analysis, as discussed in Appendix A.

[29] Although Intalco accomplished a considerable amount of work in 2008 and 2009 to support remedial design, Intalco has not fully addressed all the questions previously raised by the Agencies, as discussed in Forest Service (2010a). For example, the extent of creek relocation proposed by Intalco (see Figure 3.1 of ERM and URS 2009a) may not provide adequate room for construction of a groundwater barrier and collection system between the west portion of the north-facing slope of Tailings Pile 1 and the existing Railroad Creek channel. The extent of Railroad Creek relocation will need to be further assessed as part of remedial design.

barrier and collection system could be modified at a future time if Intalco does not demonstrate that Alternative 13M is protective of Railroad Creek adjacent to and downstream of Tailings Piles 2 and 3.

The Agencies adopted Intalco's proposed concept of creek relocation as a component of the new Alternative 14, as depicted on Figure 14, with the understanding that the actual extent of creek relocation will need to be further assessed during remedial design. The extent of the groundwater barrier and collection system for Alternative 14 was determined based on MTCA requirements, as discussed in Appendix D.

If Intalco demonstrates that impacted groundwater above proposed cleanup levels is not entering Railroad Creek adjacent and downstream of Tailings Piles 2 and 3, the extent of the groundwater barrier and collection system may be modified after the ROD and the basis for this change documented.

4.2.2 East and West Waste Rock Piles

Like the tailings piles, cleanup of the East and West Waste Rock Piles can be accomplished by a combination of approaches that include capping, consolidation, downgradient barriers to contain impacted groundwater, and institutional controls.

Capping the existing East and West Waste Rock Piles is needed to reduce infiltration, prevent direct contact, prevent dispersal of the waste rock by erosion or mass wasting, and to satisfy the requirements for closure of limited purpose landfills [WAC 173-350-400] and other ARARs.

The waste rock slopes will need to be regraded prior to capping to assure long-term stability. Waste rock that is displaced by slope regrading could be consolidated to remain within the modified footprint of the waste rock pile(s); consolidated onto one of the three tailings piles prior to capping; and/or placed in an on-site landfill that meets state requirements for limited purpose landfills (WAC 173-340-400).

Alternative 11M includes capping the regraded East and West Waste Rock Piles with two feet of soil and a geomembrane.

For Alternative 13M, Intalco proposed covering the regraded East and West Waste Rock Piles with a vegetated 6-inch soil cover on the top and 8- to 12-inch soil cover on the side slopes [see also URS (2010a) for a different approach]. Intalco also proposed that excess waste rock from regrading the East and West

Waste Rock Piles could be used as fill over the former Mill Building area, and capped with a vegetated 6-inch soil cover.[30]

For evaluation of Alternative 14, the Agencies used a 2-foot-thick soil cover over the regraded East and West Waste Rock Piles, which they believe may satisfy the performance requirements for final closure of limited purpose landfills [WAC 173-350-400(3)(e)(i)]. As noted in footnote 27, an important consideration that will need to be addressed is the requirement that the cap be capable of sustaining native communities. Final determination of the type of soil, thickness, and other details, such as erosion prevention and control of run-on and runoff, would be determined during remedial design.

Downgradient barriers to contain groundwater impacted by releases from the East and West Waste Rock Piles (and other portions of the Site) are needed as part of cleanup since it is not practicable to clean up all such impacted groundwater or prevent ongoing contamination of groundwater beneath the waste rock piles, as discussed in Section 4.1.1.3.1 of the SFS. A groundwater barrier and collection system downgradient of the East and West Waste Rock Piles is included in alternatives 11M, 13M and 14.

Finally, institutional controls are needed as part of the cleanup action to protect integrity of the cap; protect and assure performance of the groundwater containment, collection and treatment system; and to prevent human exposure to groundwater that exceeds drinking water standards due to releases from the waste rock piles (and other areas of the Site).

4.2.3 Honeymoon Heights Waste Rock Piles

As noted in Section 1.3.3 the Honeymoon Heights Waste Rock Piles are located on a steep slope and at least partially within riparian areas. These areas are biologically important and portions of these areas may be subject to protection as wetlands under state and federal law.

Alternative 11M includes removing the Honeymoon Heights Waste Rock Piles for consolidation and capping with other waste rock from the East and West Waste Rock Piles. However, removal or capping of the Honeymoon Heights Waste Rock Piles would likely require construction of an access road for heavy equipment, as well as significant disturbance of the areas immediately adjacent

[30] Intalco did not address whether disposal of waste rock over the former Mill Building area would constitute a new landfill that would need to meet applicable provisions of the limited purpose landfill requirements (e.g., liner system design and leachate collection and control systems [WAC 173-350-400(3)(b) and (3)(c)] and other ARARs).

to the waste rock piles. The Honeymoon Heights access road would need to be benched into the hillside for stability. Due to the steepness of the hillside, the benches would typically need to be constructed by excavating into the shallow bedrock. Downslope soils would be loosened by the blasting, which, along with drainage changes, could accelerate erosion. After construction of the Honeymoon Heights access road was complete, it would not be possible to completely restore the disturbed areas because the steepness of the slope would limit the area where soil could be replaced in a stable configuration.

Intalco has suggested that there are areas along the Honeymoon Heights access road, and possibly underlying the waste rock piles, where there is likely insufficient rock thickness for safe access across portions of the abandoned underground workings. Even if an access road alignment could be established to avoid crossing unsafe mine workings, the disturbance due to road construction is likely to be permanent.[31]

Short-term impacts related to erosion, changes in existing drainage patterns, and potential slope instability are also likely to occur downslope of the piles and downslope of the access road, and there is some potential that these adverse impacts would continue long after implementation of the remedy. The effect of these impacts would be the loss or degradation of habitat and removal of vegetation and topsoil. Since Honeymoon Heights is relatively steep, it would be difficult to mitigate erosion and instability in the areas disturbed, or to restore lost topsoil.

The area of disturbance to remove or cap the Honeymoon Heights Waste Rock Piles would include the waste rock piles themselves as well as about five more acres that would need to be cleared for the Honeymoon Heights access road prism and construction access to work around the waste. In addition, the Agencies estimate that an additional area of approximately 70 acres downslope of the Honeymoon Heights access road would likely to be impacted by erosion and potential instability during or following construction.

In order to avoid the adverse impacts of removal or capping the Honeymoon Heights Waste Rock Piles, Intalco proposed no action to protect terrestrial ecological receptors from risks associated with the Honeymoon Heights Waste Rock Piles as part of Alternative 13M (ERM and URS 2009a). Instead, Intalco

[31] Helicopter access would also involve significant disturbance to provide landing zones on the steep hillside, as well as disturbance of the waste rock piles and immediately adjacent areas, and potential long-term impacts. Helicopters have been proposed by the Forest Service as a means of delivering construction equipment and removing waste rock at other abandoned mine sites, but have not been evaluated in detail at Holden.

proposed reliance on "monitored natural recovery," although it did not present any discussion of how this recovery would improve conditions over time.

Under Alternative 14, the Agencies propose to mitigate the environmental threat posed by existing contamination in such a way as to avoid the long-term habitat destruction that would result from removal or capping the Honeymoon Heights Waste Rock Piles. *In situ* treatment may adequately reduce risk to terrestrial receptors from the mobility and bioavailability of the hazardous substances, where this is related to soil pH, as discussed in Appendix B.[32]

The Honeymoon Heights Waste Rock Piles were apparently loose-dumped on the existing steep hillside, and the waste rock slopes are marginally unstable. These slopes are susceptible to instability related to mass wasting and erosion due to seasonal precipitation and snowmelt runoff. Based on stability analyses of the main East and West Waste Rock Pile slopes, the Honeymoon Heights Waste Rock Pile slopes would likely be unstable under moderate seismic shaking. Avalanches and other instabilities would likely lead to fresh exposure of relatively unweathered waste rock over time. As a result, the Agencies anticipate that the area impacted by releases from the Honeymoon Heights Waste Rock Piles would increase over time, as the waste rock is dispersed downslope by erosion and mass wasting. Therefore, *in situ* treatment would need to be designed to include not only the waste rock piles themselves, but the impacted DSHH areas.

Alternative 14 includes the use of *in situ* treatment for soil at several areas, including the Honeymoon Heights Waste Rock Piles and the DSHH. This approach is proposed for these areas instead of more intrusive measures, such as excavation, because it avoids potentially permanent destruction of habitat. The Agencies anticipate that this approach would adequately reduce risk to terrestrial organisms, and this would be confirmed based on treatability studies conducted during remedial design. However, even if these studies conclude that *in situ* treatment is not fully effective at reducing risk to terrestrial organisms, the Agencies do not anticipate that more intrusive cleanup measures, such as those proposed under Alternative 11M, would be implemented because the anticipated habitat loss would outweigh any benefits of the action.

[32] Various studies have indicated that the mobility and bioavailability of hazardous substances released from the waste rock could be reduced if pH is adjusted, for example, by periodic application of granulated limestone. However, the efficacy of this has not been demonstrated in all cases, and increased pH may itself adversely affect some species. The feasibility, effectiveness, application method, rate, extent, and frequency of application would need to be determined during remedial design. Appendix B provides an overview of lime application used in mine reclamation and in related studies.

Under CERCLA, the potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation must be considered before implementing a remedy [40 CFR 300.430(e)(9)(iii)(E)(3)]. CERCLA guidance (EPA 1999) also advises that some areas may be better left unremediated if the cleanup would cause greater ecological harm. In the event that *in situ* treatment is not completely effective and more intrusive cleanup measures would cause significant environmental harm, the ARAR setting forth the cleanup level may be waived, in accordance with CERCLA Section 121(d)(4)(B), through an ESD or ROD Amendment. The Agencies also anticipate that Ecology, using its substantive authority under SEPA, would not require the implementation of more intrusive measures with potential adverse impacts to these areas.

Alternatives 11M, 13M and 14 all include installation of air-tight closures of the Honeymoon Heights adits, to reduce the rate that hazardous substances are released into groundwater within the mine. These closures can likely be accomplished by low-impact methods (e.g., hand placement of polyurethane foam), but may require some excavation.

The Alternatives 11M, 13M, and 14 also include downgradient collection for treatment of groundwater impacted by releases from the Honeymoon Heights Waste Rock Piles before it discharges into Railroad Creek. This would include collection of seeps SP-12 and SP-23 for treatment. Groundwater monitoring is required in the DSHH to determine whether groundwater, in addition to seeps SP-12 and SP-23, should be collected and treated, due to releases from the Honeymoon Heights Waste Rock Piles.

Finally, because concentrations exceed human health criteria, institutional controls are needed as part of the cleanup action to prevent direct contact with and disturbance of the waste rock piles, as well as to prevent human exposure to groundwater that exceeds drinking water standards due to releases from these waste rock piles.[33]

[33] The Agencies consider institutional controls are likely to be effective for elimination of the human health risks due to hazardous substances in the Honeymoon Heights Waste Rock Piles (and in the impacted areas immediately downslope discussed in Section 4.2.4). There is only limited access along a single trail in this steep sloped area, and warning signs along the trail and at the Honeymoon Heights Waste Rock Piles could be used to alert visitors to avoid hazardous substances in or released from the waste rock. Recreational visitors (hikers) are unlikely to be present in this area for extended periods (e.g. camping is more likely to occur in less steep areas within the Railroad Creek valley).

4.2.4 TEE Areas Downslope from the Honeymoon Heights Waste Rock Piles

As noted in Section 1.3.4, the TEE described the DSHH AOI as consisting of a total of about 3 acres of riparian forest habitat directly downslope from the Honeymoon Heights Waste Rock Piles associated with the 300-, 550-, 700-, 800-, and 1100-level portals. The largest of the DSHH, as defined by the TEE, is shown on Figure 3. Like the Honeymoon Heights Waste Rock Piles, the DSHH are located on a relatively steep north-facing slope.

As described for the Honeymoon Heights Waste Rock Piles, active remedial measures to achieve proposed cleanup levels in the DSHH by consolidation, stabilization, or capping would cause significant disturbance to more than 8 acres, including the Honeymoon Heights access roadway prism, and potential long-term impacts to approximately 70 acres of the downslope of the Honeymoon Heights access road. Alternative 11M includes this approach for purposes of comparison to other remedy alternatives.

Alternative 13M (ERM and URS 2009a) would rely on "...monitored natural recovery, including regular inspections of progress and periodic evaluations of whether more aggressive actions are required for this AOI."

As discussed for the Honeymoon Heights Waste Rock Piles, active remediation of the DSHH would result in long-term habitat destruction that would likely outweigh the environmental threat posed under existing conditions. Therefore, Alternative 14 includes *in situ* treatment of the DSHH. The Agencies anticipate that this approach would adequately reduce risk to terrestrial organisms, and this would be confirmed based on treatability studies conducted during remedial design. However, even if these studies conclude that *in situ* treatment is not fully effective at reducing risk to terrestrial organisms, the Agencies do not anticipate that more intrusive cleanup measures, such excavation or capping, would be implemented because of the anticipated habitat loss would outweigh any benefits of the action.

Under CERCLA, the potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation must be considered before implementing a remedy [40 CFR 300.430(e)(9)(iii)(E)(3)]. CERCLA guidance (EPA 1999) also advises that some areas may be better left unremediated if the cleanup would cause greater ecological harm. In the event that *in situ* treatment is not completely effective and more intrusive cleanup measures would cause significant environmental harm, the ARAR setting forth the cleanup level may be waived, in accordance with CERCLA Section 121(d)(4)(B), through an ESD or ROD Amendment. The

Agencies also expect that Ecology, using its substantive authority under SEPA, would not require the implementation of more intrusive measures with potential adverse impacts to these areas.

The proposed cleanup for the DSHH AOI would address protection of Railroad Creek from the downgradient soil-to-groundwater-to-surface water pathway through the same downgradient seep collection and monitoring described for the Honeymoon Heights Waste Rock Piles.

The proposed cleanup approach for the DSHH would also protect human health through institutional controls, as described for the Honeymoon Heights Waste Rock Piles to reduce risk of direct contact, prevent disturbance of the impacted areas, and prevent consumption of impacted groundwater.

4.2.5 Ballfield Area

The Ballfield Area has little native habitat and is largely covered by introduced species. Cleanup could be accomplished by removal of soils with elevated hazardous substance concentrations (as evidenced by visible tailings or waste rock, staining, or other indicators), and consolidated into the main tailings piles prior to capping the tailings.

Alternative 11M includes removal of soils with hazardous substance concentrations above proposed cleanup levels.

Intalco (ERM and URS 2009a) described the Ballfield Area as having dense plant cover with high species richness and structural complexity, but did not specifically address whether this was limited to the disturbed Ballfield Area, or the adjacent National Forest that extends into the Glacier Peak Wilderness Area. Intalco proposed to rely on "monitored natural recovery, including regular inspections of progress and periodic evaluations of whether more aggressive actions are required" for cleanup of the Ballfield Area under Alternative 13M.

Under Alternative 14, soils with hazardous substances above proposed cleanup levels would be removed from previously disturbed area, and consolidated into the tailings piles prior to capping the tailings. Areas where soil is removed to protect terrestrial receptors would be revegetated with native vegetation to satisfy ARARs and TBC criteria.

If further characterization during remedial design or remedial action shows soils above proposed cleanup levels extend into forest areas with high habitat value, such as old growth timber, such areas could be remediated through *in situ* treatment to reduce the mobility and bioavailability of hazardous substances.

The Agencies anticipate that this approach would adequately reduce risk to terrestrial organisms, and this would be confirmed based on treatability studies conducted during remedial design. However, even if these studies conclude that *in situ* treatment is not fully effective at reducing risk to terrestrial organisms, the Agencies do not anticipate that more intrusive cleanup measures, such excavation or capping, would be implemented because the anticipated habitat loss would outweigh any benefits of the action.

Under CERCLA, the potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation must be considered before implementing a remedy [40 CFR 300.430(e)(9)(iii)(E)(3)]. CERCLA guidance (EPA 1999) also advises that some areas may be better left unremediated if the cleanup would cause greater ecological harm. In the event that *in situ* treatment is not completely effective and more intrusive cleanup measures would cause significant environmental harm, the ARAR setting forth the cleanup level may be waived, in accordance with CERCLA Section 121(d)(4)(B), through an ESD or ROD Amendment. The Agencies also anticipate that Ecology, using its substantive authority under SEPA, would not require the implementation of more intrusive measures with potential adverse impacts to these areas.

4.2.6 Holden Village

Remedial measures in Holden Village need to be coordinated to minimize potential adverse impacts to Village operations and existing buildings, roads and pipelines. The Village is in a designated historic district and remediation needs to address historic preservation ARARs.

Under Alternative 13M, Intalco proposed no action to clean up Holden Village as long as the existing land use continued (ERM and URS 2009a). In the event that Holden Village, Inc. discontinued use of the buildings and grounds, Intalco proposed to reevaluate the area at that time to determine if remedial actions are required.

For Alternatives 11M and 14, the Agencies propose that cleanup rely on *in situ* treatment, monitoring, and institutional controls. Cleanup includes removal or capping of impacted soils if encountered within the Village during construction. A soil management plan would be developed to minimize impacts to Village operations during remedy implementation, and as an institutional control, to address potential future exposure of impacted soils after the initial remediation is accomplished.

4.2.7 Lower West Area

4.2.7.1 Lower West Area-West

The Lower West Area west of the road to the Maintenance Yard (Lower West Area-West) is relatively undisturbed except for the Lagoon immediately adjacent to the road, and has mature stands of both conifers and riparian vegetation.

Intalco proposed that Alternative 13M would rely on "monitored natural recovery," including regular inspections of progress and periodic evaluations of whether more aggressive actions are required for cleanup of the Lower West Area-West (ERM and URS 2009a).

Remedial measures to achieve proposed cleanup levels by consolidation, stabilization, or capping the Lower West Area-West would require extensive disturbance of high-quality riparian habitat that is minimally impacted by releases from the Site. Such disturbance is incompatible with management of the area as a riparian reserve in accordance with the Wenatchee National Forest Land and Resource Management Plan (LRMP). As a result, the Agencies propose that cleanup of the Lower West Area-West would be accomplished by *in situ* treatment under both Alternatives 11M and 14. The Agencies expect that this approach would adequately reduce risk to terrestrial organisms, and would be confirmed based on treatability studies conducted during remedial design. However, even if these studies conclude that *in situ* treatment is not fully effective at reducing risk to terrestrial organisms, the Agencies do not anticipate that more intrusive cleanup measures such as excavation or capping would be implemented because the potential habitat loss would outweigh any benefits of the action.

Under CERCLA, the potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation must be considered before implementing a remedy [40 CFR 300.430(e)(9)(iii)(E)(3)]. CERCLA guidance (EPA 1999) also advises that some areas may be better left unremediated if the cleanup would cause greater ecological harm. In the event that *in situ* treatment is not completely effective and more intrusive cleanup measures would cause significant environmental harm, the ARAR setting forth the cleanup level may be waived, in accordance with CERCLA Section 121(d)(4)(B), through an ESD or ROD Amendment. The Agencies also anticipate that Ecology, using its substantive authority under SEPA, would not require the implementation of more intrusive measures with potential adverse impacts to these areas.

Remedial measures in the Lower West Area-West under Alternatives 11M, 13M, and 14 also include a downgradient groundwater barrier and collection system to contain groundwater that exceeds aquatic life protection criteria.

Alternatives 11M, 13M, and 14 include institutional controls to protect and assure performance of the groundwater containment, collection and treatment system, and to protect humans from direct contact and ingestion (including groundwater consumption) of hazardous substances in the Lower West Area soils.

4.2.7.2 Lower West Area-East

The Lower West Area-East is relatively disturbed and typically has little high-quality habitat, except for discontinuous stands of mature conifers and riparian vegetation, especially along the south bank of Railroad Creek.

Under Alternative 13M, Intalco proposed locating the major portion of a groundwater treatment facility in the Lower West Area-East, which would include removal or covering impacted soils in portions of this AOI (ERM and URS 2009a). Intalco proposed cleanup of the remainder of the Lower West Area-East would be accomplished by "monitored natural recovery," including periodic evaluation of the need for other cleanup measures.

Under Alternatives 11M and 14, the Agencies propose cleanup of soils with elevated hazardous substance concentrations in disturbed or accessible areas of the Lower West Area-East be accomplished by removing soil above proposed cleanup levels and consolidating these soils into the tailings piles. The specific areas within the Lower West Area-East where soils would be cleaned up by such measures would be determined during RD/RA based on further characterization and/or other indicators such as visible tailings or staining.

Under Alternative 14, like Alternative 13M, location of a groundwater treatment facility in the Lower West Area-East would enable removal or capping impacted soils in portions of this AOI. Additional removal of soils above proposed cleanup levels would be accomplished in disturbed areas with low habitat value, and *in situ* treatment would be accomplished in areas with mature riparian habitat (high habitat value).

Areas where soil is removed or capped to protect terrestrial receptors would be revegetated with native vegetation to satisfy ARARs and TBC criteria.

Soils above proposed cleanup levels in areas with high habitat value would be remediated by *in situ* treatment under Alternatives 11M and 14. The Agencies anticipate that this approach would adequately reduce risk to terrestrial organisms, and would be confirmed based on treatability studies conducted during remedial design. However, even if these studies conclude that *in situ* treatment is not fully effective at reducing risk to terrestrial organisms, the Agencies do not anticipate that more intrusive cleanup measures, such excavation or capping, would be implemented because the anticipated habitat loss would outweigh any benefits of the action.

Under CERCLA, the potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation must be considered before implementing a remedy [40 CFR 300.430(e)(9)(iii)(E)(3)]. CERCLA guidance (EPA 1999) also advises that some areas may be better left unremediated if the cleanup would cause greater ecological harm. In the event that *in situ* treatment is not completely effective and more intrusive cleanup measures would cause significant environmental harm, the ARAR setting forth the cleanup level may be waived, in accordance with CERCLA Section 121(d)(4)(B), through an ESD or ROD Amendment. The Agencies also anticipate that Ecology, using its substantive authority under SEPA, would not require the implementation of more intrusive measures with potential adverse impacts to these areas.

Remedial measures in the Lower West Area-East under Alternatives 11M, 13M, and 14 also include a downgradient groundwater barrier and collection system to limit dispersal of impacted groundwater.

These alternatives would also include institutional controls to prevent human exposure to soils with hazardous substances that exceed criteria for direct contact and ingestion, to prevent consumption of groundwater that exceeds drinking water standards, and to protect and assure performance of the groundwater containment, collection and treatment system.

4.2.8 Lagoon Area

Active remedial measures for soils in the Lagoon Area would include consolidation and capping soils that exceed proposed cleanup levels under Alternatives 11M, 13M, and 14. The Lagoon is within the Lower West Area groundwater barrier containment area that is part of all of these alternatives.

Under Alternative 11M, soils above proposed cleanup levels would be removed to the tailings piles prior to capping of the tailings piles, and the excavated area would be backfilled and revegetated.

Under Alternatives 13M and 14, impacted soils in the Lagoon would be excavated and the excavation incorporated into a groundwater treatment facility to be constructed as part of the remedy. The excavated soils would be consolidated with the tailings piles prior to capping.

4.2.9 Wind-Blown Tailings Area

Active remedial measures to clean up this AOI by consolidation, stabilization, or capping would significantly disturb existing terrestrial habitat.

There is little or no opportunity to remove soils above proposed cleanup levels without extensive adverse impacts to the existing forest habitat in this AOI.

Therefore, Alternative 11M proposes *in situ* treatment to reduce the mobility and bioavailability of hazardous substances through pH adjustment. The Agencies anticipate that this approach would adequately reduce risk to terrestrial organisms, and this would be confirmed based on treatability studies conducted during remedial design. However, even if these studies conclude that *in situ* treatment is not fully effective at reducing risk to terrestrial organisms, the Agencies do not anticipate that more intrusive cleanup measures, such excavation or capping, would be implemented because the anticipated habitat loss would outweigh any benefits of the action.

Under CERCLA, the potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation must be considered before implementing a remedy [40 CFR 300.430(e)(9)(iii)(E)(3)]. CERCLA guidance (EPA 1999) also advises that some areas may be better left unremediated if the cleanup would cause greater ecological harm. In the event that *in situ* treatment is not completely effective and more intrusive cleanup measures would cause significant environmental harm, the ARAR setting forth the cleanup level may be waived, in accordance with CERCLA Section 121(d)(4)(B), through an ESD or ROD Amendment. The Agencies also anticipate that Ecology, using its substantive authority under SEPA, would not require the implementation of more intrusive measures with potential adverse impacts to these areas.

However, in the event that land use changes in the future—for example, if this area is logged—removal or capping of impacted soils could be accomplished.

Under Alternative 13M, a portion of impacted soils will be removed (or possibly covered) as part of relocating Railroad Creek.[34] Intalco proposed monitored natural recovery for the remainder of this AOI.

Alternative 14, like Alternative 13M, would include removal of some impacted soils as part of relocating Railroad Creek. Excavated soils above proposed cleanup levels would be consolidated with the tailings prior to capping of the tailings piles.[35] For the remainder of this AOI, Alternative 14 includes *in situ* treatment. The Agencies anticipate that this approach would adequately reduce risk to terrestrial organisms, and this would be confirmed based on treatability studies conducted during remedial design. However, even if these studies conclude that *in situ* treatment is not fully effective at reducing risk to terrestrial organisms, the Agencies do not anticipate that more intrusive cleanup measures such as excavation or capping would be implemented because the anticipated habitat loss would outweigh any benefits of the action.

Under CERCLA, the potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation must be considered before implementing a remedy [40 CFR 300.430(e)(9)(iii)(E)(3)]. CERCLA guidance (EPA 1999) also advises that some areas may be better left unremediated if the cleanup would cause greater ecological harm. In the event that *in situ* treatment is not completely effective and more intrusive cleanup measures would cause significant environmental harm, the ARAR setting forth the cleanup level may be waived, in accordance with CERCLA Section 121(d)(4)(B), through an ESD or ROD Amendment. The Agencies also anticipate that Ecology, using its substantive authority under SEPA, would not require the implementation of more intrusive measures with potential adverse impacts to these areas.

In the event of land-use changes that would reduce habitat values in this area—such as logging—alternative active cleanup measures would then be considered.

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[34] Intalco (ERM and URS 2009a) referred to covering soils above cleanup levels as part of the Alternative 13M creek relocation, but did not discuss this in detail. Caps for soils left in place with hazardous substances above cleanup levels would need to satisfy the performance criteria that are discussed in Appendix C.

[35] Capping impacted soils in place under Alternative 14, as suggested by Intalco as part of creek relocation, might also be possible, e.g., as part of constructing berms for flood protection. Whether this could be accomplished in a manner that would comply with ARARs would need to be determined during remedial design.

4.2.10 Maintenance Yard

Alternatives 11M, 13M, and 14 all include capping soils above proposed cleanup levels in the Maintenance Yard to prevent direct contact and reduce infiltration. The extent of the cap will need to be determined during remedial design. Caps used in areas that are not limited purpose landfills (e.g., the Maintenance Yard) would need to meet cap performance standards as described in Appendix C.

The Maintenance Yard is upgradient of the WMA that consists of the Lower West Area and Tailings Pile 1, that would be contained inside a groundwater barrier and collection system for Alternatives 11M, 13M, and 14.

Institutional controls would be required to protect integrity of the cap, protect and assure performance of the downgradient groundwater containment system, and to prevent any future use of groundwater in this area as a drinking water source.

4.2.11 Former Mill Building

Alternatives 11M and 14 include removal of ore and soil-like processing residuals, following demolition of unsafe portions of the structure, and installation of a downgradient barrier to contain impacted groundwater. Any soils left in place above proposed cleanup levels would be capped. Performance requirements for capping soils above proposed cleanup levels are discussed in Appendix C.

For Alternative 13M, Intalco has proposed demolition of the former Mill Building superstructure and removal and/or covering of contaminated material remaining on the former Mill Building foundation with waste rock (ERM and URS 2009a). Intalco proposed covering the mill area with waste rock and a soil cap after structural demolition, so that materials with hazardous substance concentrations above proposed cleanup levels would either be removed or buried with waste rock at a depth of 6 feet or more. If waste rock is disposed of in this manner, the soil cap would need to meet the performance criteria for limited purpose landfill covers [WAC 173-350-400(3)(e)(i)], just as would the caps for the tailings piles and main East and West Waste Rock Piles.

The Mill Building is upgradient of the Lower West Area and Tailings Pile 1 WMA that would be contained inside a groundwater barrier and collection system for Alternatives 11M, 13M, and 14.

Institutional controls would be required under Alternatives 11M, 13M, and 14 to protect integrity of the cap and the downgradient groundwater containment system, and to prevent any future use of groundwater as a drinking water source in this area. Dangerous waste materials, if encountered, would be removed for appropriate disposal, or potentially could be managed on site.

4.2.12 Ventilator Portal Surface Water Retention Area

Remedial measures within the former pond, including impacted soils in the side berms, are anticipated to include removal of soil with visible tailings along with other soils that have elevated hazardous substance concentrations for Alternatives 11M, 13M, and 14. Excavated soils above proposed cleanup levels would be consolidated onto the tailings piles prior to capping.

Alternatives 11M and 14 include groundwater monitoring in new monitoring wells and at seeps downgradient of the Surface Water Retention Area and Honeymoon Heights to determine whether groundwater collection and treatment, or other measures, need to be implemented to be protective and satisfy potential ARARs.

Intalco did not propose any groundwater cleanup or further monitoring downgradient of the Surface Water Retention Area. Intalco asserts that it is not necessary to clean up soils for the protection of groundwater in this area, since groundwater (seep SP-26) downgradient of the Surface Water Retention Area does not exceed ARARs for protection of human health (ERM and URS 2009a, page 94). However, groundwater from seep SP-26 groundwater exceeds proposed cleanup levels based on protection of surface water aquatic life for cadmium, copper and zinc. Intalco did not propose to monitor or collect seep SP-26 or other groundwater in this area as part of Alternative 13M, even though Intalco noted that "groundwater impacted by mining activities is expected to discharge from...former Surface Water Retention Area (seep SP-26)."

5. CLEANUP ACTION ALTERNATIVES CONSIDERED

The following Sections 5.1, 5.2, and 5.3 discuss how Alternatives 11M, 13M, and 14 would address cleanup of soils, groundwater, surface water, and sediment. Although Alternatives 11M, 13M, and 14 differ in some aspects, these alternatives also have a number of components that are similar.

Alternatives 11M, 13M and 14 are compared in Section 6 to determine which would best satisfy CERCLA and MTCA requirements for selection of a permanent remedy for the Site.

5.1 Alternative 11M

Alternative 11M would address cleanup of impacted media at the Site as summarized below.

5.1.1 Soil

Under Alternative 11M, the tailings piles and the East and West Waste Rock Piles would be regraded to improve slope stability and capped in accordance with state landfill standards [WAC 173-350-400] to protect human and terrestrial ecological receptors. The caps would consist of 2 feet of soil and a geomembrane (the presumptive cover prescribed by state regulations), unless analyses during remedial design indicates an alternative cover would satisfy performance standards for landfill closure [WAC 173-350-400(3)(e)(i)].

Under Alternative 11M, the Honeymoon Heights Waste Rock Piles and the impacted DSHH would be cleaned up by consolidation onto the West Waste Rock Pile prior to capping. Soils exceeding proposed cleanup levels at the former Mill, Lagoon, the Ballfield Area, portions of the Lower West Area, and the Surface Water Retention Area would be consolidated into a permanent on-site containment area and soils exceeding proposed cleanup criteria in the Maintenance Yard would be capped with a concrete or asphalt slab. Soils in the Mill Area classified as State Dangerous Wastes would be disposed of off site.

Alternative 11M also includes cleanup in portions of the Ballfield Area and the Lower West Area, and in the Wind-Blown Tailings Area and Holden Village using *in situ* treatment. Institutional controls would be implemented to protect human health in the Lower West Area, assure that remedy components would continue to function in all areas as long as needed, and, in some cases, to enable additional cleanup in the event of changes in land use.[36]

Finally, Alternative 11M would include characterization of the Lucerne-Holden Road, to determine whether cleanup was needed to address hazardous substances from waste rock that may have been used for road surfacing.

5.1.2 Groundwater

Alternative 11M includes a continuous groundwater containment barrier and collection system around the WMAs (including the tailings piles and the Lower

[36] Institutional controls in Holden Village would include development of a soil management plan covering removal or capping of impacted soils where encountered during construction within the Village, as discussed in Section 4.2.6.

West Area) to protect surface water from release of groundwater above aquatic protection standards and to prevent downgradient expansion of the groundwater plume. This is discussed in Sections 3.2.3 and 4.2.3 of the SFS.

Groundwater seep and base flow into Railroad Creek from the Lower West Area (including groundwater from the upgradient areas) and from below the tailings piles would be contained and collected using groundwater barrier wall technology and an associated collection system. The groundwater barrier wall would be fully penetrating (i.e., keyed into a lower, relatively impermeable layer of glacial till or bedrock).

All collected groundwater would be treated using acid neutralization and precipitation to achieve proposed cleanup levels in a treatment plant located downstream of Tailings Pile 3 on the north side of Railroad Creek, as described in Appendix F of the SFS.

Under Alternative 11M, contaminated groundwater that would otherwise enter Railroad Creek from the mine portal, Honeymoon Heights seeps, Lower West Area, and Tailings Piles 1, 2, and 3 would be collected and treated.

Alternative 11M would use a pump system to convey water into the treatment system from the low point of the gravity collection and conveyance trenches, near the northeast corner of Tailings Pile 3. After dewatering, metal hydroxide sludge produced as a byproduct of treatment would be disposed of in a limited purpose landfill constructed on the tailings piles in conformance with state standards. Treated water would be discharged into Railroad Creek.

Alternative 11M also includes hydraulic bulkheads installed in the mine to control the rate of groundwater discharging from the Main Portal of the mine. Air restrictions would be installed within open portals to reduce oxygen transport through the mine to slow the release of hazardous substances in the Main Portal drainage.

Groundwater at the Site is not currently used for drinking water. Alternative 11M includes institutional controls to prevent potential future use of groundwater that exceeded human health risk-based criteria as a drinking water source.

5.1.3 Surface Water

The three tailings piles would be regraded (prior to capping) to move the edges of the piles back from Railroad and Copper Creeks to reduce the risk of future slope failures releasing wastes into the creeks.

The Copper Creek channel would also be modified under Alternative 11M to constrain future channel migrations that could erode the tailings. The Copper Creek Diversion would be placed into a lined channel or culvert from the hydroelectric plant to Railroad Creek to avoid seepage through tailings in this area.

Upgradient water diversion swales or French drains would be constructed south of the tailings and waste rock piles to reduce the amount of clean water run-on that would otherwise contact the tailings and waste rock materials.

5.1.4 Sediment

Alternative 11M includes removal of ferricrete from Railroad Creek and long-term sediment monitoring in Railroad Creek and in Lake Chelan (at the Lucerne Bar) to determine whether additional sediment cleanup actions are required following the elimination of the sources of hazardous substances.[37]

5.2 Alternative 13M

Alternative 13M is fully described in ERM and URS (2009a). Alternative 13M includes implementation of institutional controls to limit potential exposures to groundwater or source materials that could impact human health or the environment, and to prevent actions that may interfere with the effectiveness of other remedy components. Alternative 13M provides for cleanup of impacted media at the Site as summarized below.

5.2.1 Soil

Under Alternative 13M, the tailings pile side slopes would be regraded for stability, including construction of a stabilizing berm. A cover, consisting of 6 inches of soil/gravel and wood slash, would be placed on the top surfaces of the tailings piles and 8 to 12 inches of soil/gravel would be placed on the tailings pile side slopes. [ERM and URS (2009). Intalco subsequently amended its proposed cover, see URS (2010a)].

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[37] As described in Section 1.2.2.4 of the SFS, the Lucerne Bar is an underwater feature resulting from the deposition of sediment suspended in the Railroad Creek water that discharges into Lake Chelan. Due to releases from the Site, Lucerne Bar sediment has hazardous substance concentrations that exceed sediment quality guidelines. However, bioassay tests on Lucerne Bar sediment identified only minor adverse effects on aquatic organisms. Overall, the Agencies do not consider these effects to be severe enough nor widely distributed enough to require an active sediment cleanup (Forest Service 2003).

The former Mill Building superstructure would be demolished, and contaminated materials remaining on the former Mill Building foundation would be removed and/or covered with waste rock, and capped with a six-inch soil cover and revegetated.

The East and West Waste Rock Pile side slopes would be regraded for stability, and the excess rock generated from the regrading actions would be relocated onto the former Mill Building foundation and Tailings Pile 1. A vegetated soil cover that is 6 inches on the top surface and 8 to 12 inches thick on the side slopes would be placed on the waste rock piles [see also URS (2010a)].

Contaminated soils associated with the Surface Water Retention Area and Lagoon would be excavated under Alternative 13M and placed in a permanent, on-site disposal facility. Contaminated soils in the Maintenance Yard would be covered with a concrete slab or impermeable liner and gravel.

Soil in other areas of the site that exceed proposed cleanup levels (i.e., the Ballfield Area, Lower West Area, Wind-Blown Tailings Area, and Honeymoon Heights) would be monitored based on Intalco's assertion that remediation would occur naturally over time (referred to as natural restoration). This limited action is unlikely to meet proposed terrestrial ecological risk-based soil cleanup levels within a reasonable restoration time frame. Alternative 13M does not include any other cleanup actions for these areas other than institutional controls.

5.2.2 Groundwater

Under Alternative 13M contaminated groundwater that would otherwise enter Railroad Creek and Copper Creek from the Lower West Area and Tailings Pile 1, would be contained and collected using a fully penetrating groundwater barrier and collection system. The collected water would be conveyed to a treatment facility located east of Tailings Pile 3, referred to as the East Treatment System.

Railroad Creek would be diverted, beginning near the middle of the northern side of Tailings Pile 1, and extending east (downstream) to a point where it would rejoin the original channel about 1,200 feet east of Tailings Pile 3. Along the northwest side of Tailings Pile 2, the former creek channel would be used to collect groundwater impacted by seepage from the western portion of Tailings Pile 2, and conveyed to the treatment system east of Tailings Pile 3. Intalco proposed that the collection trench would extend from the vicinity of Copper Creek to an area near Railroad Creek station RC-7; however, the extent of the collection trench would be further evaluated during remedial design.

Groundwater impacted by seepage from Tailings Pile 3 and the remainder of Tailings Pile 2 would not be contained or collected, but instead would be allowed to flow eastward and enter Railroad Creek at an unknown location.

Intalco presented groundwater quality data obtained in 2008-2009 that indicate some reduction in concentrations of dissolved hazardous substances downgradient of Tailings Piles 2 and 3. The Draft Alternative 13M Evaluation Report (ERM and URS 2009a) asserted that these data evidenced natural attenuation that was protective of Railroad Creek. For Alternative 13M, Intalco assumed that natural attenuation and other components of the remedy would reduce concentrations of hazardous substances in groundwater to acceptable levels before entering Railroad Creek and, thus, eliminate the need for groundwater containment and collection east of Tailings Piles 2 and 3.[38] Intalco also stated that "...if after an extended period of monitoring ARARs are not achieved at the CPOC(s) downstream of the terminus of the realigned creek channel, contingent actions would be evaluated under Alternative 13M." These contingent actions were not specified in the Draft Alternative 13M Evaluation Report (ERM and URS 2009a), although the July 10, 2009, Draft Hydrogeology Technical Memorandum (later included by reference as Appendix E of the Draft Alternative 13M Report, URS 2009c) showed a contingent barrier wall located north and east of Tailings Pile 3.[39]

The Honeymoon Heights seeps and the Main Portal drainage would be collected and treated with acid neutralization and precipitation in a treatment facility constructed in the Lagoon Area of the Lower West Area, referred to as the West Treatment System.

The Draft Alternative 13M Evaluation Report indicated that treated water would be discharged into Railroad Creek from both the East and West Treatment Systems. However, Appendix H of the report (ERM and URS 2009b) indicated better treatment results would result from conveying treated water from the west (Lagoon Area) facility to the facility east of Tailings Pile 3, for further treatment.[40] Metal hydroxide sludge produced as a byproduct of treatment

[38] The other components referred to by Intalco include diversion trenches upslope of the tailings piles, regrading and capping the tailings piles, collection and treatment of groundwater in the Lower West Area and Tailings Piles 1, and collection and treatment of groundwater northwest of Tailings Pile 2. These components are common to Alternatives 11M, 13M and 14, see Table 15.

[39] Intalco subsequently provided an analysis of when potential contingent actions for Alternative 13M should be evaluated (URS 2010). The Agencies' comments on Intalco's analysis are presented in Forest Service (2010a).

[40] The Agencies anticipate Intalco will further evaluate water treatment methods as a result of pilot treatability studies now ongoing.

would be disposed of in a limited purpose landfill constructed on the tailings piles in conformance with state standards.

Under Alternative 13M, hydraulic bulkheads would be installed in the mine to control and equalize the rate of groundwater discharging from the Main Portal of the mine. Air restrictions would be installed within open portals to reduce oxygen transport through the mine on the premise that this would slow the release of hazardous substances in the Main Portal drainage.

Alternative 13M also included institutional controls to prevent future use of groundwater that exceeds human health risk-based criteria from future use as drinking water.

5.2.3 Surface Water

Railroad Creek would be realigned to the north of its existing channel from the approximate midpoint of Tailings Pile 1 downstream to a point approximately 1,200 feet downstream of Tailings Pile 3, where the new channel would rejoin the existing channel. The relocated reach would be lined with a low permeability material to reduce seepage into the old channel that would be used to collect and convey contaminated groundwater from Tailings Piles 2.

The three tailings piles would be benched and regraded to reduce the risk of future slope failures releasing wastes into the creeks, and the Copper Creek channel would be modified to constrain future channel migrations that could erode the tailings.[41]

Under Alternative 13M, the Copper Creek channel would be modified to constrain future channel migrations that could erode the tailings. The Copper Creek Diversion would be placed into a lined channel or culvert from the hydroelectric plant to Railroad Creek, to avoid seepage through tailings in this area.

Upgradient water diversion swales or French drains would be constructed south of the tailings and waste rock piles to reduce the amount of clean water run-on that would otherwise contact the tailings and waste rock materials.

[41] The extent of regrading proposed by Intalco for Alternative 13M is more limited than that proposed by the Agencies under Alternatives 11M and 14 (see Figures 9, 10, and 11). Intalco did not propose regrading the east- and west-facing slopes of the tailings piles. The Agencies consider regrading to achieve stability of <u>all</u> the tailings pile side slopes to be a necessary part of closure to conform with ARARs including the Forest Service standards and guidelines of MM3 (see Section 2.3.3.3 of the SFS) and performance requirements for closure of limited purpose landfills (WAC 173-350-400).

5.2.4 Sediment

Ferricrete and other sediments would be isolated from aquatic life in the reach of Railroad Creek that would be relocated. Intalco did not address whether floc containing hazardous substances related to iron-rich seepage from the tailings piles would continue to form in Railroad Creek downstream of the relocated reach. Except for reducing sources of hazardous substances to Railroad Creek, no other actions to address sediments are included in Alternative 13M.

5.3 Alternative 14

This section describes the remedial action components that, in combination, are referred to as Alternative 14. These components were largely drawn from Alternatives 11M and 13M, and modified as described herein. Alternative 14 would address cleanup of impacted media at the Site as described below in sections 5.3.1 through 5.3.4. Figure 14 shows the principal components of Alternative 14.

Many details of Alternative 14 would be determined during remedial design in the event this alternative is selected for cleanup of the Site. This would include, for example, specific design elements for the groundwater treatment facilities, and the areal extent, application rate, and frequency of *in situ* soil treatment to reduce mobility and bioavailability of hazardous substances.

5.3.1 Soil

Alternative 14 uses a combination of actions to remediate impacted soils (including waste rock and tailings) depending on specific conditions in each AOI, as discussed in Section 4.2. These actions include:

- Consolidation of impacted soils from the Lagoon, Surface Water Retention Area, Ballfield Area, former Mill Building, and areas of the Lower West Area-East that have low existing habitat value;

- Capping of the three tailings piles, the East and West Waste Rock Piles, and soils in the Maintenance Yard area; and

- *In situ* treatment of soils above proposed cleanup levels in the Honeymoon Heights Waste Rock Piles and the DSHH; Holden Village; portions of the Lower West Area; portions of the Ballfield Area; and the Wind-Blown Tailings Area.

Specific soil cleanup components are discussed below for specific AOIs.

5.3.1.1 Tailings Piles 1, 2, and 3

Under Alternative 14, the tailings pile slopes would be regraded to improve stability, including construction of benches and buttressing to achieve configurations that are stable as required by ARARs under steady state and seismic (maximum design earthquake [MDE]) conditions.

As part of its geotechnical analyses in 2008 to 2009, Intalco found that a buttress would need to be constructed along the toe of the tailings piles in order to assure seismic stability. The cost estimate for Alternative 14 includes a buttress of this type, based on analyses that are described in Appendix A.

Depending on the extent of stream relocation, as determined during remedial design, Alternative 14 may also include pulling back portions of the toes of one or more of the tailings piles to provide sufficient room for construction of the barrier wall, groundwater collection system, and slope toe buttress adjacent to Railroad Creek. Alternative 14 would also include pulling the toe of Tailings Piles 1 and 2 slopes away from Copper Creek, unless it is demonstrated during remedial design that this is unnecessary, e.g., there is: a) no risk of flooding or meandering to impact stability of the regraded tailings slopes, and b) no risk of slope instability causing release of tailings into the creek.

Closure of the tailings piles includes consolidation of excess waste rock from regrading the East and/or West Waste Rock Piles and impacted soils from other portions of the Site.

Closure of the tailings would include installation of a cap on the top and side slopes of tailings piles (including any relocated waste rock or other hazardous substances) with a soil cover that satisfies the performance requirements for closure of limited purpose landfills.

5.3.1.2 East and West Waste Rock Piles

Under Alternative 14 closure of the East and West Waste Rock Piles would include regrading the side slopes to configurations that are stable as required by ARARs under steady state and seismic conditions.

The top and side slopes of the waste rock piles would be capped with a soil cover that satisfies the performance requirements for closure of limited purpose landfills.

5.3.1.3 Honeymoon Heights Waste Rock Piles (Including DSHH)

Under Alternative 14, the Honeymoon Heights Waste Rock Piles and DSHH AOIs would be cleaned up using *in situ* treatment to reduce bioavailability and mobility of hazardous substances by adjusting pH, to the extent practicable, without degrading existing habitat.[42] The method and rate of application, frequency of treatment and other aspects would be determined based on treatability tests during remedial design, and monitoring. Alternative 14 also includes institutional controls to protect humans from direct contact with, and ingestion of, hazardous substances in the waste rock. *In situ* treatment is proposed for the Honeymoon Heights Waste Rock Piles in order to avoid the habitat destruction that would occur due to construction of an access road that would be needed to move or cap these piles.

5.3.1.4 Ballfield Area

Under Alternative 14, soils with hazardous substances above proposed cleanup levels would be removed and consolidated into the tailings piles prior to capping, and the disturbed area revegetated with native vegetation. *In situ* treatment may also be used if further characterization indicates that hazardous substances extend into areas with highly valued habitat.

5.3.1.5 Holden Village

Under Alternative 14, *in situ* remediation would be accomplished to reduce risk to terrestrial receptors. Institutional controls consisting of a soil management plan to address handling of excavated soils during Holden Village occupancy would be developed and implemented. In the event that future land use changes, Alternative 14 includes provisions to further address cleanup of soils with hazardous substances at that time.

5.3.1.6 Lower West Area, including the Lagoon

Under Alternative 14, a groundwater treatment system would be located in a portion of the Lower West Area that has low existing habitat value due to past disturbance or the presence of hazardous substances. Soils above proposed

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[42] To the extent that soil cleanup levels are not met because greater harm would be caused to highly valued habitat by taking action, the Agencies would waive the cleanup level ARARs under CERCLA. Such a decision would be contained in an ESD or ROD Amendment. This is true for each area where this might be the case, i.e., the Ballfield Area, Wind-Blown Tailings Area, Holden Village, certain portions of the Lower West Area, as well as the Honeymoon Heights Waste Rock Piles and DSHH.

cleanup levels would be removed as part of constructing the groundwater treatment facility and wherever else accessible, primarily in the Lagoon area and the Lower West Area-East. The excavated soils would be consolidated into the tailings piles prior to capping.

Institutional controls would be used to protect humans from direct contact and ingestion of hazardous substances in Lower West Area soils. Soils in the Lower West Area that have hazardous substances above proposed cleanup levels in areas of existing high-valued riparian and/or old growth habitat would be treated *in situ* to reduce bioavailability and mobility of hazardous substances by adjusting pH. In the event of future land use changes (e.g., if timber harvesting occurs in this AOI), Alternative 14 includes provisions to further address cleanup of soils with hazardous substances at that time.

5.3.1.7 Wind-Blown Tailings Area

Under Alternative 14, a portion of the impacted soils in the Wind-Blown Tailings Area would be excavated as part of creek relocation, and consolidated into the tailings piles prior to capping. In areas of high value riparian and/or old growth habitat that are impacted by hazardous substances, Alternative 14 includes treatment of soils in the remaining portion of this AOI *in situ* to reduce bioavailability and mobility of hazardous substances by adjusting soil pH. Additional removal or treatment of soils above proposed cleanup levels would be evaluated in the event that land use changes (e.g., if timber harvesting occurs) in the future.

5.3.1.8 Maintenance Yard Soils

Under Alternative 14, the Maintenance Yard area would be capped with asphalt or concrete pavement, or an alternative cap that meets performance requirements as described in Appendix C, to isolate contaminated soils. The extent of the cap would be determined based on characterization during RD/RA. Institutional controls would be implemented to preserve integrity of the cap over time.

5.3.1.9 Former Mill Building

Under Alternative 14, the unsafe structural components would be demolished as needed to remove contaminated soils and processing residuals for appropriate disposal. This may include off-site disposal in the event State Dangerous Wastes are encountered. The disturbed area would be stabilized to prevent long-term erosion and revegetated.

5.3.1.10 Surface Water Retention Area Soils

Under Alternative 14, soils above proposed cleanup levels would be excavated from the Surface Water Retention Area and consolidated into the tailings piles prior to capping. The disturbed area would be stabilized and revegetated.

5.3.1.11 Lucerne-Holden Road

As described in Section 1.3.13, Forest Service records suggests that waste rock may have been used in the past to resurface the Lucerne-Holden Road. Under Alternative 14, a sampling and analysis plan would be developed during remedial design for an investigation to evaluate the nature and extent of environmental impacts related to the potential presence of waste rock on the road. This investigation would be carried out during remedial design; the results of the investigation would be used to develop a cleanup approach which, if necessary, would be carried out during remedial implementation.

5.3.2 Groundwater

Alternative 14 is similar to Alternatives 11M and 13M in the west portion of the Site. All three alternatives include a groundwater containment barrier wall and collection system around Tailings Pile 1 and the Lower West Area. This area extends west of Copper Creek to where the Portal drainage currently discharges into Railroad Creek, (referred to by its sample location designation, P-5, see Figure 5).

Alternative 14, like Alternatives 11M and 13M, also includes collection and treatment of drainage from the main 1500-level mine portal, and seeps SP-12 and SP-23 downslope of Honeymoon Heights (Figure 5).[43] Alternative 14 also includes groundwater monitoring in the areas downgradient of Honeymoon Heights and the Surface Retention Area, to determine the extent of groundwater collection that may be required in this area.

Alternative 14 includes installation of hydraulic bulkheads within the mine for flow equalization of portal drainage. Additional measures to reduce airflow through the mine by closing other mine entries or other features that enable

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[43] Seeps designated SP-12 and SP-23 refer to approximately five discrete locations where seepage has been observed, which are referred to in some documents individually (e.g., as seep SP-12B) and elsewhere are referred to collectively. The seeps are surface expressions of groundwater, as defined in the SFS. Delineation of the extent of groundwater above cleanup levels that must be collected downslope of Honeymoon Heights will be determined during remedial design.

airflow into the mine, to reduce the rate of oxidation within the mine would also be accomplished where possible.

Alternative 14 includes designation of a waste management area (WMA) that encompasses the source areas of groundwater contamination, with institutional controls to prevent use of the groundwater as drinking water within the WMA (see Figure 11).

Alternative 14 includes the concept of relocating Railroad Creek, as proposed in Alternative 13M, to reduce the amount of tailings regrading compared to Alternative 11M. Stream relocation would allow use of a portion of the former creek channel (along the northwest portion of Tailings Pile 2, more or less) for collection of impacted groundwater for conveyance to a downgradient treatment facility.

Alternative 14 also includes a fully penetrating groundwater containment (barrier wall) and collection system downgradient of Tailings Piles 2 and 3. Water collected by this system would be treated at the east treatment system. The former Railroad Creek channel may form part of the collection system along the northwest side of Tailings Pile 2. The groundwater containment barrier design could be modified, or the barrier may not need to be built, if Intalco can demonstrate that: 1) groundwater above drinking water standards will remain contained within the WMA; and 2) an alternative approach, such as monitored natural attenuation, is effective at reducing groundwater concentrations to below proposed cleanup levels at the point(s) where groundwater discharges to Railroad Creek. In the second case, the conditional point of compliance has to be in groundwater at or before groundwater discharges into surface water. Consideration must also be given to the factors outlined in WAC 173-340-370(7). Such a change may constitute a significant change to the selected remedy and would require documentation of the basis for the change.

Alternative 14, like Alternative 13M, includes groundwater treatment facilities in both the Lower West Area and east of Tailings Pile 3.[44] The Agencies note that Appendix H of the Alternative 13M Evaluation Report (published separately as ERM and URS 2009b) indicates it may be beneficial to operate the west and east treatment facilities in series rather than separately, and details such as this would be depend on results of the treatability studies now in progress, as well as evaluations during remedial design/remedial action.

[44] The treatment plants would be capable of expansion or modification if the remedy is constructed in phases, or as needed to meet ARARs and to protect human health or the environment.

5.3.3 Surface Water

Alternative 14 includes regrading the tailings piles and buttress construction as part of closure to prevent future release of tailings into Railroad and Copper Creeks. Alternative 14 also includes cleanup of soils that would adversely impact surface water quality via the soil to groundwater to surface water pathway.

As previously noted, Alternative 14 includes relocation of some portion(s) of Railroad Creek. The extent of stream relocation and tailings regrading will need to be further assessed during remedial design for a number of reasons. For example, the creek relocation proposed by Intalco for Alternative 13M may not leave enough room for construction of the barrier wall adjacent to the west part of Tailings Pile 1. Under Alternative 14, the reach to be relocated could be extended upstream to avoid the need to move the toe of Tailings Pile 1 slopes in this area (see the dashed line segments on the creek relocation on Figure 14). Similarly, feasibility of relocating Railroad Creek adjacent to Tailings Pile 2 needs to be further evaluated to demonstrate whether buttress construction can be accomplished without pulling back the toe of the tailings (or alternatively moving the Holden-Lucerne Road). Finally, the extent of relocating the Railroad Creek Channel downstream of Tailings Pile 3 may depend on further geomorphic analysis and further evaluation of the area required for the proposed water treatment facility east of Tailings Pile 3. The Agencies found Intalco's analysis of these issues, to date, to be sufficient for remedy selection, but not sufficient for final design (see Forest Service 2010a).

The relocated reach of Railroad Creek would be lined with a low permeability material if needed to control seepage.

Alternative 14 also includes stabilizing the Copper Creek channel to improve its stability to prevent scour and erosion of Tailings Piles 1 and 2, and construction of a lined channel or pipeline to convey the Copper Creek Diversion in a manner that avoids contact with tailings.[45]

Finally, Alternative 14 includes construction of stormwater diversion swales and other measures, upgradient from Tailings Piles 1, 2, and 3 and East and West Waste Rock Piles, to control run-on as part of meeting ARARs.

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[45] The Agencies note there are many issues that need to be addressed in cleanup of the area west of the main portion of Tailings Pile 1, including dispersed tailings around the Copper Creek Diversion, Holden Village utilities and other infrastructures, and that the extent of cleanup in this area will need to be further addressed during RD/RA.

5.3.4 Sediment

Alternative 14 includes relocation of Railroad Creek so that the portions impacted by existing ferricrete would become part of the groundwater collection system and would not pose a risk to aquatic life. Alternative 14 would prevent release of hazardous substances into stream sediments through source controls across the Site.

As described in Section 1.2.2.4 of the SFS, the Agencies do not consider existing sediment concentrations (other than the formation of ferricrete) to be severe enough, or widely distributed enough, to require active sediment cleanup. Alternative 14 includes monitoring in Railroad Creek and at the Lucerne Bar in Lake Chelan to determine whether additional sediment actions are needed in the future.

5.3.5 Site-Wide Activities and Other Remediation Components

Alternative 14 also includes other remedial activities and components not referred to above.

Alternative 14 would include construction of a limited purpose landfill for long-term disposal of sludge from future operations of the water treatment systems, and potentially contaminated soils that may be generated by future excavations in Holden Village or other portions of the Site. For cost estimating purposes, the Agencies assumed this landfill would be located on top of the tailings piles, but final location would need to be determined during remedial design.

In addition to the treatability studies during remedial design that were previously noted, Alternative 14 would include Site-wide baseline monitoring in accordance with an approved monitoring plan. This plan would include identification of monitoring locations, parameters and sampling frequency acceptable to the Agencies. Monitoring would include assessing Intalco's contention that natural attenuation and other remedy components are preventing the release of groundwater above proposed cleanup levels into Railroad Creek downgradient of Tailings Piles 2 and 3, which could enable modification of the remedy.[46] Baseline monitoring would provide a basis for later assessing ARAR compliance and protectiveness of remedy. Additional sampling would also be accomplished

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[46] Post-ROD activities would include collection of sufficient information to support design and construction of the remedy. If the information gathered during design or after implementation indicates that changes to the selected remedy should be made, the Agencies may modify the remedy decision in the form of an ESD or ROD Amendment, depending on the extent of the modification.

to support remedial design, for example, to determine the extent of cleanup in Holden Village.

Alternative 14 would include development of remedy infrastructure including quarry site(s), borrow pit(s), reconstruction of the Lucerne barge landing facility, improvements to the Lucerne-Holden Road including bridges, electric power infrastructure, construction work camp and related infrastructure improvements in Holden Village, and other infrastructure as needed. The Agencies consider the development of hydroelectric power generating capacity to be highly desirable and consistent with TBCs.

Alternative 14 includes institutional controls to prevent development of groundwater as a drinking water source; prevent changes in Site use that would reduce effectiveness of the remedy; require future remediation prior to changes in land use for various AOIs; provide financial assurance and permanent access to privately-owned lands; and to monitor and maintain the remedy. Institutional controls would be appropriately memorialized for example placing notations on Forest Service land status records for National Forest System land, and proprietary controls, such as an environmental covenant for private property associated with the remedy.

Finally, Alternative 14 would include long-term monitoring to assess remedy performance, ARAR compliance and protectiveness. Monitoring would include assessing Intalco's contention that natural attenuation and other remedy components are preventing release of groundwater above proposed cleanup levels into Railroad Creek downgradient of Tailings Piles 2 and 3, which could enable modification of the remedy. [47]

6. DETAILED ANALYSIS OF ALTERNATIVES 11M, 13M, AND 14

A proposed remedial alternative for the Site must meet the criteria of *both* CERCLA and MTCA to be selected for implementation. The analysis presented in this section provides the basis for identification of a preferred alternative in the Proposed Plan.

[47] Post-ROD activities would include collection of sufficient information to support design and construction of the remedy. If the information gathered during design or after implementation indicates that changes to the selected remedy should be made, the Agencies may modify the remedy decision and document the basis for the change. This documentation could be in the form of an Explanation of Significant Difference or ROD Amendment, depending on the extent of the modification.

The detailed analysis of Alternatives 11M, 13M, and 14 is presented in this section. The detailed analysis of Alternatives 9, 10, 11, and 12 (the No Action Alternative) was previously presented in Section 4 of the SFS; therefore, the analysis of Alternative 11M presented here includes references to the SFS for remedial components that did not change from Alternative 11 to 11M. This ASFS focuses on the remedial components that were revised from Alternative 11 to develop Alternative 11M. The detailed analysis of Alternatives 1 through 8 was provided in the DFFS and the Agencies' comments on the DFFS (Forest Service 2007a).

The analysis of alternatives (including the No Action Alternative) that was previously presented in the SFS and the DFFS, and other related information, is not repeated herein.

6.1 CERCLA and MTCA Criteria for Remedy Selection

The following subsections provide a summary of the remedy selection criteria under CERCLA and MTCA; the criteria are described in detail in Section 4.1 of the SFS.

6.1.1 Regulatory Overview and Application

6.1.1.1 CERCLA Overview

Under CERCLA, the following criteria are used to evaluate remedial alternatives:

Threshold Criteria

1) Overall protection of human health and the environment.
2) Compliance with ARARs.

Primary Balancing Criteria

3) Long-term effectiveness and permanence.
4) Reduction of toxicity, mobility, and volume through treatment.
5) Short-term effectiveness.
6) Implementability.
7) Cost.

Modifying Criteria

8) State acceptance of the alternatives.
9) Community acceptance of the alternatives.

The threshold criteria are requirements that an alternative must meet to be eligible for selection. The primary balancing criteria form the basis for evaluation of alternatives that satisfy the threshold requirements. The modifying criteria are evaluated in the ROD following the receipt of state and public comments on the RI/FS and the Proposed Plan, and are not evaluated in this document.

6.1.1.2 MTCA Overview

Under MTCA, the following criteria are used to evaluate remedial alternatives:

Threshold Requirements

1) Protect human health and the environment.
2) Comply with cleanup standards.
3) Comply with applicable state and federal laws.
4) Provide for compliance monitoring.

Other Requirements

5) Use permanent solutions to the maximum extent practicable.
6) Provide a reasonable restoration time frame.
7) Consider public concerns.

Action-Specific Requirements (pertaining to)

8) Groundwater.
9) Soils at current or potential future residential areas and soils at schools and child care centers.
10) Institutional Controls.
11) Releases and Migration.
12) Dilution and Dispersion.
13) Remediation Levels.

As with CERCLA, the MTCA threshold requirements must be met for an alternative to be considered further. The remaining nine requirements, along with the threshold requirements, are used to evaluate alternatives that satisfy the threshold criteria.

Alternatives 11M, 13M, and 14 are first evaluated under the CERCLA criteria in Section 6.2, then evaluated under the MTCA criteria in Section 6.3.

6.1.1.3 Proposed Points of Compliance

CERCLA and MTCA require that performance of a remedy be assessed at a point of compliance, which refers to the locations where cleanup levels must be attained. There are both standard points of compliance and, under MTCA, there are conditional points of compliance. Points of compliance were discussed above in Section 2.6 and in Section 4.1.1.3 of the SFS and are summarized in Table 13.

6.2 Detailed Analysis of Alternatives 11M, 13M, and 14 Under CERCLA

This section presents the detailed analysis of alternatives based on the CERCLA criteria outlined in the previous section. Section 6.3 analyzes the alternatives under MTCA's remedy selection criteria.[48]

6.2.1 Alternative 11M

This section describes the Agencies' evaluation of Alternative 11M using the CERCLA remedy selection criteria.

6.2.1.1 Overall Protection of Human Health and the Environment

Alternative 11M eliminates human-health risk from contact with impacted soils through a combination of removal, capping and institutional controls.

Groundwater is not currently used for domestic use, but institutional controls would prevent potential human exposure through ingestion in the future. Other institutional controls to protect future human health and safety would include land use restrictions and signage at the Site to notify users about potential risks. Mine access restrictions such as a Forest Order and deed restrictions for private property would also be implemented.

Containment and treatment of virtually all sources of hazardous substance releases to surface water through implementation of Alternative 11M would immediately and substantially reduce the exposure risk to aquatic life and terrestrial receptors to hazardous substances. Reduction of iron and aluminum releases into Railroad Creek would reduce adverse physiological impacts on salmonids and eliminate ferricrete formation that adversely impacts habitat for the benthic macroinvertebrates that sustain the creek's food chain.

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[48] In addition to having participated in the Agencies' review of alternatives and selection of a proposed cleanup action under CERCLA, Ecology has analyzed these alternatives under MTCA. Based on the analysis under CERCLA and MTCA, the Agencies will present a Proposed Plan that identifies a Preferred Alternative for public comment. The Agencies will review comments at the close of the public comment period and may modify the Preferred Alternative or select another cleanup action based on new information or public comments. Following consideration of and response to public comments, the Agencies will document selection of a cleanup action in a record of decision (ROD) for the Site. Ecology intends to adopt the ROD as a cleanup action plan (CAP) under MTCA, pursuant to WAC 173-340-380(4).

Risks to terrestrial organisms from soil (including tailings and waste rock) that exceed proposed terrestrial ecological risk-based cleanup levels would be addressed by capping the material in place, or by consolidation and then capping, to prevent exposure in these areas: Tailings Piles 1, 2, and 3; East and West Waste Rock Piles; Honeymoon Heights Waste Rock Piles; former Mill Building; Lagoon; Maintenance Yard; a portion of the Ballfield Area, a portion of the Lower West Area, and the Surface Water Retention Area. *In situ* treatment would be used to reduce risks from hazardous substances in Holden Village; a portion of the Lower West Area; a portion of the Ballfield Area; and the Wind-Blown Tailings Area.

In summary, Alternative 11M is anticipated to be protective of human health and the environment, which satisfies the first CERCLA threshold criteria for selection of a remedy.

6.2.1.2 Compliance with Potential Applicable or Relevant and Appropriate Requirements (ARARs)

ARARs and TBC criteria are discussed above in Section 2.2 and Appendix F, and in Section 2.3 of the SFS.

6.2.1.2.1 Potential Chemical-Specific Requirements for Surface Water

Alternative 11M addresses all identified, existing sources of hazardous substance releases into surface waters through containment, collection, and treatment. Thus, the alternative is expected to satisfy potential chemical-specific ARARs for surface water including the National Recommended Water Quality Criteria (NWQC), National Toxics Rule, Maximum Contaminant Levels (MCLs), Washington State Drinking Water Standards, Washington State Water Quality Standards for Surface Water, and MTCA, which are described in Appendix F.

Alternative 11M includes design and operation of the treatment plant to meet discharge limits, which could include a mixing zone, if approved.

6.2.1.2.2 Potential Chemical-Specific Requirements for Groundwater

Alternative 11M would contain and provide active measures to collect and treat all identified groundwater sources that exceed proposed surface water ARARs and that would otherwise enter Railroad Creek or other surface waters including the Copper Creek Diversion and the wetlands east of Tailings Pile 3. Alternative 11M would rely on groundwater barriers, which are a proven technology for the containment of contaminated groundwater within the WMAs (e.g., below waste piles that are left in place). Groundwater downgradient of the containment barrier is anticipated to meet potential chemical-specific ARARs following construction of the barrier around the source areas, based on experience at other sites that is described in Appendix C of the SFS.

Human exposure to groundwater above drinking water standards (e.g., MCLs) at the Site would be prevented through institutional controls. Groundwater outside designated WMAs would begin to be cleaned up immediately following implementation of containment measures, so as to meet groundwater and surface water ARARs. However, it would be technically impracticable to meet groundwater ARARs within areas designated as WMAs (i.e., the main tailings and waste rock piles and the Lower West Area) within a reasonable restoration time frame. Therefore, in these areas, the Agencies may need to consider a waiver of groundwater ARARs under CERCLA.

In summary, groundwater containment would allow chemical-specific ARARs to be satisfied outside of the WMAs. Within the WMAs, institutional controls would protect human health, but chemical-specific ARARs would not be met and a waiver of these ARARs may be required.

6.2.1.2.3 Potential Chemical-Specific Requirements for Soil

Alternative 11M specifies the excavation and/or capping of tailings, waste rock piles, and soil at the former Mill Building, Surface Water Retention Area, the Lagoon Area, Ballfield Area, and the Maintenance Yard or other areas, as needed, to meet proposed soil cleanup levels. Alternative 11M would also address soil contamination in other areas of the site through *in situ* treatment in a manner that complies with MTCA and the substantive provisions of SEPA. To the extent that soil cleanup levels are not met because greater harm would be caused by taking action, the Agencies would waive the cleanup level ARARs under CERCLA. Such a decision would be contained in an ESD or ROD Amendment.

6.2.1.2.4 Potential Chemical-Specific Requirements for Sediment

As presented in Section 2.3.3.1.4 of the SFS, there are no chemical-specific ARARs for sediments at the Site.[49] Alternative 11M includes elimination of the release of hazardous substances to sediments in Railroad Creek and the removal of ferricrete in Railroad Creek. Alternative 11M also includes sediment monitoring to determine whether additional sediment cleanup would be required to protect aquatic organisms and to satisfy potential TBC criteria

[49] Proposed cleanup levels for sediments presented in Table 1 are based on TBC criteria as shown in Table 11.

including the Interim Final Sediment Evaluation Framework for the Pacific Northwest (US Army Corps of Engineers et al. 2006), and the state's Sediment Management Standards (Chapter 173-204 WAC).

6.2.1.2.5 Potential Action- and Location-Specific Requirements

The Agencies anticipate that Alternative 11M would satisfy all of the potential action-specific ARARs, including MTCA and the state's limited purpose landfill standards, and location-specific ARARS such as the National Forest Management Act (NFMA) and Land and Resource Management Plan for Wenatchee National Forest (LRMP) as amended.[50] Potential action- and location-specific ARARs are discussed in Appendix F.

Monitoring during and after implementation would be used to assess compliance, as required under both CERCLA and MTCA.

6.2.1.2.6 Summary of Compliance with Potential ARARs

As presented in Sections 6.2.1.2.1 through 6.2.1.2.5, Alternative 11M is anticipated to comply with all potential ARARs, which satisfies the second CERCLA threshold criteria for selection of a remedy.

6.2.1.3 Long-Term Effectiveness and Permanence

6.2.1.3.1 Magnitude of Residual Risk Remaining at the Conclusion of the Remedial Activities

Risks to human health from exposure to contaminants remaining in groundwater would be reduced under Alternative 11M through institutional controls.

Risks to human health from exposure to soils, tailings, and waste rock above proposed cleanup levels would be reduced under Alternative 11M through a combination of institutional controls, capping, and consolidation.

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[50] Mitigation to address adverse impacts of the cleanup action, such as destruction of habitat to construct remedy components, disturbance of habitat (especially for threatened and endangered species) during construction, visual quality, air quality, etc., would be implemented as required by the Forest Plan. In the event mitigation would not satisfactorily address requirements of the Forest Plan, the Forest Service may amend the Forest Plan or portions of this ARAR could be waived under CERCLA.

Alternative 11M includes permanent containment, collection, and treatment of all identified sources of groundwater that exceed proposed cleanup levels within the WMAs.

Alternative 11M includes regrading and pulling back the toe of the three tailings piles away from Railroad and Copper Creeks. Flattening the slopes would reduce the risk of seismic slope failures or surficial erosion of the tailings piles. Alternative 11M would also include construction of a toe buttress to improve stability of the regraded tailings. The need for and benefit of the buttress was determined by analyses based on the new geotechnical information Intalco obtained in 2008 and 2009. The Agencies assume Intalco would normally have obtained such information as part of remedial design, but since the information now exists, costs for the buttress have been incorporated into the Agencies' cost estimate for Alternative 11M, as discussed in Appendix A. Pulling the toe of the slope back away from the creeks would greatly reduce the risk of slope failures caused by scour that could undermine the riprap, or flooding that could overtop the riprap. Thus, Alternative 11M would mitigate the risk of erosion or large-scale slope failures that could release substantial volumes of tailings, with hazardous substances above proposed cleanup levels, directly into Railroad Creek and, ultimately, Lake Chelan.

Closure of the tailings and waste rock piles in conformance with state landfill regulations and other ARARs would reduce the risk of exposure to humans and terrestrial ecological receptors. Other areas of the Site with soil concentrations above proposed cleanup levels would be consolidated and capped as part of the tailings and waste rock piles, or capped in place to protect terrestrial receptors and prevent infiltration, including the former Mill Building, Maintenance Yard, portions of the Ballfield Area, Surface Water Retention Area, Lagoon and portions of the Lower West Area.

Alternative 11M would also address risk to terrestrial receptors in other areas of the Site through *in situ* treatment where soil exceeds proposed terrestrial ecological risk-based cleanup levels. These areas include Holden Village, the Wind-Blown Tailings area, portions of the Ballfield Area and portions of the Lower West Area.

For Alternative 11M, there could be some increased long-term risks to human health and the environment associated with the operation and maintenance of the remedy itself. These could include air emissions from a diesel generator (needed to supply power to the water treatment plant if hydroelectric or other alternate sources of power are insufficient), increased vehicle emissions associated with long-term operation, maintenance and monitoring (OMM) of the remedy, and potential contamination of soil, groundwater, or surface water from leaks or spills of diesel fuel, lime, or other chemicals while being transported to the Site or during routine use.[51] Such risks would be minimized through appropriate design (e.g., emission controls on the generator) and implementation of best management practices (BMPs) for transportation and handling of fuel, lime, and chemicals.

6.2.1.3.2 Adequacy and Reliability of Controls

To assess the adequacy and reliability of controls at the Site, items to be addressed under CERCLA include: 1) uncertainties associated with land disposal of treatment system residuals; 2) the potential need to replace technical components of the remedy; and 3) the potential risk if components of the remedy need to be replaced.

The main treatment system residual under Alternative 11M is metal hydroxide sludge. Under Alternative 11M, sludge would be disposed of in an on-site lined disposal landfill, or possibly in an unlined landfill if: a) design testing shows the sludge is stable and monitoring indicates the leachate metals concentrations meet proposed surface water cleanup levels; or b) if the landfill is located inside a groundwater containment system. Disposal in a lined on-site landfill as proposed for Alternative 11M significantly reduces potential uncertainties associated with land disposal of treatment system residuals and would satisfy ARARs [WAC 173-350-400(3)], since leachate could be collected and managed to avoid potential adverse impacts. However, pending additional evaluation during remedial design, the alternatives of: a) disposal inside a groundwater containment area without a liner or separate leachate collection system; or b) reliance on the sludge being inert and unable to re-release hazardous substances to the environment, might be shown to satisfy ARARs and be protective.

The main remedy components that would require replacement under this alternative are the water treatment system components. Other components of the remedy, such as creek bank protection and treatment system ditches, would also require periodic maintenance and repair to operate properly. Since all of these components involve conventional wastewater treatment or construction means and methods, the Agencies anticipate that all of these components can

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[51] If all the electricity were obtained from a diesel generator instead of hydroelectric or other alternative sources, Alternative 11M is anticipated to require about 34,700 gallons of diesel per year compared to 8,850 gallons per year for Alternative 14, based on evaluations prepared for the cost estimates discussed in Appendix A. The Agencies have expressed a preference for hydroelectric power to avoid negative environmental consequences of the use of diesel fuel, consistent with TBCs. Risks related to fuel use would be reduced for all Alternatives if a hydroelectric source of power is successfully developed as desired.

be readily replaced, maintained, and repaired as the need arises, as described in Section 4.2.3.3.2 and Appendix F of the SFS.

Adequacy and reliability of controls includes long-term maintenance of the Alternative 11M remedy components to reduce or eliminate the need for replacement of technical components of the remedy. This includes active measures to protect the integrity of the geomembrane used as part of the cap on the tailings and waste rock piles, to preserve impermeability of the geomembrane. Maintenance is required to protect the geomembrane from damage caused by burrowing wildlife and deep-rooted plants. Typically, such maintenance requires spraying or mowing to eliminate undesirable forms of vegetation on the cap and modifying habitat to make the cap less desirable to burrowing wildlife. Other adaptive management techniques (e.g., pest control) may also be required for wildlife.

Unanticipated failure of a remedial system component could result in an uncontrolled release of hazardous substances to surface water. Such a failure could have a sudden, acute impact on aquatic life within Railroad Creek if hazardous substance concentrations were high enough. Long-term deterioration of the geomembrane cap on the tailings and waste rock piles would increase the concentration of hazardous substance in groundwater and/or the volume of groundwater that is collected and treated. This would not necessarily be a problem, provided the groundwater treatment system can be adapted as needed to accommodate the changes over time.

The groundwater treatment system will also require maintenance in order to function reliably. However, an accidental release caused by a short-term failure of a treatment system component is expected to have a significantly less adverse effect than the existing ongoing releases.[52] Planned maintenance and periodic replacement of components in accordance with an approved maintenance plan for the groundwater collection, conveyance, and treatment system components typically would minimize or prevent shutting down the remediation system.

Based on the analysis described above, Alternative 11M includes sufficiently adequate and reliable controls to provide long-term protection of the environment.

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[52] As discussed in Appendix F of the SFS, the treatment system would be designed to accommodate temporary increases in flow due to stormwater. Standard engineering controls such as redundancy in pumps and power supply components would need to be provided to satisfy ARARs [e.g., WAC 173-240-130(2)(q)], TBCs, and meet BMPs.

6.2.1.3.3 Summary of Long-Term Effectiveness and Permanence

Based on the analysis discussed above, Alternative 11M is anticipated to provide acceptable long-term effectiveness and permanence for selection as a remedy.

6.2.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 11M would use active water treatment to reduce the toxicity of hazardous substances in groundwater (including seeps and the mine portal drainage) to surface water. Hazardous substances removed from the treated groundwater would be immobilized in the treatment sludge, which would be landfilled on site.

Alternative 11M does not rely on destruction or recycling of hazardous substance materials.

Alternative 11M would use active treatment to reduce the toxicity and mobility of an estimated average of 624 million gallons per year (MGY) of contaminated water. Alternative 11M would remove and dewater the sludge from the treatment plant to reduce the potential leaching of constituents of concern. The process would produce an estimated 10.7 million gallons of sludge (based on 4 percent solids) during the first year of operation, and this volume would decrease over time as indicated in Table D4 of the DFFS and Appendix F of the SFS.

Alternative 11M is anticipated to reduce toxicity, mobility and volume of hazardous substances to the degree necessary for selection as a remedy.

6.2.1.5 Short-Term Effectiveness

6.2.1.5.1 Short-Term Risks to the Community During Implementation

Short-term health risks to the community during implementation primarily consist of increased exposure to construction traffic. Short-term risks to the local community due to implementation of Alternative 11M can be adequately mitigated through active measures taken during construction. This would include a traffic control plan for joint use of the Lucerne-Holden Road by construction traffic and the Holden Village community.

Potential exposure to construction dust, noise, and vehicle exhaust emissions is not anticipated to present risks to the Holden Village community or other members of the public using the adjacent forest lands.

6.2.1.5.2 Potential Impacts on Workers during the Remedial Action and the Effectiveness and Reliability of Mitigative Measures During Implementation

Short-term human health risks from implementation of Alternative 11M at the Site primarily involve construction safety and operation of the treatment facility (which may also pose longer-term risks).

Human health risks to construction workers during remedy implementation include the following: underground mine hazards; construction traffic; exposure to soils with elevated concentrations of hazardous substances and TPH; exposure to noise and dust; and exposure to demolition activities and debris during removal of the derelict mill structure. Additional risks would be related to construction activities associated with regrading, barrier wall construction, ditch excavations, and treatment plant construction (e.g., open excavations, heavy equipment operations). There is also some risk to workers associated with handling caustic chemicals used in treatment system operations.

Construction activities will need to adhere to applicable OSHA, Washington State Department of Labor and Industries (L&I), and, potentially, MSHA regulations. Construction workers will be required to have HAZWOPER training. Dust concerns would be managed through best management practices (BMPs).

6.2.1.5.3 Potential Environmental Impacts of the Remedial Action and the Effectiveness and Reliability of Mitigative Measures during Implementation

Potential environmental impacts of Alternative 11M include the following:

1. Risk of a tailings release to Railroad or Copper Creeks due to slope failures or stormwater runoff during regrading;
2. Risk of bentonite or cement releases to the creeks during barrier wall construction;
3. Risks associated with construction of hydraulic barriers in the underground mine;
4. Risk of sediment release to the creeks during construction of groundwater and seep collection components, and use of temporary stream crossings during construction;
5. Risk to humans and the environment from construction vehicle emissions, noise, and dust;

6. Risk of fuel spills, especially if hydroelectric power is unavailable or insufficient;
7. Risk of surface water quality exceedances during and after startup of the treatment plant; and
8. Short-term habitat loss or degradation in areas where active remedial measures are implemented, such as along a temporary access road to the Surface Water Retention Area, and other areas disturbed for construction.

Maintenance of the cap on the tailings and waste rock piles would need to include spraying or mowing to control vegetation, and perhaps other measures to reduce the risk of damage to the geomembrane from burrowing wildlife. These measures to protect the cap will produce adverse short- and long-term environmental impacts since the result will be terrestrial habitat that is less diverse and less ecologically robust compared to natural forest conditions.[53]

Alternative 11M would also immediately produce a net loss of habitat, and long-term habitat degradation over the area downslope of the Honeymoon Heights where the access road would be constructed, and in the area where the groundwater treatment facility will be located north of Railroad Creek.[54]

Alternative 11M includes relocating the Honeymoon Heights Waste Rock Piles and DSHH soils to the tailings piles, where they will be capped. This approach would eliminate exposure of plants and animals to hazardous substances in the waste rock; however, high-quality habitat is unlikely to re-establish in the Honeymoon Heights area following construction, given the steep slopes and shallow soils. Some permanent loss of habitat is also expected to be associated with the construction access areas and area downslope of the haul road that is necessary to remove the waste rock. Successful restoration of the footprint of the haul road to high-quality habitat is unlikely to be completely effective, given the steep slopes, shallow soils, high spring season runoff, and consequent mass wasting processes.

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[53] Adverse impacts would include: continual setbacks to ecosystem development and succession, vulnerability to invasive species, reduced ability to develop soils that support a diverse ecosystem, increased potential for erosion, potential for contamination from herbicides, impacts to small mammal populations from control efforts, etc.

[54] There may also be other areas where there would be permanent disturbance due to implementation of Alternative 11M, e.g., along the surface water diversions upslope of the tailings and waste rock piles. It is not possible to precisely quantify such impacts prior to remedial design, but it is also likely these incidental impacts are similar from one alternative to another. Such impacts can, however, be addressed under NRDA.

Alternative 11M includes pulling the tailings back from Railroad Creek, to improve long-term stability and enable barrier wall construction, as well as to enhance existing riprap to mitigate potential future flood impacts. Mitigative measures for potential tailings and sediment releases include construction BMPs, such as sediment fencing and barriers that could be advanced along the edge of the creek as the regrading advances.

Areas disturbed during construction would be promptly revegetated under Alternative 11M, in compliance with ARARs to limit soil loss and surface water impacts, and to control the establishment of noxious weeds. However, it would not be possible to restore habitat equivalent to that which is damaged in some AOIs, such as on Honeymoon Heights where a net habitat loss would be likely to occur.

Finally, under Alternative 11M, as with other alternatives, the risk of fuel spills, or bentonite or cement releases would be mitigated through an SPCC Plan implemented for construction, and adherence to regulations regarding storage, transportation, and dispensing of fuel.

6.2.1.5.4 Time until Protection is Achieved

Alternative 11M would immediately protect human health and is anticipated to be protective of the environment at the time the remedy is implemented.

6.2.1.5.5 Summary of Short-Term Effectiveness

Based on the analysis discussed above, Alternative 11M is anticipated to provide acceptable short-term effectiveness for selection as a remedy. However, some long-term adverse impacts would result from the effects of removing waste rock from Honeymoon Heights, construction of the groundwater treatment facility, and other permanent impacts that would need to be addressed through SEPA mitigation under the Forest Plan, SEPA, the Clean Water Act Section 404 and other ARARs.

6.2.1.6 Implementability

This section describes the CERCLA evaluation of the implementability of Alternative 11M, based on consideration of its technical feasibility, administrative feasibility, and the availability of needed services and materials.

6.2.1.6.1 Technical Feasibility

Alternative 11M is technically feasible. The remedy could be implemented using conventional construction equipment and techniques.

The proposed groundwater treatment system may need to be augmented beyond simple lime addition and precipitation, in order for the effluent to meet criteria for discharge to surface water. The final treatment system design needs to be based on treatability tests (such as are now underway, and/or as part of remedial design), and could require modification to enhance treatment as discussed in Appendix F of the SFS. Reported experience of other comparable systems is discussed in Appendix F of the SFS and Appendix H of ERM and URS (2009). The ease of undertaking additional remedial measures varies, depending on the measures that might be needed. However, the proposed treatment system would not preclude potential additional measures.

The feasibility of operating the Alternative 11M groundwater collection and conveyance system year-round may be limited by seasonal freezing or iron fouling of ditches used for collection and conveyance of groundwater, conveyance piping, pumps, and treatment facility components. If Alternative 11M is selected, performance of the ditch system used for collection and conveyance, and its susceptibility to freezing or other problems should be further evaluated during remedial design to determine whether an alternative approach, such as the seep collection system proposed for Alternative 9, would be more effective.

6.2.1.6.2 Administrative Feasibility

Alternative 11M is administratively feasible.

The land affected by the remedy is under the control of the Forest Service, except for patented mine claims that are owned by Holden Village, Inc. The Agencies anticipate that the remedy will include some active measures as well as access and institutional controls on lands owned by Holden Village, Inc.

No wastes are anticipated to be moved off the Site for disposal, with the possible exception of residual processing wastes which may be designated as state Dangerous Wastes or asbestos encountered during cleanup of the former Mill Building. The potential need for off-site disposal of such wastes does not affect the feasibility of Alternative 11M.

6.2.1.6.3 Availability of Services and Materials

The technologies required for each of the components in Alternative 11M are known and proven technologies. The Agencies anticipate that there will be companies willing to do this work and that the contractors bidding for this work will be experienced in the technologies required for the alternative. Alternative 11M would rely on construction means and methods that are readily available in Washington, and it is also likely that a remedial construction project of this magnitude would attract interested contractors from outside the region. Despite the Site's remote geographic location, necessary equipment could be moved to the Site for construction of Alternative 11M.

6.2.1.6.4 Summary of Implementability

Based on the analysis discussed above, Alternative 11M would satisfy the remedy selection criterion for implementability.

6.2.1.7 Cost

CERCLA requires that an alternative selected as a cleanup action shall be cost-effective, provided that it first satisfies the threshold criteria. The Agencies' detailed cost estimate is presented in Appendix A. The table below summarizes the Agencies' estimate.

Alternative 11M [55]	
Estimated Capital Cost	$88,500,000
Net Present Value of Long-Term Operations, Maintenance and Monitoring	$31,800,000
Total Estimated Cost:	$120,000,000

Alternative 11M would address all areas of the Site where contaminated groundwater has been identified as entering Railroad Creek, and all other areas with constituents of concern above proposed cleanup levels in soil, waste rock, or tailings. The cost estimate shown above is for implementing Alternative 11M as a final remedy based on available information. See Appendix A for additional information on estimated costs.

[55] Costs are shown in 2010 dollars, rounded to three significant figures.

6.2.1.8 State Acceptance

Ecology has participated in evaluating remedy alternatives for the Site. The State's evaluation of Alternative 11M under MTCA is summarized below in Section 6.3.

6.2.1.9 Community Acceptance

CERCLA provides that final remedy selection will consider public comment on the remedial alternatives. Community acceptance of alternatives will be evaluated after the public comment period ends, and will be described in the ROD for the Site.

6.2.1.10 Summary of Alternative 11M

Based on the analyses discussed above, Alternative 11M would satisfy all the CERCLA criteria for selection of a permanent remedy.

6.2.2 Alternative 13M

This section describes the Agencies' evaluation of Alternative 13M using the CERCLA remedy selection criteria.

6.2.2.1 Overall Protection of Human Health and the Environment

Alternative 13M addresses human-health risk from contact with impacted soils, tailings, and waste rock through a combination of removal, capping, and institutional controls. However, Alternative 13M does not fully protect environmental receptors in both the aquatic and the terrestrial environments.

Alternative 13M includes capping the tailings and waste rock piles that contain hazardous substances above human health-based criteria for protection of groundwater. Alternative 13M would rely on institutional controls and natural recovery to address soils above human health-based criteria for protection of groundwater at the Honeymoon Heights Waste Rock Piles, DSHH, and the Lower West Area.

Alternative 13M would rely on consolidation and capping to prevent direct contact with soils that exceed human health criteria in the Lagoon and Maintenance Yard areas. However, Alternative 13M would rely on institutional controls instead of any active cleanup measures to protect humans from direct contact with or ingestion of soils that exceed human health criteria in the remainder of the Lower West Area (i.e., outside the Lagoon Area).

Groundwater is not currently used for domestic purposes, but institutional controls would prevent potential human exposure through ingestion in the future. Other institutional controls to protect future human health and safety would include land use restrictions and signage at the Site to notify users about potential risks.

Containment and treatment of some sources of hazardous substance releases to surface water would reduce contaminant concentrations in surface water and reduce the associated risk to aquatic life. However, groundwater from beneath Tailings Pile 3 and at least part of Tailings Pile 2 would continue to discharge untreated into Railroad Creek under Alternative 13M. Intalco has not shown how groundwater concentrations may be attenuating downgradient of Tailings Piles 2 and 3, or whether such attenuation is adequately protective of Railroad Creek.

Intalco has postulated that groundwater from Tailings Piles 2 and 3 may meet proposed surface water cleanup levels at a point downstream from Tailings Piles 2 and 3, where it discharges to Railroad Creek. This could be the result of natural attenuation due to dispersion, dilution, source depletion, or other processes, but Intalco has not yet identified a mechanism such as biodegradation or chemical degradation as required for a remedy to rely on natural attenuation [WAC 173-340-370(7)(c)]. Intalco has shown that groundwater concentrations east of Tailings Pile 3 are above surface water protection criteria where groundwater enters Railroad Creek, and available data suggest a complex hydrogeologic regime that may make it difficult to demonstrate that natural attenuation of hazardous substances in groundwater is protective of surface water (see Figure 8). Efforts are ongoing to identify the groundwater discharge location(s) and to evaluate whether natural processes are or will eventually reduce contaminant concentrations sufficiently. However, with the information currently available, the Agencies cannot conclude that such processes adequately ensure the protection of the aquatic environment. (See Agencies' comments to the Draft Alternative 13M Evaluation Report and related documents, [Forest Service 2010a].)

Intalco also believes that components of Alternative 13M including diversion trenches, regrading and capping the tailings piles, collection and treatment of groundwater in the Lower West Area and below Tailings Pile 1, and collection and treatment of groundwater northwest of Tailings Pile 2, will result in achieving ARARs in Railroad Creek. These components are common to Alternatives 11M, 13M and 14, see Table 15. However, the Agencies do not have sufficient information to show that proposed cleanup levels, including those based on protection of surface water, would be met in groundwater before it enters Railroad Creek downstream of Tailings Piles 2 and 3, without a barrier wall.

Alternative 13M also includes possible implementation of unspecified contingent actions should natural processes, in conjunction with other remedial components, be shown to not be protective of aquatic life. As described in ERM and URS (2009a):

> *". . . if after an extended period of monitoring ARARs are not achieved at the [conditional point(s) of compliance] downstream of the terminus of the realigned [Railroad Creek] channel, contingent actions would be evaluated under Alternative 13M."*

Absent proof that natural processes currently result in groundwater discharge from the Site meets proposed cleanup levels at the default point(s) of compliance, the evaluation of contingent actions at an undefined time in the future does not adequately protect aquatic organisms. Despite Intalco's proposed reliance on a conditional point of compliance where groundwater discharges into surface water downstream of the tailings piles, Intalco has not shown that Alternative 13M satisfies AKART and other criteria for a conditional point of compliance [WAC 173-340-720(8)(d)(i)].

Alternative 13M would protect terrestrial plants and animals in many areas through the removal or capping of impacted soil, tailings, and waste rock. However, it does not protect terrestrial organisms at the Honeymoon Heights Waste Rock Piles, DSHH, Holden Village, the Lower West Area, the Wind-Blown Tailings Area, and the Ballfield Area, where soil or waste rock exceeds proposed terrestrial ecological risk-based cleanup levels. Intalco has suggested that risks to terrestrial receptors would diminish through "natural recovery" but has not described any process that would cause this to occur, or suggested how long it would take.

In summary, although Alternative 13M would be protective of human health, it is not sufficiently protective of aquatic and terrestrial organisms, and thus does not satisfy the first CERCLA threshold criteria for selection of a remedy.

6.2.2.2 Compliance with Potential Applicable or Relevant and Appropriate Requirements (ARARs)

ARARs and TBC criteria are discussed in Appendix F.

6.2.2.2.1 Potential Chemical-Specific Requirements for Surface Water

Alternative 13M addresses many—but not all—identified, existing sources of hazardous substance releases into surface waters through containment, collection, and treatment. Thus, the alternative may not satisfy potential chemical-specific ARARs for surface water, such as the NWQC, Washington State Water Quality Standards for Surface Water, and MTCA, which are described in Appendix F.

6.2.2.2.2 Potential Chemical-Specific Requirements for Groundwater

Alternative 13M would contain and provide active measures to collect and treat many—but not all—identified groundwater sources that exceed proposed cleanup levels and would otherwise enter Railroad or Copper Creeks. Groundwater that discharges from below Tailings Pile 2 and Tailings Pile 3 above proposed cleanup levels would not be contained; thus, Alternative 13M would not meet potential chemical-specific ARARs for the protection of surface water, including the NWQC, Washington State Water Quality Standards for Surface Water, and MTCA, which are described in Appendix F.

Alternative 13M relies on institutional controls to prevent future human groundwater consumption at the Site. This alone would not satisfy ARARs. Alternative 13M does not support justification of a waiver of ARARs (e.g., MCLs) within the WMAs.[56]

6.2.2.2.3 Potential Chemical-Specific Requirements for Soil

Alternative 13M would not satisfy all chemical-specific ARARs for soil.

Alternative 13M includes the excavation and/or capping of tailings, waste rock piles, and soil at the former Mill Building, Surface Water Retention Area, the Lagoon, and the Maintenance Yard or other areas, as needed, to meet proposed soil cleanup levels in these areas. However, Alternative 13M does not address soil contamination in some other areas of the site (e.g., Honeymoon Heights Waste Rock Piles, DSHH, Lower West Area, Holden Village, Wind-Blown Tailings Area and the Ballfield Area) in a manner that complies with ARARs for protection of terrestrial receptors[WAC 173-340-740(2)(b)(iii)].

6.2.2.2.4 Potential Chemical-Specific Requirements for Sediment

Alternative 13M includes rerouting a portion of Railroad Creek that includes the areas impacted by ferricrete, which effectively addresses this issue. Alternative 13M also includes containment of groundwater impacted by releases from

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[56] Intalco specifically failed to address the definition of a waste management area to allow an alternative point of compliance for groundwater (referred to as a conditional point of compliance under MTCA), as requested by the Agencies (USDA OGC 2008, attachment labeled as Handout No. 1).

Tailings Pile 1 to sediments in Railroad Creek, but does not provide source control for groundwater impacted by releases from Tailing Piles 2 and 3.

Intalco's Alternative 13M description (ERM and URS 2009a, page 2) refers to prospective sediment monitoring, but does not include any details; Intalco characterizes sediments in Railroad Creek and Lake Chelan as not being included in the areas/media it considered for remediation at the Site. Without such monitoring over time it would not be possible to confirm whether implementation of Alternative 13M would comply with ARARs, such as WAC 173-204-120, and TBCs for the protection of aquatic organisms. Potential TBCs include the Interim Final Sediment Evaluation Framework for the Pacific Northwest (US Army Corps of Engineers et al. 2006), and the state's Sediment Management Standards (Chapter 173-204 WAC).

6.2.2.2.5 Potential Action- and Location-Specific Requirements

The Agencies anticipate that Alternative 13M would satisfy most, but not all, potential action- and location-specific ARARs.[57] Additional information would need to be developed during remedial design/remedial action to confirm that Alternative 13M would satisfy potential action- and location-specific ARARs, such as the following:

- Intalco has not presented information that shows that the 6-inch cover of soil/gravel and wood slash proposed for the tailings and waste rock piles [or the 12-inch cover discussed in URS (2010a)] would satisfy the performance requirements for closure of limited purpose landfills [WAC 173-350-400(3)(e)(i)]; and

- Intalco has not presented information to support its proposal to construct unlined ponds as part of the groundwater treatment system. It is not clear that this would satisfy ARARs such as WAC 173-240-130(2)(t) and comply with state or local water quality management plans.

In addition to developing additional information during remedial design, monitoring during and after implementation would be used to assess compliance with ARARs.

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[57] Mitigation to address adverse impacts such as permanent destruction of habitat, temporary disturbance of habitat during construction, visual impacts, etc., would be implemented as required by the Forest Plan. In the event mitigation would not satisfactorily address requirements of the Forest Plan, the Forest Service may amend the Forest Plan or portions of this ARAR could be waived under CERCLA.

6.2.2.2.6 Summary of Alternative 13M Compliance with the CERCLA Threshold Requirements for Remedy Selection

Alternative 13M does not satisfy the threshold requirements for selection of a permanent remedy, as discussed in Sections 6.2.2.1, 6.2.2.2.2, and 6.2.2.2.3, and may not satisfy other potential ARARs as discussed in sections 6.2.2.2.1 and 6.2.2.2.4. As a result, Alternative 13M cannot be selected as a permanent remedy for the Site.

Since Alternative 13M does not meet the threshold requirements there is no requirement to further evaluate it with respect to the primary balancing criteria under CERCLA. However, for the sake of completeness, the following sections discuss the degree to which Alternative 13M would satisfy the other CERCLA criteria for remedy selection.

6.2.2.3 Long-Term Effectiveness and Permanence

6.2.2.3.1 Magnitude of Residual Risk Remaining at the Conclusion of the Remedial Activities

Risks to human health from exposure to groundwater would be reduced under Alternative 13M through institutional controls.

Risks to human health from exposure to soil, tailings, and waste rock above proposed cleanup levels would be reduced under Alternative 13M through a combination of institutional controls, capping, and removal.

Alternative 13M includes permanent containment, collection, and treatment of many identified sources of groundwater that exceed proposed cleanup levels. However, Alternative 13M would not effectively address discharge of groundwater from Tailings Piles 2 and 3 to surface water.

Alternative 13M includes construction of toe buttresses along with regrading portions of the slopes of the three tailings piles to address the risk of seismic slope failures or surficial erosion of the tailings piles. These actions, along with relocating Railroad Creek, would reduce the risk of slope failures due to scour that could undermine the toe of the tailings piles, or flooding that could overtop the existing riprap. Alternative 13M would mitigate the residual risk of erosion or large-scale slope failures that could release substantial volumes of tailings with hazardous substances above proposed cleanup levels directly into Railroad Creek and, ultimately, Lake Chelan. However, Alternative 13M does not include regrading steep tailings pile slopes adjacent to Copper Creek to the same degree as for slopes adjacent to Railroad Creek (see Figure 3-1 in the Draft Alternative 13M Remedy Evaluation Report [ERM and URS 2009a]).

Although Intalco asserts that capping the tailings and waste rock piles would adequately reduce the risk of exposure to terrestrial receptors, it has not shown that the proposed 6-inch cover of soil/gravel and wood slash would satisfy the performance standards for closure of limited purpose landfills, such as minimizing infiltration [WAC 173-350-400(3)(e)(i)(B)] and the capacity to support native vegetation [WAC 173-350-400(3)(e)(i)(D)].

Alternative 13M would address risks to terrestrial and aquatic receptors in some—but not all—areas of the Site where soil (including tailings) exceeds proposed terrestrial ecological and aquatic risk-based cleanup levels. Intalco's proposal to rely on "monitored natural recovery" will not reduce risk to terrestrial receptors.

Alternative 13M, like the other alternatives, could also result in some increased long-term risks to human health and the environment associated with the operation and maintenance of the remedy itself. These could include air emissions from a diesel generator (needed to supply power to the water treatment plant if hydroelectric power or other alternate sources of power are insufficient), increased vehicle emissions associated with long-term operation, maintenance and monitoring (OMM) of the remedy, and potential contamination of soil, groundwater, or surface water from leaks or spills of diesel fuel, lime, or other chemicals while being transported to the Site or during routine use. Such risks would be minimized through appropriate design (e.g., emission controls on the generator) and implementation of best management practices (BMPs) for transportation and handling of fuel, lime, and chemicals.[58]

6.2.2.3.2 Adequacy and Reliability of Controls

To assess the adequacy and reliability of controls at the Site, items to be addressed under CERCLA include: 1) uncertainties associated with land disposal of treatment system residuals; 2) the potential need to replace technical components of the remedy; and 3) the potential risk if components of the remedy need to be replaced.

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[58] The Agencies have expressed a preference for hydroelectric power to avoid negative environmental consequences of the use of diesel fuel, consistent with TBCs. Risks related to fuel use would be reduced for all Alternatives if a hydroelectric source of power is successfully developed as desired.

The main treatment system residual under Alternative 13M is sludge. In discussing ARARs [Section 2.2.2.10 of ERM and URS (2009a)] Intalco indicated that a liner and leachate collection system may not be required to satisfy limited purpose landfill standards (WAC 173-350-400) for sludge disposed of in a landfill constructed on the tailings piles. Intalco did not include a liner and leachate control system in its cost estimate for Alternative 13M (URS 2009a). Since it is not clear whether an unlined sludge disposal facility would satisfy ARARs, it is not clear whether the approach used in Intalco's Alternative 13M cost estimate is an adequate method for land disposal of treatment system residuals.

The main remedy components that would require replacement under Alternative 13M are the water treatment system components. Other components of the remedy, such as river bank protection and treatment system ditches, would also require periodic maintenance and repair to operate properly. Since all of these components involve conventional industrial or construction means and methods, the Agencies anticipate that all of these components can be readily replaced, maintained, and repaired as the need arises.

Unanticipated failure of a remedial system component could result in an uncontrolled release of hazardous substances to surface water. Such a failure could have a sudden, acute impact on aquatic life within Railroad Creek if the hazardous substance concentrations were high enough. However, an accidental release caused by a short-term failure of a remedy component is expected to have a significantly less adverse effect than the existing ongoing releases. Planned maintenance and periodic replacement of components for the groundwater collection, conveyance, and treatment systems typically can be arranged to minimize or avoid shutting down the remediation system.

Based on the analysis described above, Alternative 13M includes sufficiently adequate and reliable controls for the groundwater treatment system. However, the proposed omission of a liner and leachate collection system for the Alternative 13M sludge disposal facilities may not provide long-term protection of the environment.

6.2.2.3.3 Summary of Long-Term Effectiveness and Permanence

Based on the analysis discussed above, Alternative 13M would not provide acceptable long-term effectiveness and permanence for selection as a remedy, since it would leave residual risk to terrestrial and aquatic receptors after implementation.

6.2.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 13M would use active water treatment to reduce the toxicity of hazardous substances in some of the groundwater from the Site (including seeps and mine portal drainage) that discharges to surface water. Alternative 13M would treat an estimated 710 million gallons of contaminated water per year. Toxic metals from the treated portion of the groundwater would be immobilized in the treatment sludge, which would be disposed of in an on-site landfill that meets the state's Limited Purpose Landfill regulations. The process would produce an average of approximately 7.2 million gallons of sludge (based on 4 percent solids) per year during the first year of operation, and this volume would decrease over time as indicated in Table D4 of the DFFS and discussed in Appendix F of the SFS.

Alternative 13M does not rely on destruction or recycling of hazardous substance materials.

6.2.2.5 Short-Term Effectiveness

6.2.2.5.1 Short-Term Risks to the Community During Implementation

Short-term health risks to the community during implementation primarily consist of increased exposure to construction traffic. Potential exposure to construction dust, noise, and vehicle exhaust emissions is not anticipated to present risks to the Holden Village community or other members of the public using the adjacent forest lands.

Short-term risks to the local community due to implementation of Alternative 13M can be adequately mitigated through active measures taken during construction, as discussed in Section 4.1.3.3.1 of the SFS. This would include a traffic control plan for joint use of the Lucerne-Holden Road by construction traffic, the Agencies, visitors to the National Forest, and the Holden Village community.

6.2.2.5.2 Potential Impacts on Workers during the Remedial Action and the Effectiveness and Reliability of Mitigative Measures During Implementation

Short-term human health risks from implementation of Alternative 13M are primarily focused on construction safety and potential longer-term risks associated with operation of the treatment facility.

Human health risks to construction workers during remedy implementation include the following: underground mine hazards; construction traffic; exposure to soils with elevated concentrations of hazardous substances and TPH; exposure to noise and dust; and exposure to demolition activities and debris due to removal of the derelict mill structure. Additional risks would be related to construction activities associated with regrading, barrier wall construction, ditch excavations, and treatment plant construction (e.g., open excavations, heavy equipment operations). There is also some risk to workers associated with handling caustic chemicals used in treatment system operations.

Construction activities will need to adhere to applicable OSHA, L&I, and, potentially, MSHA regulations. Construction workers will be required to have HAZWOPER training. Dust concerns would be managed through BMPs.

6.2.2.5.3 Potential Environmental Impacts of the Remedial Action and the Effectiveness and Reliability of Mitigative Measures during Implementation

Potential environmental impacts of the remedial action include the following:

1. Risk of a tailings release to Railroad or Copper Creeks due to slope failures or stormwater runoff during regrading or relocation of Railroad Creek;
2. Risk of bentonite or cement releases to the creeks during barrier wall construction;
3. Risks associated with construction of hydraulic barriers in the underground mine;
4. Risk of sediment release to the creeks during construction of groundwater and seep collection components, and use of temporary stream crossings during construction;
5. Risk to humans and the environment from construction vehicle emissions, noise, and dust;
6. Risk of fuel spills, especially if hydroelectric power is unavailable or insufficient;
7. Risk of surface water quality exceedances during and after startup of the treatment plant; and
8. A net permanent loss of habitat in the area along the new Railroad Creek channel and in the areas where the groundwater treatment facilities will be located. The areas impacted by the proposed Alternative 13M treatment systems include the riparian forest area where the west treatment system would be located, and the wetlands where the east treatment facilities would

be located. Implementation of Alternative 13M will require mitigation for the loss of the wetlands and riparian forest in order to comply with the Forest Plan and other ARARs.[59] [60] [61] Mitigation to address adverse impacts such as permanent destruction of habitat, temporary disturbance of habitat during construction, visual impacts, etc., would be implemented as required by the Forest Plan. In the event mitigation would not satisfactorily address requirements of the Forest Plan, the Forest Service may amend the Forest Plan or portions of this ARAR could be waived under CERCLA.

Mitigation for constructing the groundwater treatment facility within the existing wetlands will need to be addressed during remedial design. Mitigation could include, for example, expansion or enhancement of existing riparian wetlands along Railroad Creek (see Figure 4, for example), creation of wetlands as part of cleanup in the Lower West Area, and/or expansion or enhancement of wetlands in other areas (for example, see Hart Crowser 2005).

There will also be additional short-term habitat loss or degradation in other areas where active remedial measures are implemented, such as along a temporary access road to the Surface Water Retention Area, and other areas disturbed for construction.

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[59] There may also be other areas where there would be permanent disturbance due to implementation of Alternative 13M, e.g., along the surface water diversions upslope of the tailings and waste rock piles. It is not possible to precisely quantify such impacts prior to remedial design, but it is also likely these incidental impacts are similar from one alternative to another. Such impacts can, however, be addressed under the NRDA for the Site.

[60] Intalco has proposed use of an engineered wetland for polishing treated groundwater in the east treatment system, but has not provided any explanation for why the proposed Alternative 13M east treatment system would use a wetlands component for polishing, while the west treatment system would use a sand filter system. Intalco has not provided any discussion of the relative merits of a sand filter system compared to a wetlands system for polishing. Intalco has not provided any information on how long-term sludge accumulation would be managed for the wetlands system. Intalco has not provided any details on discharge from the wetlands system, and whether this discharge would be regulated as a discharge to groundwater or a point source discharge to surface water. Intalco has also not identified any habitat value for the engineered wetlands. Construction of the Alternative 13M treatment facility in the existing wetlands will require mitigation under the Forest Plan and other ARARs. Also, the Forest Service, Ecology, and the Yakama Nation, who are also Natural Resource Trustees, do not anticipate the proposed engineered wetlands would produce any NRD credit for the existing wetlands that have been impacted by hazardous substances released from the tailings piles; or NRD credit for the loss of wetlands that would result from construction of the Alternative 13M treatment facilities. Wetlands used as part of a water treatment system would not be expected to have the biological complexity of a natural system and could be an attractive nuisance for wildlife if the water flowing through them does not meet surface water quality criteria (see EPA 2007). Compensation for loss of the wetlands east of Tailings Pile 3 will need to be addressed as natural resource damages.

[61] Compensation for these areas is also subject to recovery for NRD under CERCLA.

Alternative 13M includes rerouting Railroad Creek away from the toe of the tailings (and regrading the tailing slopes to increase stability), as well as enhancing existing riprap to mitigate potential future flood impacts. Mitigative measures for potential tailings and sediment releases include construction BMPs such as sediment fencing and barriers, which could be advanced along the edge of the creek as the Lower West Area/Tailings Pile 1 barrier is constructed, and adjacent to construction of the new creek channel upslope of the existing Railroad Creek channel.

In addition, all areas disturbed during construction would need to be promptly revegetated to limit soil loss and surface water impacts, and to control the establishment of noxious weeds.

The risk of fuel spills, or bentonite or cement releases would be mitigated through an SPCC Plan implemented for construction, and adherence to regulations regarding storage, transportation, and dispensing of fuel.[62]

6.2.2.5.4 Time until Protection is Achieved

Alternative 13M would immediately protect human health but would not be entirely protective of terrestrial or aquatic organisms.

- Alternative 13M would rely on natural recovery to eliminate risks to terrestrial receptors in the Honeymoon Heights Waste Rock Piles, DSHH, Ballfield Area, Lower West Area, Holden Village, and Wind-Blown Tailings AOIs. Intalco has not identified any mechanism for natural attenuation of hazardous substances in soils, or indicated how much time would elapse before natural recovery is complete.

- Alternative 13M has not been shown to be protective of Railroad Creek downstream of Tailings Piles 2 and 3 following remedy implementation. Even if natural attenuation is shown to be effective in protecting aquatic receptors downgradient of Tailings Piles 2 and 3 at some future time, it is not evident when that would occur.

[62] The Agencies have expressed a preference for hydroelectric power to avoid negative environmental consequences of the use of diesel fuel, consistent with TBCs. Risks related to fuel use would be reduced for all Alternatives if a hydroelectric source of power is successfully developed as desired.

6.2.2.5.5 Summary of Short-Term Effectiveness

Based on the analysis discussed above, Alternative 13M is not anticipated to provide acceptable short-term effectiveness for selection as a remedy. Although potential short-term risks to the community, remediation workers, and environmental impacts of remedy implementation could likely be managed, it is unclear when protection of aquatic and terrestrial environmental receptors would be achieved.

As with other remedial alternatives, Alternative 13M would produce some long-term adverse impacts due to construction of the groundwater treatment facilities and other permanent impacts that would need to be addressed through mitigation required under the Forest Plan, SEPA, and the Clean Water Act (Section 404 wetlands mitigation).

6.2.2.6 Implementability

This section describes the CERCLA evaluation of the implementability of Alternative 13M, based on consideration of its technical feasibility, administrative feasibility, and the availability of needed services and materials.

6.2.2.6.1 Technical Feasibility

Alternative 13M is technically feasible. The remedy could be implemented using conventional construction equipment and techniques.

The proposed groundwater treatment system may need to be augmented beyond simple lime addition and precipitation in order for the effluent to meet criteria for discharge to surface water. The final treatment system design needs to be based on treatability tests (such as are now underway, and/or as part of remedial design), and could require modification to enhance treatment as discussed in Appendix F of the SFS. Reported experience of other comparable systems is discussed in Appendix F of the SFS and Appendix H of ERM and URS (2009a). The ease of undertaking additional remedial measures varies, depending on the measures that might be needed. However, the proposed treatment system would not preclude potential additional measures.

The feasibility of operating the proposed Alternative 13M groundwater collection and conveyance system year-round may be limited by seasonal freezing or iron fouling of ditches used for collection and conveyance of groundwater, conveyance piping, pumps, and treatment facility components. If Alternative 13M is selected, the performance of the ditch system used for collection and conveyance, and its susceptibility to freezing or other problems should be further evaluated during remedial design to determine whether an alternative approach, such as the seep collection system proposed for Alternative 9, would be more effective.

6.2.2.6.2 Administrative Feasibility

Alternative 13M is administratively feasible.

The land affected by the remedy is under the control of the Forest Service, except for patented mine claims that are owned by Holden Village, Inc. The Agencies anticipate that the remedy will include some active measures as well as access and institutional controls on lands owned by Holden Village, Inc.

No wastes are anticipated to be moved off the Site for disposal, with the possible exception of residual processing wastes, which may be designated as state Dangerous Waste, and asbestos encountered during cleanup of the former Mill Building. The potential need for off-site disposal of such wastes does not affect the feasibility of Alternative 13M.

6.2.2.6.3 Availability of Services and Materials

The technologies required for each of the components in Alternative 13M are known and proven technologies. The Agencies anticipate that there will be companies willing to do this work and that the contractors bidding for this work will be experienced in the technologies required for the alternative.

Alternative 13M would rely on construction means and methods that are readily available in Washington, and it is also likely that a remedial construction project of this magnitude would attract interested contractors from outside the region. Despite the Site's remote geographic location, necessary equipment could be moved to the Site for construction of Alternative 13M.

6.2.2.6.4 Summary of Implementability

Based on the analysis discussed above, Alternative 13M would satisfy the remedy selection criterion for implementability.

6.2.2.7 Cost

CERCLA requires that an alternative selected as a cleanup action shall be cost-effective, provided that it first satisfies the threshold criteria. The Agencies' detailed cost estimate is presented in Appendix A. The table below summarizes the Agencies' estimate.

Alternative 13M [63]	
Estimated Capital Cost	$56,400,000
Net Present Value of Long-Term Operations, Maintenance and Monitoring	$23,400,000
Total Estimated Cost:	$79,800,000

Additional information on estimated costs is presented in Appendix A.

6.2.2.8 State Acceptance

Ecology has participated with the lead Agency in evaluating remedy alternatives for the Site. The state's evaluation of Alternative 13M under MTCA is summarized below in Section 6.3.

6.2.2.9 Community Acceptance

CERCLA provides that final remedy selection will consider public comment on the remedial alternatives.

Community acceptance of alternatives will be evaluated after the public comment period ends, and will be described in the ROD for the Site.

6.2.2.10 Summary of Alternative 13M

Based on the analyses discussed above in Sections 6.2.2.1; 6.2.2.2; 6.2.2.3; and 6.2.2.5; Alternative 13M would not satisfy all the CERCLA criteria for selection of a permanent remedy.

6.2.3 Alternative 14

This section describes the Agencies' evaluation of Alternative 14 using the CERCLA remedy selection criteria.

6.2.3.1 Overall Protection of Human Health and the Environment

Risks to humans from soil, tailings, and waste rock that exceed human health risk-based criteria would be addressed under Alternative 14 by capping the material in place or moving the material and then capping it to prevent exposure in these areas: Tailings Piles 1, 2, and 3; East and West Waste Rock Piles; former Mill Building; Lagoon Area; Maintenance Yard; a portion of the Lower West

[63] Costs are shown in 2010 dollars, rounded to three significant figures.

Area; a portion of the Ballfield Area; and the Surface Water Retention Area. Human health risks in the Honeymoon Heights Waste Rock Piles, and the areas downslope of Honeymoon Heights would be addressed by institutional controls and access restrictions.

Groundwater at the Site that exceeds drinking water criteria is not currently used as drinking water sources and surface water does not currently exceed drinking water standards. However, any potential future use of groundwater and surface water that exceeds human health risk-based criteria would be restricted by institutional controls.

Safety to residents and visitors would be addressed by implementing and maintaining mine access restrictions.

Risks to terrestrial organisms from soil, tailings, and waste rock that exceed proposed terrestrial ecological risk-based cleanup levels would be addressed by capping the material in place or moving it and then capping to prevent exposure in these areas: Tailings Piles 1, 2, and 3; East and West Waste Rock Piles; former Mill Building; Lagoon Area; a portion of the Lower West Area; a portion of the Ballfield Area; Maintenance Yard; and Surface Water Retention Area. Risks from materials in other areas (e.g., Holden Village; a portion of the Lower West Area; Wind-Blown Tailings Area; a portion of the Ballfield Area; the Honeymoon Heights Waste Rock Piles; and the DSHH) would be addressed by *in situ* treatment such as pH adjustment, monitoring, and possible future removal, capping, or treatment if land use changes.

To protect aquatic organisms, contaminant inputs from groundwater (including groundwater base flow, seeps and mine drainage) would be intercepted and treated before discharge to surface water, thereby reducing concentrations in Railroad Creek and the Copper Creek Diversion to levels protective of aquatic life. Mine air flow restrictions and capping of sources would help to reduce contaminant loading to the treatment system.

Sediment release and aquatic habitat disturbance from potential failure of the tailings pile and waste rock slopes would be prevented by regrading, constructing stabilizing berms where needed, and protecting from erosion and scour.

Risks to aquatic organisms from exposure to ferricrete in Railroad Creek would be addressed by rerouting the creek. Sediment in Railroad Creek and Lake Chelan at the Lucerne Bar would be monitored to confirm that risks to benthic macroinvertebrates remain low and decrease over time with continued natural deposition of clean sediment.

In summary, Alternative 14 is anticipated to be protective of human health and the environment, which satisfies the first CERCLA threshold criteria for selection of a remedy.

6.2.3.2 Compliance with Potential Applicable or Relevant and Appropriate Requirements (ARARs)

ARARs and TBC criteria were discussed above in Section 2.2, and Appendix F.

6.2.3.2.1 Potential Chemical-Specific Requirements for Surface Water

Alternative 14 addresses all identified, existing sources of hazardous substance releases into surface waters through containment, collection, and treatment. Thus, the alternative is expected to satisfy potential chemical-specific ARARs for surface water, including the NWQC, National Toxics Rule, Maximum Contaminant Levels, Washington State Drinking Water Standards, Washington State Water Quality Standards for Surface Water, and MTCA, which are described in Appendix F.

Alternative 14 includes design and operation of two groundwater treatment plants that may be operated in series or in parallel to treat flows from different portions of the Site to meet discharge limits, which could include a mixing zone, if approved.

6.2.3.2.2 Potential Chemical-Specific Requirements for Groundwater

Alternative 14 would contain and provide active measures to collect and treat all identified groundwater sources that exceed proposed surface water cleanup levels and that would otherwise enter Railroad or Copper Creeks. Alternative 14 would rely on groundwater barriers, which are a proven technology for the containment of contaminated groundwater within the WMAs (e.g., below waste piles that are left in place; see Appendix C of the SFS). By using such barriers, Alternative 14 would provide source control to the maximum extent practicable, which is one of the requirements to enable the cleanup to rely on a conditional point of compliance for groundwater under MTCA. Groundwater downgradient of the containment barrier is anticipated to meet potential chemical-specific ARARs following construction of the barrier around the source areas, based on experience at other sites that is described in Appendix C of the SFS.

Human exposure to groundwater above drinking water standards (e.g., MCLs) at the Site would be prevented through institutional controls. Groundwater outside designated WMAs would begin to be cleaned up immediately following implementation of containment measures. However, it would be technically impracticable to meet drinking water standards within areas designated as WMAs (i.e., the main tailings and waste rock piles and the Lower West Area) within a reasonable restoration time frame. Therefore, in these areas, the Agencies may need to consider a waiver of groundwater ARARs under CERCLA.

In summary, groundwater containment would allow chemical-specific ARARs to be satisfied outside of the WMAs. Within the WMAs, institutional controls would protect human health, but chemical-specific ARARs would not be met and a waiver of these ARARs may be required.

6.2.3.2.3 Potential Chemical-Specific Requirements for Soil

Soil exceeding proposed cleanup levels would be addressed under Alternative 14 through a combination of removal, containment, *in situ* treatment (pH adjustment), monitoring, and institutional controls to comply with ARARs for protection of human health, terrestrial receptors, and surface water under MTCA, as described above in Section 5.3.1. Where such action is not compatible with existing highly valued habitat, the Agencies would waive the soil cleanup level ARAR where greater harm would be caused by taking action. Such an ARAR waiver would occur through an ESD or ROD Amendment.

6.2.3.2.4 Potential Chemical-Specific Requirements for Sediment

Sediment would be isolated (e.g., ferricrete in Railroad Creek) and monitored downstream from the relocated stream section and in Lake Chelan at the Lucerne Bar. These actions are expected to comply with ARARs.

As presented in Section 2.3.3.1.4 of the SFS, no chemical-specific ARARs have been proposed for sediments at the Site. Alternative 14 includes elimination of the release of hazardous substances to sediments in Railroad Creek and sediment monitoring to determine whether further sediment clean up would be required to protect aquatic organisms and to satisfy potential TBC criteria (e.g., US Army Corps of Engineers et al. 2006 and Chapter 173-204 WAC).

6.2.3.2.5 Potential Action- and Location-Specific Requirements

Alternative 14 would comply with cleanup standards in AOIs where active remedial measures (including *in situ* treatment) are accomplished. The design of *in situ* treatment would need to be further evaluated during remedial design. The combination of *in situ* treatment, where feasible, and monitoring, would comply with cleanup standards.[64] Therefore, Alternative 14 complies with potential action-specific ARARs, including MTCA and the state's limited purpose landfill standards, and location-specific ARARS such as the National Forest Management Act (NFMA) and the Land and Resource Management Plan for Wenatchee National Forest (LRMP) as amended.[65] Potential action- and location-specific ARARs are discussed in section 2.3.3 of the SFS.

Monitoring during and after implementation would be used to assess compliance, as required under both CERCLA and MTCA.

6.2.3.2.6 Summary of Compliance with Potential ARARs

As presented in Sections 6.2.3.2.1 through 6.2.3.2.5, Alternative 14 is anticipated to comply with all potential ARARs, which satisfies the second CERCLA threshold criteria for selection of a remedy.

6.2.3.3 Long-Term Effectiveness and Permanence

6.2.3.3.1 Magnitude of Residual Risk Remaining at the Conclusion of the Remedial Activities

Risks to human health from exposure to groundwater would be reduced under Alternative 14 through institutional controls.

Risks to human health from exposure to soil, tailings, and waste rock above proposed cleanup levels would be reduced under Alternative 14 through a combination of institutional controls, capping, and consolidation.

Alternative 14 includes permanent containment, collection, and treatment of all identified sources of groundwater that exceed proposed cleanup levels.

Alternative 14 includes construction of toe buttresses along with regrading portions of the slopes of the three tailings piles to address the risk of seismic slope failures or surficial erosion of the tailings piles. These actions, along with

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[64] *In situ* soil treatment may be a long-term process that involves repeated applications of agricultural lime or a comparable product to adjust soil pH at regular intervals. In the event of future land use changes, such as a significant forest fire, alternate measures might be implemented if monitoring indicates it is appropriate.

[65] Mitigation to address adverse impacts such as permanent destruction of habitat, temporary disturbance of habitat during construction, visual impacts, etc., would be implemented as required by the Forest Plan. In the event mitigation would not satisfactorily address requirements of the Forest Plan, the Forest Service may amend the Forest Plan or portions of this ARAR could be waived under CERCLA.

relocating Railroad Creek, would reduce the risk of slope failures due to scour that could undermine the toe of the tailings piles, or flooding that could overtop the existing riprap. Alternative 14 would mitigate the residual risk of erosion or large-scale slope failures that could release substantial volumes of tailings with hazardous substances above proposed cleanup levels directly into Railroad Creek and, ultimately, Lake Chelan.

Closure of the tailings and waste rock piles in conformance with state landfill regulations and other ARARs would reduce the risk of exposure to humans and terrestrial ecological receptors. Other areas of the Site with soil concentrations above proposed cleanup levels would be consolidated and capped as part of the tailings and waste rock piles, or capped in place to protect terrestrial receptors and prevent infiltration, including the former Mill Building, Maintenance Yard, a portion of the Ballfield Area, Surface Water Retention Area, Lagoon and a portion of the Lower West Area.

Alternative 14 would also address risk to terrestrial receptors in other areas of the Site through *in situ* treatment where soil exceeds proposed terrestrial ecological risk-based cleanup levels. These areas include the Honeymoon Heights Waste Rock Piles, DSHH, Holden Village, the Wind-Blown Tailings area, a portion of the Ballfield Area and a portion of the Lower West Area.

Alternative 14, along with Alternatives 11M and 13M, could result in some increased long-term risks to human health and the environment associated with the operation and maintenance of the remedy itself. These could include risks related to air emissions from a diesel generator to supply power to the water treatment plants, if hydroelectric or other alternate sources of power are unavailable or insufficient. Other risks could involve increased vehicle emissions and potential contamination of soil, groundwater, or surface water from leaks or spills of diesel fuel, lime, or other chemicals while being transported to the Site or during routine use.[66] Such risks would be minimized through appropriate design (e.g., emission controls on the generator) and implementation of best management practices (BMPs) for transportation and handling of fuel, lime, and chemicals.

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[66] If all the electricity were obtained from a diesel generator (instead of hydroelectric or other alternative sources) Alternative 14 is anticipated to require about 8,850 gallons per year of diesel compared to 12,000 gallons per year for Alternative 13M, and 34,700 gallons per year for Alternative 11M, based on the evaluations discussed in Appendix A. The Agencies have expressed a preference for hydroelectric power to avoid negative environmental consequences of the use of diesel fuel, consistent with TBCs. Risks related to fuel use would be reduced for all Alternatives if a hydroelectric source of power is successfully developed as desired.

6.2.3.3.2 Adequacy and Reliability of Controls

To assess the adequacy and reliability of controls at the Site, items to be addressed under CERCLA include: 1) uncertainties associated with land disposal of treatment system residuals; 2) the potential need to replace technical components of the remedy; and 3) the potential risk if components of the remedy need to be replaced.

Sludge from the water treatment systems would be the primary treatment system residual requiring land disposal under this alternative. Under Alternative 14, water treatment system sludge would be disposed of in a lined on-site landfill designed and constructed for this purpose. The Agencies consider there to be a low level of uncertainty associated with this approach related to adequacy and reliability of controls, although the potential use of an unlined sludge disposal facility, possibly on Tailings Pile 1 (i.e., within a groundwater containment area) could be further evaluated for Alternative 14, as proposed by Intalco for Alternative 13M.

Technical components of Alternative 14 that are subject to replacement or significant maintenance are the water treatment and associated collection system, caps on tailings and waste rock piles (especially the slopes of these landfills), and stream bank protection including the rerouted channel of Railroad Creek. All of these components involve conventional construction or industrial means and methods and, thus, are considered to be readily able to be replaced, maintained, and repaired as required.

Unanticipated failure of a remedial system component could result in an uncontrolled release of contaminated water or soil (including tailings) to surface water. Such a failure could conceivably have an acute impact on aquatic life within Railroad Creek if the hazardous substance concentrations were high enough. However, an accidental release caused by a short-term failure of a remedy component under Alternative 14 is anticipated to have significantly less effect than the existing ongoing releases. Planned maintenance and periodic replacement of components in accordance with an approved maintenance plan for the groundwater collection, conveyance, and treatment systems would typically minimize or avoid shutting down the remediation system.

Based on the analysis described above, Alternative 14 includes sufficiently adequate and reliable controls to provide long-term protection of the environment.

6.2.2.3.3 Summary of Long-Term Effectiveness and Permanence

Based on the analysis discussed above, Alternative 14 is anticipated to provide acceptable long-term effectiveness and permanence for selection as a remedy.

6.2.3.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 14 would use active water treatment to reduce the toxicity of hazardous substances in groundwater (including seeps and mine portal drainage) that discharge to surface water. Hazardous substances would be immobilized in the treatment sludge, which would be landfilled on site.

Alternative 14 would use active treatment to reduce the toxicity and mobility of an estimated average of 620 million gallons of contaminated water per year. Alternative 14 would include removing approximately 10.6 million gallons of sludge from the east and west treatment plants during the first year of operation, and this volume would decrease over time as indicated in Table D4 of the DFFS and discussed in Appendix F of the SFS.

Alternative 14 is anticipated to reduce toxicity, mobility and volume of hazardous substances from the overall Site, to the degree necessary to be selected as a permanent remedy.

6.2.3.5 Short-Term Effectiveness

6.2.3.5.1 Short-Term Risks to the Community During Implementation

Short-term human health risks to the local community during implementation of Alternative 14 primarily consist of increased exposure to construction traffic. Potential exposure to construction dust, noise, and vehicle exhaust emissions is not anticipated to present risks to the Holden Village community or other members of the public using the adjacent forest lands.

Short-term risks to the local community due to implementation of Alternative 14 can be adequately mitigated through active measures taken during construction. This would include a traffic control plan for joint use of the Lucerne-Holden Road by construction traffic, the Agencies, visitors to the National Forest, and the Holden Village community.

6.2.3.5.2 Potential Impacts on Workers during the Remedial Action and the Effectiveness and Reliability of Mitigative Measures During Implementation

Short-term human health risks from implementation of Alternative 14 primarily include construction safety and potential longer-term risks associated with operation of the treatment facility.

Human health risks to construction workers during remedy implementation include the following: underground mine hazards; construction traffic; exposure to soils with elevated concentrations of hazardous substances and TPH; exposure to noise and dust; and exposure to demolition activities and debris due to removal of the derelict mill structure. Additional risks would be related to construction activities associated with regrading, barrier wall construction, ditch excavations, and treatment plant construction (e.g., open excavations, heavy equipment operations). There is also some risk to workers associated with handling caustic chemicals used in treatment system operations.

Construction activities will need to adhere to applicable OSHA, L&I, and, potentially, MSHA regulations. Construction workers will be required to have HAZWOPER training. Dust concerns would be managed through BMPs.

6.2.3.5.3 Potential Environmental Impacts of the Remedial Action and the Effectiveness and Reliability of Mitigative Measures during Implementation

Potential environmental impacts of the remedial action include the following:

1. Risk of a tailings release to Railroad or Copper Creeks due to slope failures or stormwater runoff during regrading;
2. Risk of bentonite or cement releases to the creeks during barrier wall construction;
3. Risks associated with construction of hydraulic barriers in the underground mine;
4. Risk of sediment release to the creeks during construction of groundwater and seep collection components, and use of temporary stream crossings during construction;
5. Risk to humans and the environment from construction vehicle emissions, noise, and dust;
6. Risk of fuel spills, especially if hydroelectric power is unavailable or insufficient;

7. Risk of surface water quality exceedances during and after startup of the treatment plant; and
8. A net permanent loss of habitat in the area along the new Railroad Creek channel and in the areas where the groundwater treatment facilities will be located. The areas impacted by the proposed Alternative 14 treatment systems include the riparian forest area where the west treatment system would be located, and the wetlands where the east treatment facilities would be located. Implementation of Alternative 14 will require mitigation for the loss of the wetlands and riparian forest in order to comply with the Forest Plan and other ARARs.[67] [68]

Mitigation for constructing the groundwater treatment facility within the existing wetlands will need to be addressed during remedial design. Mitigation could include, for example, expansion or enhancement of existing riparian wetlands along Railroad Creek (see Figure 4, for example), creation of wetlands as part of cleanup in the Lower West Area, and/or expansion or enhancement of wetlands in other areas (for example, see Hart Crowser 2005).

There will also be additional short-term habitat loss or degradation in other areas where active remedial measures are implemented, such as along a temporary access road to the Surface Water Retention Area, and other areas disturbed for construction.

Alternative 14 includes rerouting Railroad Creek away from the toe of the tailings, regrading the tailings pile slopes, constructing buttresses to increase slope stability, as well as placing riprap along the new creek channel to mitigate potential future flood impacts. Mitigative measures for potential tailings and sediment releases include construction BMPs such as sediment fencing and barriers, which could be advanced along the edge of the creek as the Lower West Area/Tailings Pile 1 barrier is constructed, and adjacent to construction of the new creek channel upslope of the existing Railroad Creek channel.

In addition, all areas disturbed during construction would be promptly revegetated in compliance with ARARs to limit soil loss and surface water impacts, restore habitat, and to control the establishment of noxious weeds.

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[67] There may also be other areas where there would be permanent disturbance due to implementation of Alternative 14, such as along the surface water diversions upslope of the tailings and waste rock piles. It is not possible to precisely quantify such impacts prior to remedial design, but it is also likely these incidental impacts are similar from one alternative to another. Such impacts can, however, be addressed under the NRDA for the Site.

[68] Compensation for these areas will also be required for NRD.

The risk of fuel spills or bentonite or cement releases would be mitigated through an SPCC Plan implemented for construction, and adherence to regulations regarding storage, transportation, and dispensing of fuel.

6.2.3.5.4 Time Until Protection is Achieved

Alternative 14 would immediately protect human health and is anticipated to be protective of the environment at the time the remedy is implemented.

6.2.3.5.5 Summary of Short-Term Effectiveness

Based on the analysis discussed above, Alternative 14 is anticipated to provide acceptable short-term effectiveness for selection as a remedy. As with other remedial alternatives, some long-term adverse impacts would result from the construction of the groundwater treatment facilities and other permanent impacts that would need to be addressed through SEPA mitigation under ARARs such as the Forest Plan, SEPA, and the Clean Water Act.

6.2.3.6 Implementability

This section describes the CERCLA evaluation of the implementability of Alternative 14, based on consideration of its technical feasibility, administrative feasibility, and the availability of needed services and materials.

6.2.3.6.1 Technical Feasibility

Alternative 14 is technically feasible. The remedy could be implemented using conventional construction equipment and techniques.

The proposed groundwater treatment system may need to be augmented beyond simple lime addition and precipitation in order for the effluent to meet criteria for discharge to surface water. The final treatment system design needs to be based on treatability tests (such as are now underway, and/or as part of remedial design), and could require modification to enhance treatment as discussed in Appendix F of the SFS. Reported experience of other comparable systems is discussed in Appendix F of the SFS and Appendix H of ERM and URS (2009a). The ease of undertaking additional remedial measures varies, depending on the measures that might be needed. However, the proposed treatment system would not preclude potential additional measures.

Like Alternatives 11M and 13M, the feasibility of operating the groundwater collection and conveyance system year-round may be limited by seasonal freezing or iron fouling of ditches used for collection and conveyance of groundwater, conveyance piping, pumps, and treatment facility components. If Alternative 14 is selected, the performance of the ditch system used for collection and conveyance, and its susceptibility to freezing or other problems should be further evaluated during remedial design to determine whether an alternative approach, such as the seep collection system proposed for Alternative 9, would be more effective.

6.2.3.6.2 Administrative Feasibility

Alternative 14 is administratively feasible.

The land affected by the remedy is under the control of the Forest Service, except for patented mine claims that are owned by Holden Village, Inc. The Agencies anticipate that the remedy will include access and institutional controls on lands owned by Holden Village, Inc.

No wastes are anticipated to be moved off the Site for disposal, with the possible exception of residual processing wastes, which may be designated as state Dangerous Waste, or asbestos encountered during cleanup of the former Mill Building. The potential need for off-site disposal of such wastes does not affect the feasibility of Alternative 14.

6.2.3.6.3 Availability of Services and Materials

The technologies required for each of the components in Alternative 14 are known and proven technologies. The Agencies anticipate that there will be companies willing to do this work and that the contractors bidding for this work will be experienced in the technologies required for the alternative. Alternative 14 would utilize conventional construction means and methods that are readily available in Washington State. The Agencies do not expect there would be any shortage of contractors in the region who are capable and interested in taking on this work; it is also likely that a remediation project of this scale would attract bidders from outside the region. Despite the Site’s remote geographic location, necessary equipment could be moved to the Site for construction of Alternative 14.

6.2.3.6.4 Summary of Implementability

Based on the analysis discussed above, Alternative 14 would satisfy the remedy selection criterion for implementability.

6.2.3.7 Cost

CERCLA requires that an alternative selected as a cleanup action shall be cost-effective, provided that it first satisfies the threshold criteria. The Agencies' detailed cost estimate is presented in Appendix A. The table below summarizes the Agencies' estimate.

Alternative 14 [69]	
Estimated Capital Cost	$76,100,000
Net Present Value of Long-Term Operations, Maintenance and Monitoring	$30,700,000
Total Estimated Cost:	$107,000,000

Additional information on estimated costs is presented in Appendix A.

6.2.3.8 State Acceptance

Ecology has participated with the lead Agency in evaluating remedy alternatives for the Site. The state's evaluation of Alternative 14 under MTCA is summarized below in Section 6.3.

6.2.3.9 Community Acceptance

CERCLA provides that final remedy selection will consider public comment on the remedial alternatives.

Community acceptance of alternatives will be evaluated after the public comment period ends, and will be described in the ROD for the Site.

6.2.3.10 Summary of Alternative 14

Based on the analyses discussed above, Alternative 14 would satisfy all the CERCLA criteria for selection of a permanent remedy.

6.3 Detailed Analysis of Alternatives 11M, 13M, and 14 Under MTCA

This section describes how the three alternatives conform to MTCA criteria for selection of a permanent remedy (WAC 173-340-360).

[69] Costs are shown in 2010 dollars, rounded to three significant figures.

6.3.1 Analysis of Alternative 11M Under MTCA

6.3.1.1 Threshold Requirements

There are seven requirements to be evaluated for selecting a final remedy under MTCA [WAC 170-340-360]. The first four requirements make up the threshold requirements, which require that the remedy: 1) protect human health and the environment; 2) comply with cleanup standards; 3) comply with applicable state and federal laws; and 4) provide for compliance monitoring.

Protect Human Health and the Environment. For the same reasons that Alternative 11M provides for "overall protection of human health and the environment" under CERCLA (see Section 6.2.1.1), Alternative 11M satisfies the MTCA requirement that the remedy protect human health and the environment.

Comply with Cleanup Standards. Cleanup standards, under MTCA, refer to the proposed cleanup levels based on potential chemical-specific ARARs; the location(s) where these cleanup levels must be met (points of compliance); and other regulatory requirements that must be met because of the type of action and/or location of the Site (potential action-specific and location-specific ARARs). MTCA requires that for a cleanup action to meet the requirements for a groundwater conditional point of compliance, groundwater discharges need to be provided with all known, available, and reasonable methods of treatment (AKART) before being released to surface waters [WAC 173-340-720(8)(d)(i)]. Alternative 11M does constitute AKART, and thus a conditional point of compliance along the groundwater-surface water interface of Railroad and Copper Creeks could be approved by Ecology for Alternative 11M.

The Agencies believe that Alternative 11M will satisfy cleanup standards under MTCA. The fully penetrating barrier extending along Railroad Creek will contain all of the identified sources of groundwater above proposed cleanup levels that would otherwise enter Railroad Creek. Groundwater downgradient of the barrier is anticipated to meet proposed cleanup levels at the conditional point of compliance at the interface between the groundwater and Railroad Creek.

Comply with State and Federal Law. As discussed with respect to CERCLA (see Section 6.2.1.2), Alternative 11M is anticipated to comply with federal environmental laws and state environmental and facility siting laws.

Provide for Compliance Monitoring. The SFS included a Conceptual Monitoring Plan (Appendix H) that the Agencies believe could be modified to be applicable to any alternative selected as the permanent remedy. Thus, Alternative 11 M would include compliance monitoring as required under

MTCA. Final details of monitoring would be established as part of a Sampling and Analysis Plan approved by the Agencies, which would be developed during remedial design.

In summary, Alternative 11M would satisfy the MTCA Threshold Requirements for selection of a permanent remedy as described in the preceding paragraphs.

6.3.1.2 MTCA Other Requirements

Other requirements that must be evaluated under MTCA for remedy selection include: 5) use permanent solutions to the maximum extent practicable; 6) provide a reasonable restoration time frame; and 7) consider public concerns.

Use of Permanent Solutions to the Maximum Extent Practicable. Alternative 11M uses permanent solutions. Alternative 11M provides for active collection and treatment of the Portal discharge and groundwater immediately adjacent to the groundwater-surface water interface, for all identified sources that discharge into Railroad Creek (e.g., the Lower West Area and Tailings Piles 1, 2, and 3). Alternative 11M would immediately and permanently reduce the magnitude of seep and groundwater flow containing excess metals concentrations into Railroad Creek; thus, it would immediately reduce toxicity to aquatic life.

Alternative 11M also includes regrading and pulling back the toe of the three tailings piles away from Railroad and Copper Creeks. Thus, Alternative 11M provides significant reduction in risk of erosion or large-scale slope failures that could release reactive tailings into Railroad and Copper Creeks. However, Alternative 11M includes capping the tailings and waste rock piles with a cover that incorporates a geomembrane in order to satisfy the presumptive closure requirements for limited purpose landfills [WAC 173-350-400], and this cap may not be permanent to the maximum extent practicable.

One of the limitations of the proposed cap for Alternative 11M is that it will require long-term maintenance to remain impermeable. Although caps of this sort are commonly considered for permanent closure of landfills, the geomembrane must be protected from the effects of burrowing wildlife and root penetration from vegetation on the cap. Typically, this requires annual mowing or spraying to promote preferred types of vegetative cover, but sometimes includes armoring with a rock cover layer, or other control measures. Where there are alternative approaches to capping that are equally effective and do not require such maintenance, a remedy like Alternative 11M may not be considered permanent to the maximum extent practicable.

As described in section 6.5.2.1, Alternative 11M does not use permanent solutions to the same extent as Alternative 14.

Provide for a Reasonable Restoration Time Frame. Alternative 11M provides for a reasonable restoration time frame for the Site. Alternative 11M will contain all the groundwater that exceeds proposed cleanup levels, so surface water quality will immediately improve at the point of compliance. This alternative would also quickly achieve soil cleanup at the Honeymoon Heights Waste Rock Piles and the DSHH area, but at the cost of eliminating existing, minimally-impacted habitat in the DSHH area. Alternative 11M would cause long-term habitat damage to the estimated 70 acre area downslope of the Honeymoon Heights access road that would need to be constructed to remove waste rock and impacted soils. For Honeymoon Heights and other impacted soil areas, Alternative 14 uses *in situ* treatment; this could take several years to achieve protection from the hazardous substances, but without the long-term damage associated with removal of the waste rock and impacted soils at Honeymoon Heights.

Consider Public Concerns. Public concerns will be addressed as part of selecting and implementing the final cleanup action in accordance with WAC 163-340-600(14) and (15).

In summary, Alternative 11M would satisfy the MTCA's Other Requirements for selection of a permanent remedy as described in the preceding paragraphs.

6.3.1.3 MTCA Action-Specific Requirements

Finally, MTCA has additional remedy selection requirements that apply specifically to cleanup actions that include groundwater cleanup actions; institutional controls; releases and migration; and dilution and dispersion.

Non-Permanent Groundwater Cleanup Actions. Since a permanent groundwater cleanup is not practicable, MTCA provides additional requirements for non-permanent cleanup actions [WAC 173-340-360(2)(c)(ii)]. As previously detailed, Alternative 11M includes the removal of some sources and the containment of other sources through capping. Alternative 11M includes groundwater containment to the maximum extent practicable to avoid lateral and vertical expansion of the groundwater affected by the hazardous substances. As a result, Alternative 11M meets the MTCA requirements for a non-permanent groundwater cleanup action [WAC 173-340-360(2)(c)(ii)].

Cleanup of Soils for Residential and School Areas. The DRI indicated that existing soil concentrations in Holden Village do not exceed human health criteria; thus, the MTCA requirement [WAC 173-340-360(2)(d)] for soil cleanup would not require action within the Village. MTCA requires that soils with hazardous substance concentrations that exceed soil cleanup levels must be treated, removed, or contained. Institutional controls and engineering measures (e.g., capping of tailings) on the remainder of the Site would be implemented under Alternative 11M to protect residential areas, schools, or childcare centers in Holden Village.

Institutional Controls. Alternative 11M satisfies requirements for institutional controls to protect human health that are specified in WAC 173-340-440. Alternative 11M does not rely primarily on institutional controls and monitoring where it is technically possible to implement a more permanent cleanup action.

Releases and Migration/Dilution and Dispersion. Alternative 11M would prevent or minimize existing and future releases and migration of hazardous substances through the use of: 1) a permanent groundwater containment barrier; 2) collection and treatment of all identified sources of groundwater contaminated with hazardous substances; 3) permanent capping to protect the tailings and waste rock piles from erosion and slope failures; and 4) removal or capping of areas with hazardous substances above proposed cleanup levels. Alternative 11M does not rely primarily on dilution and dispersion to cleanup groundwater and surface water above proposed cleanup levels. Rather, Alternative 11M uses active remedial measures to the maximum extent practicable to contain, collect, and treat groundwater and surface seeps above proposed cleanup levels.

Remediation Levels. Remediation levels are not proposed for Alternative 11M.

In summary, Alternative 11M would satisfy the MTCA Action-Specific Requirements for selection of a permanent remedy as described in the preceding paragraphs.

6.3.2 Analysis of Alternative 13M Under MTCA

6.3.2.1 Threshold Requirements

The threshold requirements under MTCA require that a remedy: 1) protect human health and the environment; 2) comply with cleanup standards; 3) comply with applicable state and federal laws; and 4) provide for compliance monitoring.

Protect Human Health and the Environment. For the same reasons that Alternative 13M may not provide for "overall protection of human health and the environment" under CERCLA (see Section 6.2.2.1 above), Alternative 13M does not satisfy MTCA's requirement that the remedy protect human health and the environment. Alternative 13M would be protective of human health but is not sufficiently protective of environmental receptors.

Comply with Cleanup Standards. Cleanup standards, under MTCA, refers to the proposed cleanup levels, the location(s) where these cleanup levels must be met (points of compliance), and other regulatory requirements that must be met because of the type of action and/or location of the Site (potential action-specific and location-specific ARARs). Soil cleanup to protect groundwater is required whenever soils exceed criteria and are not within a groundwater containment area. MTCA also requires that for a cleanup action to qualify for a groundwater conditional point of compliance, groundwater discharges must receive all known available and reasonable methods of treatment (AKART) before release to surface water. Alternative 13M does not constitute AKART, because it does not include containment of groundwater downstream of Tailings Piles 2 and 3. As a result, Ecology would not approve a conditional point of compliance along the groundwater-surface water interface of Railroad Creek for Alternative 13M. The Agencies conclude that Alternative 13M does not satisfy cleanup standards under MTCA.

Comply with State and Federal Law. As discussed with respect to CERCLA (see Section 6.2.2.2), Alternative 13M would not comply with all ARARs (i.e., federal and state environmental laws such as the NWQC, Washington State Water Quality Standards for Surface Water, and MTCA).

Provide for Compliance Monitoring. Although Intalco did not provide details of a monitoring plan for Alternative 13M, the Agencies believe that Alternative 13M could satisfy compliance monitoring requirements as part of a Sampling and Analysis Plan developed during remedial design and approved by the Agencies.

In summary, Alternative 13M would not satisfy the MTCA Threshold Requirements for selection of a permanent remedy as described in the preceding paragraphs.

6.3.2.2 MTCA Other Requirements

Other requirements that must be evaluated under MTCA for remedy selection include: 5) use permanent solutions to the maximum extent practicable; 6) provide a reasonable restoration time frame; and 7) consider public concerns.

Use of Permanent Solutions to the Maximum Extent Practicable. The Agencies do not conclude that Alternative 13M uses permanent solutions to the maximum extent practicable because, as stated above, there is uncertainty about whether proposed cleanup levels based on protection of surface water would be met in groundwater before the groundwater enters Railroad Creek downstream of Tailings Piles 2 and 3 without the barrier wall. In addition, Alternative 13M does not address soils above proposed terrestrial ecological risk-based cleanup levels in some AOIs including the Honeymoon Heights Waste Rock Piles, DSHH, Ballfield Area, Lower West Area, Holden Village, and the Wind-Blown Tailings Area.

Provide for a Reasonable Restoration Time Frame. Alternative 13M would not provide for a reasonable restoration time frame for the Site because Intalco has not adequately demonstrated that this alternative will achieve proposed cleanup levels in all areas of the Site. This includes groundwater discharging to surface water downstream of Tailings Piles 2 and 3 (see Figure 8) and soils above proposed cleanup levels in the AOIs noted in the preceding paragraph.

Consider Public Concerns. Public concerns will be addressed as part of selecting and implementing the final cleanup action in accordance with WAC 173-340-600(14) and (15).

In summary, Alternative 13M would not satisfy the MTCA's Other Requirements for selection of a permanent remedy as described in the preceding paragraphs.

6.3.2.3 MTCA Action-Specific Requirements

Non-Permanent Groundwater Cleanup Actions. Since a permanent groundwater cleanup is not practicable throughout the entire Site within a reasonable restoration time frame, Alternative 13M would need to meet MTCA's requirements for non-permanent cleanup actions [WAC 173-340-360(2)(c)(ii)]. Although Alternative 13M includes the removal of some sources and the containment of other sources through capping, Alternative 13M may not constitute groundwater containment to the maximum extent practicable (e.g., downgradient of Tailings Piles 2 and 3). As a result, Alternative 13M may not prevent lateral and vertical expansion of the groundwater plume affected by the hazardous substances. Intalco's 2008 and 2009 monitoring well observations do not demonstrate that contaminated groundwater does not enter Railroad Creek downstream of Tailings Piles 2 and 3. Furthermore, the monitoring accomplished to date by Intalco is not consistent enough to demonstrate that groundwater above proposed cleanup levels does not enter Railroad Creek adjacent to Tailing Piles 2 and 3 (e.g., seeps SP-3 and SP-4). Observations in 2008 and 2009 are not entirely consistent with earlier observations, and have not been examined statistically in such away as indicate with reasonable certainty where this water later enters Railroad Creek or at what concentrations. Groundwater modeling accomplished to date is calibrated with limited observations, and thus does not provide additional certainty (Forest Service 2010a).

Cleanup of Soils for Residential and School Areas. Although RI data indicate that soil concentrations in Holden Village do not exceed human health criteria, the MTCA requirement [WAC 173-340-360(2)(d)] for soil cleanup to protect human health requires action elsewhere within the Site to protect residential and school areas within the Village from exposure to windblown dust from the tailings and other areas with soils above proposed cleanup levels. Alternative 13M includes institutional controls and engineering measures in some AOIs (e.g., capping of tailings to prevent wind-blown dispersion) to protect residential areas, schools, or childcare centers. Although Alternative 13M does not include any actions to remediate soils above proposed direct contact and ingestion-based cleanup levels in the Lower West Area, it is unlikely that this area is a significant source of wind-blown dust. Instead of cleanup to protect human health in this AOI, Alternative 13M would rely solely on institutional controls.

Institutional Controls. Alternative 13M includes institutional controls to protect human health including prevention of groundwater consumption, and protection of remedy components over time.

Alternative 13M relies on institutional controls instead of more permanent cleanup actions for groundwater impacted by hazardous substances released from Tailings Piles 2 and 3.[70] Alternative 13M also relies on institutional controls to protect human health from soils that contain hazardous substance concentrations above concentrations protective of the direct contact and/or ingestion pathway for soils in the Honeymoon Heights Waste Rock Piles, DSHH, and the Lower West Area AOIs.

Releases and Migration/Dilution and Dispersion. It appears that Alternative 13M relies on dilution and dispersion to clean up groundwater east of Tailings Pile 3 to prevent discharge to surface water exceeding proposed cleanup levels. Although Intalco has suggested that natural attenuation is occurring

[70] Alternative 13M does not include groundwater containment around Tailings Piles 2 and 3, thus Alternative 13M relies on institutional controls and monitoring where it is technically possible to implement a more permanent cleanup action. [WAC 173-340-360(2)(e)(iii)]. Although groundwater quality data downgradient of TP-3 do not exceed drinking water standards (see Figure 8), these data are limited. There is currently no way to know whether these data are representative of groundwater quality throughout the downgradient plume and over time.

downgradient of the tailings piles, it has not demonstrated the mechanism by which this is occurring, or shown that it will permanently prevent groundwater seepage into Railroad Creek above proposed cleanup levels.

Remediation Levels. Intalco refers to remediation levels (RELs) to address human health risks for copper in the tailings piles, and lead in the East and West Waste Rock Piles, and the Honeymoon Heights Waste Rock Piles, for Alternative 13M, see Appendix F of ERM and URS (2009). However, it appears that these may be more accurately characterized as proposed site-specific human health based cleanup levels. MTCA requires that remedial actions that rely on RELs also satisfy all of the requirements of WAC 173-340-360, which Alternative 13M does not do, as noted above.

In summary, Alternative 13M would not satisfy the MTCA's Action-Specific Requirements for selection of a permanent remedy as described in the preceding paragraphs.

6.3.3 Analysis of Alternative 14 Under MTCA

6.3.3.1 Threshold Requirements

This section describes how Alternative 14 conforms to the threshold requirements under MTCA: 1) protect human health and the environment; 2) comply with cleanup standards; 3) comply with applicable state and federal laws; and 4) provide for compliance monitoring.

Protect Human Health and the Environment. Alternative 14 would provide "overall protection of human health and the environment" for the same reasons presented in Section 6.2.3.1 that Alternative 14 would protect human health and the environment under CERCLA.

Comply with Cleanup Standards. Cleanup standards, under MTCA, refers to the proposed cleanup levels, the location(s) where these cleanup levels must be met (points of compliance), and other regulatory requirements that must be met because of the type of action and/or location of the Site (potential action-specific and location-specific ARARs). Alternative 14 would comply with cleanup standards in AOIs where active remedial measures (including *in situ* treatment) are accomplished. Alternative 14 complies with potential action-specific and location-specific ARARs as described in Section 6.2.3.2.

MTCA requires that for a cleanup action to meet the requirements for a groundwater conditional point of compliance, groundwater discharges need to be provided with all known available and reasonable methods of treatment

(AKART) before being released to surface waters. Alternative 14 does constitute AKART, and thus a conditional point of compliance along the groundwater-surface water interface of Railroad and Copper Creeks could be approved by Ecology for Alternative 14. Ecology concludes that Alternative 14 will satisfy cleanup standards under MTCA.

Comply with State and Federal Law. As discussed with respect to CERCLA in Section 6.2.3.2, Alternative 14 is anticipated to comply with federal environmental laws and state environmental and facility siting laws (ARARs).

Provide for Compliance Monitoring. Alternative 14 would provide for compliance monitoring that would be established as part of a Sampling and Analysis Plan developed during remedial design and approved by the Agencies. The Agencies' Conceptual Monitoring Program for the Holden Site (Appendix H of the SFS) provides the basis for such a sampling and analysis plan.

In summary, Alternative 14 would satisfy the MTCA Threshold Requirements for selection of a permanent remedy as described in the preceding paragraphs.

6.3.3.2 MTCA Other Requirements

Other requirements that must be evaluated under MTCA for remedy selection include: 5) use permanent solutions to the maximum extent practicable; 6) provide a reasonable restoration time frame; and 7) consider public concerns.

Use of Permanent Solutions to the Maximum Extent Practicable. Alternative 14 would use permanent solutions based on the following:

Alternative 14 provides active collection and treatment of groundwater as close as possible to the source, but in no case farther downgradient than the groundwater-surface water interface. Alternative 14 would immediately reduce the magnitude of seep and groundwater flow with excess hazardous substance concentrations into Railroad Creek, thus it would immediately reduce toxicity to aquatic life. Alternative 14 would address all identified sources of groundwater entering Railroad Creek above proposed cleanup levels.

Alternative 14 provides significant reduction in risk of erosion or large-scale slope failures that could release reactive tailings into Railroad and Copper Creeks. Alternative 14 includes capping the tailings and waste rock piles with a cover that satisfies the performance requirements for closure of limited purpose landfills [WAC 173-350-400].

Alternative 14 would use *in situ* treatment to reduce the mobility and bioavailability of hazardous substances in areas that are not amenable to other active cleanup measures. *In situ* treatment of the Honeymoon Heights Waste Rock Piles and DSHH would avoid the long-term habitat destruction that would result from removal or capping the Honeymoon Heights Waste Rock Piles, including the area that would be impacted downslope of a Honeymoon Heights construction access road. *In situ* treatment of the portions of the Lower West Area, portions of the Ballfield Area, and the Wind-Blown Tailings AOIs would avoid destruction of mature conifer and riparian habitat. *In situ* treatment would also address soils with hazardous substances above proposed cleanup levels in Holden Village, without adverse impacts on the Holden Village community and infrastructure. Alternative 14 provides for additional treatment, as needed, in the event that land use changes in these AOIs in such a way as to make them more accessible to other remediation.

As described in Section 6.5.2.1, Alternative 14 uses permanent solutions to the maximum extent practicable when compared to Alternative 11M.

Provide for a Reasonable Restoration Time Frame. Alternative 14 provides for a reasonable restoration time frame for the Site. Surface water quality will immediately improve at the point of compliance by containing all the groundwater above proposed cleanup levels. Alternative 14 will also be protective of human health and reduce risk to potential terrestrial ecological receptors immediately following implementation.

Consider Public Concerns. Public concerns will be addressed as part of selecting and implementing the final cleanup action in accordance with WAC 163-340-600(14) and (15).

In summary, Alternative 14 would satisfy the MTCA Other Requirements for selection of a permanent remedy as described in the preceding paragraphs.

6.3.3.3 MTCA Action-Specific Requirements

Finally, Alternative 14 is compared to the MTCAs additional remedy selection requirements that apply specifically to cleanup actions that include groundwater cleanup actions; institutional controls; releases and migration; and dilution and dispersion.

Non-Permanent Groundwater Cleanup Actions. Since a permanent groundwater cleanup is not practicable, Alternative 14 must meet MTCA's requirements for non-permanent cleanup actions [WAC 173-340-360(2)(c)(ii)]. As previously detailed, Alternative 14 includes the removal of some sources and the containment of other sources through capping. Alternative 14 also includes groundwater containment to the maximum extent practicable to avoid lateral and vertical expansion of the groundwater affected by the hazardous substances. As a result, Alternative 14 meets the MTCA requirements for a non-permanent groundwater cleanup action [WAC 173-340-360(2)(c)(ii)].

Cleanup of Soils for Residential and School Areas. Data in the DRI indicate that soil concentrations in Holden Village do not exceed human health criteria; thus, the MTCA requirement [WAC 173-340-360(2)(d)] for soil cleanup would not require action within the Village. MTCA requires that soils with hazardous substance concentrations that exceed soil cleanup levels must be treated, removed, or contained. Institutional controls, and engineering measures (e.g., capping of tailings to prevent wind-blown dispersion) on the remainder of the Site would be implemented under Alternative 14 to protect residential areas, schools, or childcare centers in Holden Village.

Institutional Controls. Alternative 14 satisfies requirements for institutional controls to protect human health that are specified in WAC 173-340-440. Alternative 14 does not rely primarily on institutional controls and monitoring where it is technically possible to implement a more permanent cleanup action.

Releases and Migration/Dilution and Dispersion. Alternative 14 does not rely primarily on dilution and dispersion to cleanup groundwater and surface water exceeding proposed cleanup levels. Alternative 14 would contain and prevent future releases of hazardous substances through the use of a permanent groundwater containment barrier, and collection and treatment of all identified sources of groundwater contaminated with hazardous substances.

Remediation Levels. Remediation levels are not proposed for Alternative 14.

In summary, Alternative 14 would satisfy the MTCA Action-Specific Requirements for selection of a permanent remedy as described in the preceding paragraphs.

6.4 Comparative Analysis of Alternatives 11M, 13M, and 14 Under CERCLA

This section provides a comparison of Alternatives 11M, 13M, and 14 for each of the nine CERCLA criteria used to select a remedy. While the comparative analysis of each alternative must consider all nine criteria, no alternative can be selected as a final remedy unless it meets the two threshold criteria as specified in 40 CFR § 300.430(f)(1)(i)(A).

Section 6.2 presents a detailed analysis of how each alternative addresses the selection criteria; in contrast, Section 6.4 focuses on the differences between the alternatives in terms of the degree to which they address the selection criteria.

6.4.1 Threshold Criteria

This section provides a comparative evaluation of how the alternatives address the threshold criteria under CERCLA.

6.4.1.1 Overall Protection of Human Health and the Environment

6.4.1.1.1 Overall Protection of Human Health

Alternatives 11M, 13M, and 14 would protect human health.

Under Alternative 14, risks to humans from soils (including the tailings and waste rock in Tailings Piles, East and West Waste Rock Piles), at the former Mill Building, Lagoon, Maintenance Yard, a portion of the Lower West Area, and the Surface Water Retention Area would be addressed by capping the material in place or moving the material and then capping it to prevent exposure. Risks from soil materials in the remainder of the Lower West Area, Honeymoon Heights Waste Rock Piles, and DSHH would be addressed through institutional controls, *in situ* treatment, and access restrictions. Potential future use of impacted groundwater and surface water for drinking would be restricted by institutional controls. In addition, safety to residents and visitors would be addressed through mine access restrictions.

Alternative 13M addresses human-health risk from impacted soils (including soils with hazardous substances that exceed human health-based criteria for protection of groundwater) through a combination of removal, capping, and institutional controls. However, in the Lower West Area where there is also a risk to humans from direct contact or ingestion of soils, Alternative 13M would rely on institutional controls instead of any active cleanup measures.

Alternative 11M would protect human health in the same manner as Alternative 14, except that exposure to waste rock at Honeymoon Heights and soils in the DSHH that exceed proposed direct contact and ingestion-based cleanup levels would be addressed by moving the waste rock and impacted soils to the tailings piles for capping, instead of relying on institutional controls.

6.4.1.1.2 Overall Protection of the Environment

Under Alternative 14, risks to terrestrial organisms from the Tailings Piles, East and West Waste Rock Piles, Mill, Lagoon, Maintenance Yard, a portion of the Lower West Area, a portion of the Ballfield Area, and the Surface Water Retention Area would be addressed by excavation (consolidation) or capping materials with hazardous substances in place to prevent exposure. Risks to terrestrial receptors in other areas (such as the remainder of the Lower West Area, Holden Village, a portion of the Ballfield Area, and the Wind-Blown Tailings Area) would be addressed by *in situ* treatment and monitoring. To protect aquatic organisms, contaminant inputs from groundwater including base flow, seeps and the mine drainage would be intercepted and treated before discharge to surface water. The potential release of hazardous substances into Railroad and Copper Creeks from failure of the tailings pile slopes would be addressed by regrading and buttressing the slopes; and capping and stabilizing the existing and relocated reaches of Railroad Creek. Risks to aquatic organisms from ferricrete would be addressed by rerouting Railroad Creek. Sediment in Railroad Creek and Lake Chelan would be monitored to confirm that risks remain low and decrease over time following implementation of source controls.

Alternative 11M would protect the terrestrial and aquatic environment in a similar manner as Alternative 14, with a few significant differences:

- Under Alternative 11M, protection of Railroad Creek from tailings piles instability would require pulling the toe of the tailings piles back farther from the creeks. During construction, Alternative 11M would have a greater risk of tailings release into Railroad Creek compared to Alternative 14, which would relocate the creek channel prior to regrading the tailings; and

- Under Alternative 11M, exposure to waste rock at Honeymoon Heights and the DSHH would be addressed by moving the material to the tailings piles and capping it instead of through pH adjustment.[71] However, this would result in extensive, probably permanent, damage to 75 acres or more of existing steep slope forest, including some riparian habitat.

Alternatives 11M and 14 differ somewhat in other aspects related to the surface water environment. Alternative 11M would eliminate sources of hazardous

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[71] At the time Alternative 11 was originally developed, Intalco had not characterized the area downslope of the Honeymoon Heights Waste Rock Piles. Since information developed in 2008 and 2009 indicates that soils in this area have concentrations that exceed both human health and ecological protection criteria, Alternative 11M includes soil cleanup in these areas as part of removing the Honeymoon Heights Waste Rock Piles.

substances being released into the wetland east of Tailings Pile 3, and the wetland could be restored. Under Alternative 14, the wetland would become the location of a groundwater treatment facility. This would require mitigation under ARARs such as the Forest Plan and Section 404 of the CWA; and also would need to be addressed as part of natural resource damages.

Alternatives 11M and 14 would both be protective of the aquatic and terrestrial environments.

Like Alternative 14, Alternative 13M would also eliminate some mature riparian forest as part of creek relocation, and the wetland east of Tailings Pile 3 would be destroyed for construction of a groundwater treatment facility. Loss of the riparian forest and wetland would need to be mitigated in order to meet ARARs.[72]

There are significant differences in the way in which Alternative 13M would address the environment compared to Alternatives 14 and 11M.

- Under Alternative 13M, the risk to terrestrial receptors from materials in the Lower West Area, the Ballfield Area, Honeymoon Heights, DSHH, Holden Village, and the Wind-Blown Tailings Area would not be addressed, except by monitoring.

- Alternative 13M would intercept and treat groundwater from some parts of the Site before it enters surface water, and includes the former Railroad Creek channel as the collection system along the northwest side of Tailings Pile 2, but it does not include a barrier wall downgradient of Tailings Piles 2 and 3. Under Alternative 13M, there is considerable uncertainty about whether proposed groundwater cleanup levels, based on protection of surface water, would be met in groundwater before it enters Railroad Creek downstream from Tailings Piles 2 and 3. As discussed above, however, the barrier wall included in Alternative 14 to address this concern may not need to be constructed, or the design could be modified if Intalco can demonstrate that some other alternative component(s) will be protective and result in compliance. Such a demonstration would rely on groundwater monitoring data that show groundwater concentrations would protect aquatic life and comply with ARARs at the point of compliance without the barrier wall,

Alternative 13M would not fully protect the environment.

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[72] The effects on the wetland may also be addressed by the NRD process.

6.4.1.2 Compliance with Potential ARARs

The other threshold criterion under CERCLA is compliance with potential ARARs [40 CFR § 300.430(e)(9)(iii)(B)]. In this section, the alternatives are assessed to determine potential ARARs attainment under federal environmental laws and state environmental or facility siting laws, or whether there are grounds for invoking one of the waivers listed in 40 CFR § 300.430(f)(1)(ii)(C).

The ability of the alternatives to meet potential chemical-specific ARARs at the points of compliance for surface water, groundwater, and soil, and to meet potential action-specific and location-specific ARARs, is compared below.

6.4.1.2.1 Potential Chemical-Specific Requirements for Surface Water

Under Alternatives 11M and 14, implementation of cleanup actions is expected to satisfy chemical-specific ARARs for surface water based on protection of aquatic life, to be met in Railroad Creek and the Copper Creek Diversion as discussed in Section 6.2.1.2.1 and 6.2.3.2.1.

Under Alternative 13M, there is considerable uncertainty about whether proposed surface water cleanup levels would be met in Railroad Creek downstream from Tailings Piles 2 and 3 because of uncontrolled discharge of groundwater from Tailings Piles 2 and 3 to surface water. Alternative 13M may not meet chemical-specific ARARs for surface water as discussed in Sections 6.2.2.1 and 6.2.2.2.1.

A mixing zone may be required for discharge of the treated groundwater into Railroad Creek. Alternatives 11M and 14 are expected to satisfy the all known, available, and reasonable methods of treatment (AKART) requirements for Ecology to approve a mixing zone. The Agencies are not prepared to conclude that Alternative 13M satisfies AKART because, as stated above, there is uncertainty about whether proposed groundwater cleanup levels based on protection of surface water would be met before groundwater enters Railroad Creek downstream of Tailings Piles 2 and 3 without the barrier wall. As discussed above, however, the barrier wall included in Alternative 14 may not need to be constructed or the design could be modified to address this concern, if Intalco can demonstrate that some other alternative component(s) will be protective and result in compliance. Such a demonstration would rely on groundwater monitoring data that show groundwater concentrations would protect aquatic life and comply with ARARs without the barrier wall.

6.4.1.2.2 Potential Chemical-Specific Requirements for Groundwater

Under Alternatives 14 and 11M, groundwater exceeding proposed cleanup levels would be contained, collected, and treated. Exposure to drinking water above ARAR concentrations within the contained areas would be prevented through institutional controls. An ARAR waiver may also be appropriate under CERCLA where it is technically impracticable to clean up groundwater to achieve ARARs, such as within the WMAs. Alternatives 11M and 14 would rely on groundwater barriers, which are a proven technology for the containment of contaminated groundwater. (e.g., below waste piles that are left in place, see Appendix C of the SFS.) By using such barriers, these alternatives would provide source control to the maximum extent practicable. Groundwater downgradient of the containment barriers is anticipated to meet potential chemical-specific ARARs following construction of the barriers around the source areas, based on experience at other sites that is described in Appendix C of the SFS.

Under Alternative 13M, drinking water ARARs would be addressed through institutional controls. However, groundwater discharging from Tailings Piles 2 and 3 would not be contained, and may be entering Railroad Creek above concentrations that are protective of aquatic life. Protection of aquatic life is a designated beneficial use for groundwater at the Site, as discussed in Section 3.1. Alternative 13M is not eligible for a conditional point of compliance for groundwater. As a result, Alternative 13M does not meet chemical-specific ARARs for groundwater.

6.4.1.2.3 Potential Chemical-Specific Requirements for Soils

Under Alternatives 14 and 11M, soil exceeding proposed cleanup levels would be addressed through a combination of removal, containment, institutional controls, *in situ* soil treatment and monitoring. Alternatives 11M and 14 are both expected to meet chemical-specific ARARs for soil.

Alternative 13M does not address soil contamination except for monitoring in the Honeymoon Heights Waste Rock Piles, the DSHH, Lower West Area (outside the Lagoon), Holden Village, the Ballfield Area, or the Wind-Blown Tailings Area; thus, Alternative 13M would not satisfy chemical-specific ARARs for soils.

6.4.1.2.4 Potential Chemical-Specific Requirements for Sediment

Under Alternatives 14 and 13M, ferricrete in Railroad Creek would be isolated as a result of stream relocation. Ferricrete would be removed from Railroad Creek under Alternative 11M.

Remediation under Alternative 11M and 14 would include preventing all discharges of iron-rich groundwater from the tailings piles, which would eliminate formation of floc that contains hazardous substances in Railroad Creek. Under both alternatives, sediment in Railroad Creek downstream from Tailings Piles 2 and 3 and in Lake Chelan at the Lucerne Bar would be monitored to confirm that risks to benthic macroinvertebrates remain low and decrease over time with continued natural deposition of clean sediment. These actions are expected to comply with ARARs.

Under Alternative 13M, groundwater containing elevated concentrations of dissolved iron from Tailings Piles 2 and 3 would still continue to flow into Railroad Creek and it is not clear if floc would continue to form. Sediment downstream from the relocated stream section and in Lake Chelan at the Lucerne Bar may not comply with ARARs.

6.4.1.2.5 Potential Action- and Location-Specific Requirements

Final ARARs will be identified by the Agencies for the selected remedy at the time of the ROD. The Agencies anticipate that Alternatives 11M and 14 would satisfy potential action- and location-specific ARARs. Mitigation to address adverse impacts such as permanent destruction of habitat, temporary disturbance of habitat during construction, visual impacts, etc., would be implemented as required by the Forest Plan. In the event mitigation would not satisfactorily address requirements of the Forest Plan, the Forest Service may amend the Forest Plan or portions of this ARAR could be waived under CERCLA.

It is not clear whether Alternative 13M satisfies all action- and location-specific ARARs, as discussed in Section 6.2.2.2.5.

Monitoring during and after implementation would be used for all three alternatives, to assess compliance, as required under both CERCLA and MTCA.

6.4.1.2.6 Summary of Compliance with the CERCLA Threshold Requirements

Based on the analysis provided in Section 6.4.1.1 through 6.4.1.2.5 above, Alternatives 11M and 14 would meet the threshold requirements for remedy selection under CERCLA, and Alternative 13M would not.

6.4.2 Primary Balancing Criteria

According to the NCP, the selected alternative must provide the best balance of tradeoffs among alternatives that satisfy the threshold criteria, in terms of the five primary balancing criteria [40 CFR § 300.430(f)(1)(ii)(D) and (E)].

Under CERCLA, only alternatives that meet the CERCLA threshold criteria for selecting a final remedy are typically carried forward and compared using the primary balancing criteria. As presented in Sections 6.2 and 6.4, Alternatives 14 and 11M meet the threshold criteria and, therefore, will be carried forward. Although Alternative 13M does not meet the threshold criteria, it is also carried forward in the following discussion for completeness and to better compare and understand these three alternatives.

6.4.2.1 Long-Term Effectiveness and Permanence

Alternatives shall be assessed for their long-term effectiveness and permanence, along with the degree of certainty that the alternative will be successful [40 CFR § 300.430(e)(9)(iii)(C)]. The two factors that shall be considered for long-term effectiveness and permanence are:

- Magnitude of residual risk remaining from the untreated waste or treatment residuals remaining at the conclusion of the remedial activities; and
- Adequacy and reliability of controls necessary to manage treatment residuals and untreated waste.

6.4.2.1.1 Magnitude of Residual Risk Remaining at the Conclusion of the Remedial Activities

Alternatives 11M and 14 would address human health and ecological risk associated with soil (including tailings and waste rock), groundwater, surface water, and sediment, as described above in Sections 6.2.1.3.1 and 6.2.3.3.1. These alternatives would also address physical hazards associated with unauthorized mine access and risks to surface water from failure and erosion of tailings pile slopes.

Alternative 13M would rely on institutional controls alone to address human health risks associated with soils in the Lower West Area. Alternative 13M would rely on natural recovery but does not include any active measures to address risks to terrestrial organisms associated with materials in the Lower West Area, Honeymoon Heights, DSHH, the Ballfield Area, Holden Village, and the Wind-Blown Tailings Area, as discussed in Section 6.2.2.3.1. Finally, Alternative

13M would not address potential risks to aquatic organisms associated with groundwater from Tailings Piles 2 and 3 discharging to Railroad Creek.

Pending the results of treatability studies during remedial design, there is some question whether the *in situ* treatment proposed for Alternatives 11M and 14 would fully address risks to terrestrial receptors, for instance in the Wind-Blown Tailings Area and portions of the Lower West Area, and the time frame in which risk reduction would be achieved. Site-specific studies would be needed to determine the most effective methods of treatment, and whether pH adjustment could be accomplished without causing other more adverse impacts than the existing risks from hazardous substances. In spite of the uncertainties involved with *in situ* treatment, Alternative 14 is likely to lower risk to terrestrial ecological receptors to a greater degree than Alternative 13M, under which no action would be taken.

6.4.2.1.2 Adequacy and Reliability of Controls

To assess the adequacy and reliability of controls at the Site, items to be addressed under CERCLA are: 1) uncertainties associated with land disposal of treatment system residuals; 2) potential need to replace technical components of the remedy; and 3) potential risk if components of the remedy need replacement [40 CFR § 300.430(e)(9)(iii)(C)(2)]. These three items are discussed in turn below.

Uncertainties associated with land disposal of treatment system residuals. Under Alternatives 14, 11M, and 13M, water treatment system sludge would be disposed of in a monitored on-site landfill constructed for that purpose. Since the landfill would need to satisfy state requirements for location, design and construction, operation, closure, and monitoring of limited purpose landfills, (WAC 173-350-400) there is an equally low level of uncertainty associated with the risk that hazardous substances would be re-released to the environment for each of the three alternatives.

Potential need to replace technical components of the remedy. Under Alternative 14, components subject to replacement or significant maintenance involve the water treatment and associated collection system, soil caps, stream bank protection, and the rerouted channel of Railroad Creek. All could be readily replaced, maintained, and repaired, as required.

Alternative 13M would be similar to Alternative 14 except the absence of a groundwater interception system at Tailings Piles 2 and 3 would result in collecting a smaller volume of contaminated groundwater and require a smaller treatment system and potentially less maintenance. The treatment systems would involve comparable types of maintenance for both Alternatives 13M and 14.

Alternative 11M would require more complex treatment system maintenance because it relies on generators and pump components to convey water into the treatment system.

Other technical component replacement requirements under Alternative 11M would be similar to Alternatives 13M and 14, except that the membrane liner system used in the tailings and waste rock pile caps would be more difficult to maintain and repair. (Note, however, that all three Alternatives would include sludge disposal landfills that may need to be capped with a composite soil and geomembrane cover that would require the same long-term maintenance as the Alternative 11M tailings and waste rock caps).

Potential risk if components of the remedy need replacement. As discussed in Sections 6.2.1.3.2, 6.2.2.3.2, and 6.2.3.3.2, there would be a similarly low risk to human health and the environment, compared with existing conditions, should remedy components fail or need to be replaced under Alternatives 14, 11M, and 13M.

6.4.2.2 Reduction of Toxicity, Mobility, or Volume through Recycling or Treatment

The second criterion of the primary balancing criteria is assessing the degree to which alternatives employ recycling or treatment to reduce toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the site [40 CFR § 300.430(e)(9)(iii)(D)].

Under Alternatives 14, 11M, and 13M, hazardous substances would be immobilized in landfilled sludge following treatment of intercepted groundwater (including base flow to the creeks, seeps and mine drainage). Alternatives 14 and 11M would immobilize contaminants in groundwater from all known source areas. Alternative 13M would immobilize a smaller amount of contaminants because groundwater from Tailings Piles 2 and 3 would continue to discharge to Railroad Creek and would not be captured and treated.

6.4.2.3 Short-Term Effectiveness

Short-term effectiveness is the third primary balancing criteria under CERCLA. This criterion considers the following items [40 CFR § 300.430(e)(9)(iii)(E)]:

- Short-term risks that might be posed to the community during implementation of an alternative;

- Potential impacts on workers and the effectiveness and reliability of protective measures;

- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and

- Time until protection is achieved.

6.4.2.3.1 Short-Term Risks on the Community during Implementation

Short-term risks to the community would be primarily associated with construction traffic. These impacts would be similar under Alternatives 14, 11M, and 13M, and could be mitigated through implementation of a traffic control plan.

6.4.2.3.2 Potential Impacts on Workers during the Remedial Action and the Effectiveness and Reliability of Protective Measures

Potential impacts to workers during remedial construction would be similar for Alternatives 14, 11M, and 13M. Potential impacts to workers would be associated with construction hazards (mine entry, traffic, exposure to some Site soils, excavation, demolition, and heavy equipment operation). These could be adequately mitigated under each alternative through adherence to applicable safety and health regulations (OSHA, L&I, MSHA, etc.); worker training and monitoring; development of a health and safety plan; and implementation of BMPs (e.g., dust control).

Human health risks associated with remedy implementation also include handling fuel and caustic chemicals used in operating the groundwater treatment system. For all three alternatives, this risk can be mitigated through development of an appropriate accident prevention plan and worker training.

6.4.2.3.3 Potential Environmental Impacts of the Remedial Action and the Effectiveness and Reliability of Mitigative Measures during Implementation

All of the alternatives have some short-term potential adverse impacts. The relative effects of Alternatives 11M, 13M, and 14 are discussed below.

Alternatives 11M, 13M, and 14 all involve construction of hydraulic barriers in the underground mine, and share a common risk that this will degrade water quality of the mine discharge. However, each of these alternatives includes collection and treatment of the mine discharge.

Under Alternative 14, the main potential risks during construction of the remedy would be:

- Tailings release to surface water during regrading or stream relocation (slope failure or stormwater runoff). Alternative 14 would mitigate most of the risk of tailings pile instability impacting the relocated portion of Railroad Creek, but depending on the extent of stream relocation, could still require some excavation to pull the toes of the Tailings Pile 1 slopes back from a portion of Railroad Creek (e.g., along the western arc of Tailings Pile 1 upstream of the relocated reach proposed by Intalco), and would include pulling back portions of Tailings Piles 1 and 2 from Copper Creek;

- Bentonite/cement release to surface water during barrier wall construction;

- Sediment release to surface water during stream relocation, construction of the groundwater collection system, and other activities; and

- Spills of hazardous materials during construction vehicle fueling/maintenance operations.

Alternative 14 includes *in situ* treatment to address the Honeymoon Heights Waste Rock Piles, DSHH, a portion of the Ballfield Area, Holden Village, a portion of the Lower West Area, and the Wind-Blown Tailings Area. Depending on the effectiveness of *in situ* treatment, this could increase the time required before proposed cleanup levels are achieved in these areas, but with significantly less disturbance and loss of habitat compared to other more intrusive measures. If *in situ* treatment is found not to be effective, an ARAR waiver could be invoked under CERCLA. Concurrently, Ecology could exercise its substantive authority under SEPA to avoid active measures with greater potential adverse impacts to the existing steep sloping hillside where the Honeymoon Heights Waste Rock Piles and DSHH AOIs are located, and to avoid destruction of mature riparian habitat in portions of the Lower West Area and Wind-Blown Tailings AOIs.

Alternative 11M would involve risks similar to those associated with Alternative 14, except:

- Alternative 11M would involve greater risk of tailings releases to surface water than Alternative 14 because it would require excavation to pull the toe of the tailings piles back all along Railroad and Copper Creeks, and regrading immediately adjacent to Railroad Creek (i.e., without relocating the creek);

- Alternative 11M also involves increased risk of sedimentation or bentonite/cement release to surface water associated with barrier wall construction alongside the creek. Alternative 14 includes relocation of more of the creek channel away from where the barrier would be constructed, compared to Alternative 11M;

- Alternative 11M would involve additional unavoidable and permanent loss of habitat associated with construction/improvement of haul road and removal of Honeymoon Heights Waste Rock Piles; and

- Alternative 11M would have a greater risk of surface water quality exceedances associated with discharge from the groundwater treatment facility, compared to Alternatives 13M and 14. Although all three alternatives would use similar pH adjustment and precipitation methods to remove hazardous substances during treatment; Alternative 11M relies on pumping, whereas Alternatives 13M and 14 are proposed to be gravity flow-through systems. Alternative 11M could produce surface water exceedances if there is a pump or generator failure during the life of the remedy, and would also have higher fuel consumption requirements and, hence, a greater risk of a fuel spill compared to Alternatives 13M and 14.[73]

Alternative 13M would involve risks similar to those for Alternative 14, but with the following differences:

- Alternative 13M does not include excavation to pull the toes of the Tailings Pile 1 slopes back from a portion of Railroad Creek upstream from the relocated portion, or to pull back portions of Tailings Piles 1 and 2 from Copper Creek. This would produce greater risk of potential long-term tailings releases into the creeks due to future tailings pile instability; and

- Alternative 13 would involve less risk of bentonite/cement release to surface water during barrier wall construction, because no barrier wall would be constructed along Railroad Creek adjacent to Tailings Piles 2 and 3.

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[73] The Agencies have expressed a preference for hydroelectric power to avoid negative environmental consequences of the use of diesel fuel, consistent with TBCs. Risks related to fuel use would be reduced for all Alternatives if a hydroelectric source of power is successfully developed as desired.

Except for the habitat loss associated with removal of the Honeymoon Heights Waste Rock Piles under Alternative 11M, risks associated with construction activity under each of the three alternatives could be adequately mitigated through implementation of BMPs and SPCC plans. However, Alternatives 13M and 14 involve permanent destruction of mature riparian forest for relocation of a portion of Railroad Creek, and elimination of the wetland habitat east of Tailings Pile 3 for construction of a groundwater treatment facility. Alternative 11M would not involve creek relocation, and the treatment system would occupy a portion of the Wind-Blown Tailings Area, which is forested and includes some mature forest. Wetlands habitat in the Railroad Creek valley is much less common that forest habitat, so Alternatives 13M and 14 would have greater negative impacts compared to Alternative 11M in this regard.

Permanent habitat loss in the impacted area of Honeymoon Heights under Alternative 11M, and the areas of riparian forest and wetlands under Alternatives 13M and 14, would likely require mitigation under Section 404 of the Clean Water Act, and for Forest System lands (i.e., not private land on Honeymoon Heights) mitigation required by the Forest Plan.[74]

6.4.2.3.4 Time until Protection is Achieved

Alternatives 14 and 11M would immediately protect human health and are anticipated to be protective of the environment when the remedy is fully implemented. Alternative 11M would achieve cleanup of the Honeymoon Heights Waste Rock Piles and DSHH more quickly than Alternative 14, which relies on *in situ* treatment in these areas, although with much greater consequential adverse impacts. The time to achieve proposed cleanup levels through *in situ* treatment in any of the AOIs under Alternatives 11M and 14 will not be known until completion of remedial design and, perhaps, pilot studies as part of implementing the remedy.

Alternative 13M would be fully protective of human health at the time the remedy is implemented. However, Alternative 13M would not be fully protective of the environment since it relies on natural recovery to protect terrestrial receptors in the Honeymoon Heights Waste Rock Piles, DSHH, Lower West Area, the Ballfield Area, Holden Village, and the Wind-Blown Tailings AOIs.

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[74] In addition to the wetland loss, permanent habitat loss, i.e., the impacted area of Honeymoon Heights under Alternative 11M, and the areas of riparian forest impacted under Alternatives 13M and 14 may require development or improvement of habitat of equivalent value elsewhere and compensation for such losses under the NRDA process.

6.4.2.4 Implementability

Implementability is the fourth of the primary balancing criteria under CERCLA. The implementability issues to be assessed for the alternatives under CERCLA are [40 CFR § 300.430(e)(9)(iii)(F)]:

- Technical Feasibility;
- Administrative Feasibility; and
- Availability of Services and Materials.

6.4.2.4.1 Technical Feasibility

Alternatives 14, 11M, and 13M are all technically feasible and could be implemented using conventional construction equipment and methods. All three of these alternatives involve comparable risk that the proposed groundwater treatment system would need to be augmented and/or that freezing weather could impair performance of the groundwater collection and conveyance systems.

6.4.2.4.2 Administrative Feasibility

Land subject to cleanup is under the control of the Forest Service and Holden Village, Inc. Since the State of Washington and the Confederated Tribes and Bands of the Yakama Nation have assisted or consulted in selection of the remedy along with other state and federal agencies, the Agencies do not foresee any administrative barriers to implementation of Alternatives 14, 11M, or 13M.

6.4.2.4.3 Availability of Services and Materials

The services and materials to implement Alternatives 14, 11M, and 13M are readily available.

6.4.2.5 Cost

Alternative 11M would cost more than Alternative 14, primarily due to the cost of using a geomembrane as part of the cap for tailings and waste rock piles, and the cost of removing the Honeymoon Heights Waste Rock Piles and impacted soils in the DSHH. As discussed in Appendix A, eliminating the geomembrane as part of capping the tailings and waste rock piles is the single largest cost difference between Alternative 11M and Alternatives 13M and 14.

Alternative 13M would cost less than Alternatives 11M and 14, as discussed in Appendix A. However, Alternative 13M costs less than Alternatives 11M and 14 because it omits remedy components necessary to satisfy the threshold criteria under CERCLA (or MTCA), as discussed in Appendix A.

6.4.2.6 Summary of the Primary Balancing Criteria

Although both Alternatives 11M and 14 satisfy the threshold criteria for selection of a remedy under CERCLA, these two alternatives differ in the degree to which they would satisfy the primary balancing criteria. (Alternative 13M is not included in the following comparison, since it does not satisfy the threshold criteria). Overall, Alternative 14 more fully satisfies the primary balancing criteria than Alternative 11M, as summarized below.

Alternative 11M would have a somewhat lower **magnitude of residual risk at the conclusion of cleanup activities**, since there is some uncertainty as to the efficacy and timeliness of cleanup using *in situ* soil treatment in some AOIs. Although both alternatives rely on *in situ* treatment for several AOIs, Alternative 11M includes consolidation of the Honeymoon Heights Waste Rock Piles and the impacted soils in the DSHH and capping part of the tailings piles, thus it would rely less on *in situ* treatment than Alternative 14 does.

Alternative 14 has greater **adequacy and reliability of controls** with respect to water treatment than Alternative 11M, since Alternative 14 relies on a gravity flow-through treatment system, which does not require pumping all the collected groundwater before it can be treated (as Alternative 11M does). Alternative 14 is less complex mechanically, and has fewer mechanized components that would need maintenance and replacement over the life of the remedy.

Alternatives 11M and 14 have the same potential uncertainties associated with land disposal of treatment system residuals, and with potential risk if these components of the remedy need replacement.

Alternative 11M is likely to require more maintenance to assure performance of the geomembrane cap on the tailings and waste rock piles, compared to the soil only cap anticipated for Alternative 14. Maintenance of the Alternative 11M geomembrane composite cap would be more difficult compared to maintenance of the Alternative 14 cap.

Alternatives 11M and 14 would achieve comparable levels of **reduction in mobility of hazardous substances** through treatment. Neither alternative would reduce toxicity or the volume of hazardous substances.

With respect to comparing short-term effectiveness, Alternatives 11M and 14 would result in comparable levels of **short-term risks to the community** due to potential impacts of remedy construction, and comparable **potential impacts on workers during remedial action**. Both alternatives would have comparably effective and reliable protective measures. However, Alternatives 11M and 14 differ in the potential **environmental impacts of the remedial action and anticipated effectiveness and reliability of mitigative measures during implementation.**

Alternative 11M would have adverse **environmental impacts** that extend over a larger area compared to Alternative 14. In addition to differences in the size of the adversely impacted areas, the types of these impacts are different as described below.

- Adverse environmental impacts of Alternative 11M would result from the anticipated habitat destruction of about 15 acres associated with constructing a Honeymoon Heights access road and removal of waste rock and impacted soils from Honeymoon Heights, as well as the long-term impairment of about 70 more acres downslope from the Honeymoon Heights access road. These impacts outweigh the environmental threat posed by the release of hazardous substances under existing conditions.

- In order to relocate Railroad Creek, Alternative 14 would permanently eliminate about 14 acres of riparian forest that includes a mix of recently cut, mature second growth, and late successional old growth forest (Section 5.1.7, Appendix D of ERM and URS 2009a). However, the new creek channel would provide riparian habitat with much greater structural diversity and later successional stage vegetation, compared to the riparian habitat along the existing creek channel under Alternative 11M.

- About 10 acres of the second growth forest habitat north of Railroad Creek (including a portion that overlaps the creek relocation alignment) would be eliminated for construction of the Alternative 11M treatment facility. The Alternative 14 treatment facility would occupy about the same size area located on the south side of Railroad Creek, but this would include elimination of the wetlands east of Tailings Pile 3.

- Alternative 11M would also create a greater risk that tailings pile instability or erosion during regrading would adversely impact Railroad Creek, since Alternative 14 would involve relocating the creek prior to regrading, and Alternative 11M does not. For the same reason, Alternative 11M would create a greater risk of a bentonite or cement release into the creek during barrier wall construction, compared to Alternative 14.

- Alternative 11M has greater risk of surface water quality exceedances than Alternative 14, since Alternative 11M relies on mechanical pumps and generators that are susceptible to breakdown, whereas Alternative 14 relies on gravity flow. If the Alternative 11M pumps or generators break down without adequate backup systems, untreated groundwater would be released into Railroad Creek. Because it relies more on electricity, Alternative 11M also probably would have larger fuel requirements and pose a greater risk of fuel spills compared to Alternative 14.[75]

Although both alternatives are likely to have comparable **time until protection is achieved**, in most AOIs, Alternative 11M conceivably could require less time for removal of the Honeymoon Heights Waste Rock Piles to be effective compared to *in situ* treatment. However, as previously noted, the adverse effects of removing the Honeymoon Heights Waste Rock Piles likely exceed the risk from the existing hazardous substances in this location.

Both Alternatives 11M and 14 are considered to be more or less equally **implementable** based on consideration of administrative and technical feasibility, and availability of services and materials.

Finally, Alternative 14 is anticipated to **cost** less to implement compared to Alternative 11M, as discussed in Appendix A.

6.4.3 Modifying Criteria

Two additional criteria, referred to as modifying criteria, are also considered for remedy selection under CERCLA [40 CFR § 300.430(f)(1)(i)(C)]. These modifying criteria are state acceptance and community acceptance.

The CERCLA modifying criteria are a significant consideration during final remedy selection [40 CFR § 300.430(f)(4)(i)]. In the case of this Site, the state provided input throughout the RI/FS process. Intalco and Holden Village, Inc. also provided input throughout the FS process.

Additional public input will include an opportunity to comment on the draft Proposed Plan and supporting documentation.

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[75] Although the source of electrical power for the remedy has not yet been determined, the Agencies' cost estimate assumed diesel-powered generators for comparison purposes only. Although not yet complete, the Agencies appreciate the work Intalco has done to date to assess feasibility of hydroelectric power. A final decision on the power supply source is not required for remedy selection. The Agencies believe that development of hydroelectric power is consistent with the Forest Plan (potential ARAR) and EPA policy (potential TBCs).

CERCLA uses the modifying criteria, along with the primary balancing criteria, to select an alternative from the alternatives that are both protective and ARAR-compliant.

6.4.4 Summary of CERCLA Comparative Analysis of Alternatives

This section summarizes the key differences between Alternatives 14, 11M, and 13M, as described previously in Sections 6.2 and Sections 6.4.1 and 6.4.2, in terms of the extent to which they address the CERCLA selection criteria.

Alternatives 14 and 11M both meet the threshold criteria. Alternative 13M does not meet the threshold requirements because it would not be protective of the environment and does not meet ARARs in the following media and areas:

- Soil, tailings, and waste rock in the Honeymoon Heights Waste Rock Piles, DSHH, Lower West Area, Ballfield Area, Wind-Blown Tailings area, and Holden Village; and

- Groundwater at the standard points of compliance beneath Tailings Piles 2 and 3.[76]

Alternative 13M does not satisfy the CERCLA threshold criteria and could not be selected as a final remedy. Also, Alternative 13M relies on institutional controls rather than active measures to protect humans from soil with hazardous substances that exceed direct contact and ingestion criteria in the Lower West Area. Under Alternative 13M, sediment in Railroad Creek may not meet ARARs downstream of the relocated section and in Lake Chelan at the Lucerne Bar. Therefore, because Alternative 13M does not meet the threshold criteria, it is excluded from the following discussion.

Alternatives 11M and 14 both satisfy the threshold criteria for selection of a remedy under CERCLA, but differ in their ability to satisfy some of the primary balancing criteria. Analysis of how these alternatives address the CERCLA balancing criteria is presented above in Section 6.4.2. The following summary focuses only on the key differences between Alternatives 11M and 14 and explains why, overall, Alternative 14 provides a better balance among the criteria, and is identified by the Agencies as the better alternative.

The main advantages of Alternative 11M over Alternative 14 are as follows:

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[76] Alternative 13M would not be eligible for a conditional point(s) of compliance downgradient from Tailings Piles 2 and 3 because Alternative 13M does not satisfy AKART.

- Alternative 11M would quickly achieve soil cleanup at the Honeymoon Heights Waste Rock Piles and the DSHH, but at the cost of eliminating existing, minimally-impacted habitat in the DSHH, and causing long-term habitat damages on the estimated 70-acre area downslope of the Honeymoon Heights access road needed to remove the waste rock and impacted soils. Alternative 14 uses *in situ* treatment, which could take several years to achieve protection from the hazardous substances, but without the long-term damage associated with removal of the waste rock and impacted soils.

- Alternative 11M would more effectively address human health risk from exposure to waste rock at Honeymoon Heights and soils in the DSHH. Alternative 11M involves removal and capping of impacted materials to prevent exposure of visitors to these materials. Alternative 14 would, instead, establish administrative restrictions and warnings to limit human contact with impacted waste rock and soil.

- Alternative 11M preserves wetland habitat, which is relatively rare in the Railroad Creek valley, by locating the water treatment plant in an upland area north of Railroad Creek. Alternative 14 involves locating the treatment system in the wetland east of Tailings Pile 3. Alternative 14 would require mitigation for the loss of the wetland and the riparian forest impacted by creek relocation by establishing or improving wetland and riparian forest habitat.

The main advantages of Alternative 14 over Alternative 11M are as follows:

- Alternative 14 avoids long-term, potentially permanent habitat loss in the vicinity of the Honeymoon Heights Waste Rock Piles and the DSHH, and for construction of the access road to accomplish removal on Honeymoon Heights. Alternative 14 would, therefore, avoid long-term, possibly permanent, habitat degradation to an estimated 70 acres downslope of the Honeymoon Heights access road and waste rock piles caused by changes in drainage and instability. Unlike Alternative 11M, Alternative 14 uses *in situ* treatment of soils in these areas, which would not require heavy equipment access or involve soil disturbance.

- The water treatment system under Alternative 14 would be easier to maintain and would be less susceptible to mechanical failure that would potentially result in exceedances of surface water quality standards, because the Alternative 14 system does not rely on electrically driven pumps to convey water to the treatment system.

- Alternative 14 would involve less long-term risk of fuel spills because it relies on gravity flow rather than pumping all the collected groundwater for treatment. Conversely, Alternative 11M does rely on pumping and would require substantial electrical power, likely supplied by a diesel generator. The fuel would need to be loaded, unloaded, and transported to the site via barge and truck.

- Alternative 14 involves less risk of tailings releases to surface water during construction than Alternative 11M. Unlike Alternative 11M, Alternative 14 does not involve regrading and excavation immediately adjacent to Railroad Creek to relocate the toe of the tailings piles.

- Alternative 14 involves less risk of sedimentation or bentonite/cement release to surface water during construction because barrier walls would not be constructed immediately adjacent to Railroad Creek as they would under Alternative 11M.

- The soil caps used on the tailings piles and East and West Waste Rock Piles would be easier to maintain and repair than the membrane liner systems used in Alternative 11M.

- Alternative 14 would cost less than Alternative 11M, primarily because it does not involve a geomembrane as part of the cap for tailings and waste rock piles and does not involve removal of the Honeymoon Heights Waste Rock Piles and impacted soils in the DSHH.

The Agencies believe that the advantages of Alternative 11M are more than offset by the advantages of Alternative 14 and that, on balance, Alternative 14 is the better alternative.

The advantages to terrestrial organisms of removing waste rock and soil at Honeymoon Heights under Alternative 11M would be outweighed by the disadvantages of the accompanying long-term habitat destruction. Similarly, the advantage of removing the waste rock and soil to limit human exposure to hazardous substances would be outweighed by the accompanying long-term destruction of terrestrial habitat, especially in light of the expected effectiveness of institutional controls to control human exposure.

The loss of the wetland east of Tailings Pile 3 under Alternative 14 would be outweighed by the benefits of using a low-energy water treatment system. The low-energy system would be easier to maintain than the system proposed for Alternative 11M, would be less likely to fail (potentially resulting in exceedances of surface water quality standards), and would not rely as heavily on a diesel generator, along with its associated impacts to air quality and risk of fuel spills. The disadvantage of wetland loss under Alternative 14 would be further offset by required mitigation measures that establish and/or improve wetland habitat elsewhere in the Lake Chelan drainage.

As listed above, other advantages of Alternative 14 that offset those of Alternative 11M include a reduced risk of tailings, bentonite/cement, or sediment releases to surface water during construction; easier maintenance and repair of the tailings and waste rock caps; and lower overall lifecycle cost.

Alternatives 14 and 11M both satisfy the threshold criteria; however, Alternative 14 satisfies the primary balancing criteria to a greater degree than does Alternative 11M, as described above in Section 6.4.2. As described in the preceding paragraphs, the Agencies conclude that Alternative 14 satisfies the CERCLA remedy selection criteria better, overall, than does Alternative 11M and, therefore, conclude that Alternative 14 is the better alternative.

6.5 Comparative Analysis of Alternatives 11M, 13M, and 14 Under MTCA

6.5.1 Threshold Requirements

The threshold requirements under MTCA require that a remedy: 1) protect human health and the environment; 2) comply with cleanup standards; 3) comply with applicable state and federal laws; and 4) provide for compliance monitoring.

6.5.1.1 Protect Human Health and the Environment

Alternatives 11M, 13M, and 14 would protect human health.

Under Alternative 14, risks to humans from soil, tailings, and waste rock in tailings piles, East and West Waste Rock Piles, former Mill Building, Lagoon, Maintenance Yard, a portion of the Lower West Area, and Surface Water Retention Area would be addressed by capping the material in place or moving the material and then capping it to prevent exposure. Risks from soils containing hazardous substances in a portion of the Lower West Area, the Honeymoon Heights Waste Rock Piles, and DSHH would be addressed through *in situ* treatment and institutional controls. Potential future use of impacted groundwater and surface water for drinking would be restricted by institutional controls. In addition, safety to residents and visitors would be addressed through mine access restrictions.

Alternative 11M would protect human health in the same manner as Alternatives 13M and 14, except that exposure to waste rock at Honeymoon Heights would be addressed by moving the waste rock to the tailings piles and capping it instead of relying on institutional controls.

Alternatives 11M, 13M, and 14 differ in the degree to which they would protect the environment.

Under Alternative 14, risks to terrestrial organisms from the tailings piles, East and West Waste Rock Piles, former Mill Building, Lagoon, Maintenance Yard, a portion of the Lower West Area, a portion of the Ballfield Area, and the Surface Water Retention Area would be addressed by excavation (consolidation) or capping the material to prevent exposure. Risks in other areas (e.g., the remainder of the Lower West Area and Ballfield Area, Holden Village, and the Wind-Blown Tailings Area) would be addressed by *in situ* treatment and possible future removal, capping, or treatment. To protect aquatic organisms, contaminant inputs from groundwater, including base flow, seeps and the mine drainage would be intercepted and treated before discharge to surface water.

Contaminant inputs and habitat disturbance from failures of tailings and waste rock pile slopes would be addressed by relocating Railroad Creek; followed by regrading slopes and constructing a stabilizing buttress; capping; and protecting the new stream banks from erosion and scour. Risks to aquatic organisms from ferricrete in Railroad Creek would be addressed by rerouting Railroad Creek to exclude the reach where the ferricrete is present. Sediment in Railroad Creek and Lake Chelan would be monitored to confirm that risks remain low and decrease over time.

Alternative 11M would protect the terrestrial environment to the same extent as would Alternative 14, except that protection of Railroad and Copper Creeks would require pulling the toe of the tailings piles farther back from the creeks without relocating Railroad Creek, with a consequential greater risk of release of hazardous substances into the creek during the regrading. In addition, under Alternative 11M, exposure to waste rock at Honeymoon Heights and the DSHH would be addressed by moving the material to the tailings piles and capping it instead of through pH adjustment.

Alternative 11M would protect the aquatic environment with a groundwater containment, collection, and treatment system to address contaminant inputs to surface water in a manner similar to Alternative 14. In addition, ferricrete would be physically removed from Railroad Creek under Alternative 11M, instead of being addressed as part of stream relocation under Alternative 14.

Alternatives 11M and 14 would both be protective of the environment.

Alternative 13M would not fully address risk to the terrestrial environment. Risks due to hazardous substances in the Lower West Area, Honeymoon Heights Waste Rock Piles, DSHH, Holden Village, the Ballfield Area, and the Wind-Blown Tailings Area would not be addressed except by monitoring and potentially through natural recovery over an unknown period of time.

Alternative 13M would intercept and treat groundwater from some parts of the Site before it enters surface water, and includes the former Railroad Creek channel as the collection system along the northwest side of Tailings Pile 2, but it does not include a barrier wall downgradient of Tailings Piles 2 and 3. Under Alternative 13M, there is considerable uncertainty about whether proposed cleanup levels, based on protection of surface water, would be met in groundwater before it enters Railroad Creek downstream from Tailings Piles 2 and 3. As discussed above, however, the barrier wall included in Alternative 14 to address this concern may not need to be constructed, or the design could be modified if Intalco can demonstrate that some other alternative component(s) will be protective and result in compliance. Such a demonstration would rely on groundwater monitoring data that show groundwater concentrations that would protect aquatic life and comply with ARARs without the barrier wall. Risks to aquatic organisms from ferricrete would be addressed in the same manner under Alternative 13M as under Alternative 14.

Alternative 13M would not fully protect the environment.

6.5.1.2 Comply with Cleanup Standards

As presented in the ASFS Sections 6.3.1 and 6.3.3, Ecology considers that Alternatives 11M and 14 would comply with cleanup standards. Under Alternative 11M, contaminated groundwater would be contained and treated before entering the surface water. Alternative 14 also includes a barrier wall for this purpose, but the barrier wall may not need to be constructed if Intalco can demonstrate that monitoring data show groundwater concentrations that would protect aquatic life and comply with ARARs. Alternatively, the barrier wall design could be modified upon demonstrating that some other approach will be protective and comply with ARARs. Groundwater downstream from the groundwater containment would be expected to meet cleanup standards at a conditional point of compliance along the groundwater-surface water interface of Railroad Creek.

However, Ecology concludes that Alternative 13M does not satisfy cleanup standards under MTCA, as discussed in ASFS Section 6.3.2. MTCA requires that for a cleanup action to qualify for a groundwater conditional point of compliance, groundwater discharges must receive all known available and reasonable methods of treatment (AKART) before release to surface water. Alternative 13M does not constitute AKART, because this remedy does not include containment of groundwater underneath Tailings Piles 2 and 3 and information provided to date does not indicate groundwater that discharges to surface water downstream of Tailings Piles 2 and 3 will be protective of aquatic life. As a result, Ecology would not approve a conditional point of compliance along the groundwater-surface water interface of Railroad Creek for Alternative 13M.

6.5.1.3 Comply with State and Federal Law

As discussed in Sections 6.3.1, 6.3.2, and 6.3.3, Ecology considers that Alternatives 11M and 14 would comply with state and federal environmental laws but that Alternative 13M may not.

6.5.1.4 Provide for Compliance Monitoring

As discussed in Sections 6.3.1, 6.3.2, and 6.3.3, Alternatives 11M, 13M, and 14 would each provide for compliance monitoring.

6.5.1.5 Summary of Compliance with the MTCA Threshold Requirements

Based on the analysis provided in Section 6.5.1.1 through 6.5.1.4 above, Alternatives 11M and 14 would meet the threshold requirements for remedy selection under MTCA, and Alternative 13M would not.

6.5.2 MTCA Other Requirements

Other requirements that must be evaluated under MTCA for remedy selection include: 5) use permanent solutions to the maximum extent practicable; 6) provide a reasonable restoration time frame; and 7) consider public concerns.

6.5.2.1 Use of Permanent Solutions to the Maximum Extent Practicable

As a remedy selection criterion, MTCA gives preference to the cleanup alternative that provides permanent solutions to the maximum extent practicable. WAC 173-340-360(3)(b).

As explained in Section 6.3.2.2, the Agencies are not prepared to conclude that Alternative 13M uses permanent solutions to the maximum extent practicable, because there is uncertainty about whether proposed cleanup levels based on protection of surface water would be met in groundwater before the groundwater enters Railroad Creek downstream of Tailings Piles 2 and 3, without the barrier wall. In addition, Alternative 13M does not address soils above proposed terrestrial ecological risk-based cleanup levels in some AOIs including the Honeymoon Heights Waste Rock Piles, DSHH, Ballfield Area, Lower West Area, Holden Village, and the Wind-Blown Tailings Area.

As discussed in Sections 6.3.1 and 6.3.3, and in Appendix D, Alternatives 11M and 14 would both use permanent solutions.

To determine whether an alternative is permanent to the maximum extent practicable, MTCA uses a disproportionate cost analysis with seven criteria. WAC 173-340-360(3)(e). These criteria are applied to Alternatives 11M and 14 below.

Protectiveness [WAC 173-340-360(3)(f)(i)]

This criterion evaluates the degree of protectiveness of each alternative. This includes: a) the degree of risk reduction; b) restoration time frame; c) risks resulting from implementation of the alternative; and d) overall improvement in environmental quality.

The main advantages of Alternative 11M over Alternative 14 are as follows:

- Alternative 11M would quickly achieve soil cleanup at the Honeymoon Heights Waste Rock Piles and the DSHH. Although both alternatives rely on *in situ* treatment for several AOIs, Alternative 11M includes consolidation of the Honeymoon Heights Waste Rock Piles and the impacted soils in the DSHH and capping as part of the tailings piles. It would rely less on *in situ* treatment than does Alternative 14 and as a result would have a somewhat lower magnitude of residual risk at the conclusion of cleanup activities. Alternative 14 uses *in situ* treatment, which could take several years to achieve protection from the hazardous substances, but without the long-term damage associated with removal of the waste rock and impacted soils.

- Alternative 11M would more effectively address human health risk from exposure to waste rock at Honeymoon Heights and soils in the DSHH. Alternative 11M involves removal and capping of impacted materials to prevent exposing visitors to these materials. Alternative 14 would instead establish administrative restrictions and warnings to limit human contact with impacted waste rock and soil.

- Alternative 11M preserves wetland habitat, which is relatively rare in the Railroad Creek valley, by locating the water treatment plant in an upland area north of Railroad Creek. Alternative 14 involves locating the treatment system in the already-impacted wetland east of Tailings Pile 3. Alternative 14 would require mitigation for the loss of the wetland and the riparian forest impacted by creek relocation by establishing or improving wetland and riparian forest habitat elsewhere in the Lake Chelan drainage.

- Adverse environmental impacts of Alternative 11M would result from the removal of about 10 acres of waste rock and impacted soils from Honeymoon Heights, and an additional 5 acres impacted by road construction, as well as the long-term impairment of about 70 more acres downslope of the Honeymoon Heights access road. These impacts outweigh the environmental threat posed by the release of hazardous substances under existing conditions.

The main advantages of Alternative 14 over Alternative 11M are as follows:

- Alternative 14 includes a cap on the tailings and waste rock piles that would satisfy the performance standards for closure of limited purpose landfills [WAC 173-350-400(3)(e)(i)] but without the geomembrane that Alternative 11M includes to satisfy the presumptive cover requirements [WAC 173-350-400(3)(e)(ii)]. Long-term maintenance of Alternative 11M would require controlling vegetation and burrowing wildlife to prevent damage to the geomembrane, which would not be required for Alternative 14. As a result, Alternative 14 would enable restoration of more diverse, structurally complex native habitat on the tailings and waste rock piles compared to Alternative 11M.

- Alternative 14 avoids long-term, potentially permanent habitat loss in the vicinity of the Honeymoon Heights Waste Rock Piles and the DSHH, and for construction of the access road to accomplish removal on Honeymoon Heights. Alternative 14 would, therefore, avoid anticipated habitat destruction of about 15 acres associated with removal of the impacted soils and waste rock and construction of the access road needed for removal, and long-term habitat damage on the 70-acre area downslope of the Honeymoon Heights access road caused by drainage and instability. Unlike Alternative 11M, Alternative 14 uses *in situ* treatment of soils in these areas, which would not require heavy equipment access or involve soil disturbance.

- Although Alternative 14 would require mitigation for the loss of the wetland and the riparian forest impacted by creek relocation, the new creek channel would be relocated into an area of mature second growth and late successional (old growth) forest that would provide riparian habitat with much greater structural diversity and later successional stage vegetation compared to the existing riparian habitat along Railroad Creek under Alternative 11M.

Overall, despite trade-offs, the Agencies find that Alternative 14 would be more protective than Alternative 11M. The advantages to terrestrial organisms of removing waste rock and soil at Honeymoon Heights under Alternative 11M would be outweighed by the disadvantages of the accompanying long-term destruction of habitat. Similarly, the advantage of removing the waste rock and soil to limit human exposure to hazardous substances would be outweighed by the accompanying long-term destruction of terrestrial habitat, especially in light of the expected effectiveness of institutional controls to control human exposure.

The loss of the already-impacted wetland east of Tailings Pile 3 under Alternative 14 would be outweighed by the benefits of using a low-energy water treatment system. The low-energy system would be less likely to fail (potentially resulting in exceedances of surface water quality standards) and would not rely as heavily on a diesel generator, along with its associated impacts to air quality and risk of fuel spills. The disadvantage of wetland loss under Alternative 14 would be further offset by required mitigation measures that establish and/or improve wetland habitat in the Railroad Creek valley and/or elsewhere in the Lake Chelan drainage.

Permanence [WAC 173-340-360(3)(f)(ii)]

The degree to which an alternative permanently reduces the toxicity, mobility, or volume is evaluated in this criterion. This evaluation includes the degree of irreversibility of a treatment process, and the quality and quantity of residue generated by the treatment process.

Alternatives 11M and 14 would achieve comparable levels of reduction in mobility of hazardous substances through treatment. Neither alternative would reduce the toxicity or volume of hazardous substances. However, Alternative 11M would rely more on mechanical systems that require more maintenance for water treatment (compared to a gravity flow-through system for Alternative 14), and the membrane liner systems used in the tailings and waste rock pile caps under Alternative 11M would be more difficult to maintain and repair than the Alternative 14 soil caps.

Alternative 11M is more permanent than Alternative 14 to the extent it involves waste rock and soil capping and/or removal in the Honeymoon Heights Waste Rock Piles and the DSHH, while Alternative 14 relies upon *in situ* treatment. There is some uncertainty as to the efficacy and timeliness of cleanup using *in situ* soil treatment. This slightly greater permanence; however, is more than offset by the long-term habit destruction that would accompany this remedy implementation.

Cost [WAC 173-340-360(3)(f)(iii)]

The cost of implementing an alternative includes the capital costs, the operation and maintenance (O&M) costs throughout the life of the project (expressed in net present value), and Agency oversight costs. The methods and assumptions used in the Agencies' cost estimates are discussed in Appendix A of the ASFS.

Alternative 14 would cost an estimated $13 million less than Alternative 11M, primarily because it does not involve geomembrane as part of the cap for tailings and waste rock piles and does not include removal of the Honeymoon Heights Waste Rock Piles and impacted soils in the DSHH.

Long-Term Effectiveness [WAC 173-340-360(3)(f)(iv)]

The long-term effectiveness criterion evaluates the reliability of the alternative during the period that remaining hazardous substance concentrations exceed cleanup levels. The evaluation includes the degree of certainty that the alternative will be successful, residual long-term risk posed by the Site, and the effectiveness of controls to manage treatment residues and wastes remaining on Site. The MTCA suggests using the following as a guide in this evaluation, in descending order of priority:

1. Reuse/recycling;
2. Destruction/detoxification;
3. Immobilization/solidification;
4. On- or off-site disposal in an engineered structure;
5. On-site isolation/containment with engineering controls; and
6. Institutional controls with monitoring.

Alternatives 11M and 14 do not differ with respect to the above items 1, 2, or 6. Implemented as intended, Alternatives 11M and 14 would achieve comparable levels of reduction in mobility of hazardous substances through treatment. In certain soil AOIs (e.g., Honeymoon Heights Waste Rock Piles and impacted soils in the DSHH), Alternative 11M would involve greater certainty of effectiveness (through removal and/or isolation of hazardous substances) than the *in situ* treatment approach under Alternative 14. This greater certainty, however, would come at the expense of long-term habitat damage. The Agencies believe that avoiding this habitat damage outweighs the advantage of the greater certainty. Beyond this consideration, Alternative 14 offers the following advantages over Alternative 11M:

- The water treatment system under Alternative 14 would be easier to maintain and would be less susceptible to mechanical failure that would potentially result in exceedances of surface water quality standards, because the Alternative 14 system does not rely on electrically driven pumps to convey water to the treatment system.

- Alternative 14 would involve less long-term risk of fuel spills because it relies on gravity flow rather than pumping all the collected groundwater for treatment. Conversely, Alternative 11M does rely on pumping and would require substantial electrical power, possibly supplied by a diesel generator. If all the electricity were obtained from a diesel generator (instead of hydroelectric or other alternative sources), Alternative 11M is anticipated to require about 34,700 gallons of diesel per year compared to 8,850 gallons per year for Alternative 14, as discussed in Appendix A. The fuel would need to be loaded, unloaded, and transported to the Site via barge and truck.[77]

- The soil caps used on the tailings piles and East and West Waste Rock Piles in Alternative 14 would be easier to maintain and repair than the membrane liner systems used in Alternative 11M.

Based on these considerations, Alternative 14 has greater effectiveness over the long term than Alternative 11M.

Short-Term Risks [WAC 173-340-360(3)(f)(v)]

This criterion evaluates the short-term risks to human health and the environment associated with implementation of the cleanup action, including the effectiveness of measures to reduce risks during construction (e.g., best management practices).

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[77] The Agencies have expressed a preference for hydroelectric power to avoid negative environmental consequences of the use of diesel fuel, consistent with TBCs. Risks related to fuel use would be reduced for all Alternatives if a hydroelectric source of power is successfully developed as desired.

- Alternative 14 involves less risk of tailings releases to surface water during construction than Alternative 11M. Unlike Alternative 11M, Alternative 14 does not involve regrading and excavation immediately adjacent to Railroad Creek to relocate the toe of the tailings piles.

- Alternative 14 involves less risk of sedimentation or bentonite/cement release to surface water during construction because barrier walls would not be constructed immediately adjacent to Railroad Creek as they would under Alternative 11M.

Based on these considerations, Alternative 14 involves slightly less short-term risk than Alternative 11M.

Technical And Administrative Implementability [WAC 173-340-360(3)(f)(vi)]

The implementability of a project includes consideration of the following factors:

1. Technical feasibility;
2. Availability of off-site facilities (if alternative includes use of off-site treatment or disposal);
3. Availability of services and materials needed to implement the cleanup action;
4. Administrative and regulatory requirements;
5. Scheduling, size, and complexity of the action;
6. Monitoring requirements; and
7. Integration into existing operations or future potential remedial actions.

Alternatives 11M and 14 are considered to be more or less equally implementable based on consideration of administrative and technical feasibility, and availability of services and materials.

Public Considerations [WAC 173-340-360(3)(f)(vii)]

The evaluation of alternatives needs to consider public concerns and the degree to which the alternative addresses the public's concerns. This includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization having an interest in the site.

The Agencies will evaluate public concerns in response to public comments on the Proposed Plan before issuing a ROD. There is no difference in the Agencies' ability to address potential comments for either Alternative 11M or 14.

Summary of the MTCA Disproportionate Cost Analysis

Based on the preceding discussion, Alternatives 11M and 14 can be compared as follows:

- Alternative 14 is more protective than Alternative 11M;
- Alternative 11M is slightly more permanent than Alternative 14, but at a greater environmental cost;
- Alternative 14 has lower cost than Alternative 11M;
- Alternative 14 has greater effectiveness over the long term than Alternative 11M;
- Alternative 11M has slightly greater short-term risks than Alternative 14;
- Alternative 11M and Alternative 14 have essentially the same technical and administrative feasibility; and
- The Agencies have the same ability to address public concerns for both Alternative 11M and Alternative 14.

On the whole, the Agencies believe that the advantages of Alternative 11M are more than offset by the advantages of the lower cost alternative, Alternative 14. As such, Alternative 14 provides permanent solutions to the maximum extent practicable to a greater degree than Alternative 11M.

6.5.2.2 Provide for a Reasonable Restoration Time Frame

Ecology considers that Alternatives 11M and 14 would provide for a reasonable restoration time frame as discussed in Sections 6.3.1 and 6.3.3. Although Alternative 11M would likely be protective in a faster time frame for the Honeymoon Heights portion of the Site, it would eliminate the existing minimally-impacted habitat in the DSHH and produce long-term adverse impacts to the 5-acre road alignment and the estimated 70-acre area downslope of the Honeymoon Heights access road. Pending the results of treatability studies during remedial design Alternative 14 may take longer to achieve cleanup standards in the Honeymoon Heights Waste Rock Piles and DSHH AOIs, but without the environmental damages associated with Alternative 11M.

As discussed in Section 6.3.2, Alternative 13M would not provide for a reasonable restoration time frame for the Site because Intalco has not adequately demonstrated that this alternative would achieve proposed cleanup levels in all areas of the Site.

6.5.2.3 Consider Public Concerns

As discussed in Sections 6.3.1, 6.3.2, and 6.3.3, public concerns regarding any of the alternatives considered will be addressed as part of selecting and implementing the final cleanup action in accordance with WAC 173-340-600(14) and (15).

6.5.3 MTCA Action-Specific Requirements

Finally, MTCA has additional remedy selection requirements that apply specifically to cleanup actions that include groundwater cleanup actions; institutional controls; releases and migration; and dilution and dispersion.

6.5.3.1 Non-Permanent Groundwater Cleanup Actions

As discussed in Sections 6.3.1.3, 6.3.2.3, and 6.3.3.3, a permanent groundwater cleanup is not practicable throughout the entire Site within a reasonable restoration time frame. Therefore, the selected alternative must meet MTCA's requirements for non-permanent cleanup actions [WAC 173-340-360(2)(c)(ii)].

Alternatives 11M and 14 include the removal of some sources and the containment of other sources through capping. These alternatives also includes groundwater containment to the maximum extent practicable to avoid lateral and vertical expansion of the groundwater affected by the hazardous substances. As a result, Alternatives 11M and 14 meet the MTCA requirements for a non-permanent groundwater cleanup action.

Alternative 13M includes the removal of some sources and the containment of other sources through capping. However, Alternative 13M does not include groundwater containment to the maximum extent practicable downgradient of Tailings Piles 2 and 3 to avoid lateral and vertical expansion of the groundwater plume affected by the hazardous substances. Intalco's 2008 and 2009 monitoring well observations (URS 2008 and URS 2009b) suggest contaminated groundwater does not enter Railroad Creek adjacent to Tailings Pile 3 and a portion of Tailings Pile 2; however, extent of the losing reach adjacent to the tailings piles is not entirely consistent with earlier observations. Groundwater does enter the creek with concentrations above proposed cleanup levels downgradient of Tailings Piles 2 and 3 (see Figure 8). The RI (Dames & Moore 1999) and subsequent observations (URS 2008) indicate hazardous substances are released to groundwater below Tailings Piles 2 and 3. Since Alternative 13M does not provide groundwater containment to the maximum extent practicable to avoid expansion of the plume, this alternative does not satisfy the MTCA requirements for non-permanent groundwater cleanup actions.

6.5.3.2 Cleanup of Soils for Residential and School Areas

As discussed in Sections 6.3.1, 6.3.2, and 6.3.3, available data indicate that soil concentrations in Holden Village do not exceed human health criteria. Thus the MTCA requirement [WAC 173-340-360(2)(d)] for soil cleanup to protect human health would not require action within the Village. Institutional controls and engineering measures (e.g., capping of tailings to prevent wind-blown dispersion) on the remainder of the Site proposed for Alternatives 11M and 14 would protect residential areas, schools, or childcare centers. Although Alternative 13M does not include any actions to remediate soils above proposed direct contact and ingestion-based cleanup levels in the Lower West Area (other than to rely on institutional controls), this AOI is probably not a significant source of wind-blown dust.

6.5.3.3 Institutional Controls

As discussed in Sections 6.3.1 and 6.3.3, Ecology considers that Alternatives 11M and 14 each satisfy requirements for institutional controls to protect human health that are specified in WAC 173-340-440. However, Alternative 13M relies on institutional controls instead of more permanent cleanup actions to protect human health for a portion of the Site (i.e., in the Ballfield Area and Lower West Area AOIs).

6.5.3.4 Releases and Migration/Dilution and Dispersion

As discussed in Sections 6.3.1 and 6.3.3, Ecology considers that Alternatives 11M and 14 do not rely primarily on dilution and dispersion to clean up groundwater and surface water above proposed cleanup levels. However, it is not clear to what degree Alternative 13M relies on dilution and dispersion to clean up groundwater east of Tailings Pile 3 to prevent discharge to surface water above proposed cleanup levels, as discussed in Section 6.3.2. Although Intalco has provided some data in the draft Alternative 13M Evaluation Report that suggest natural attenuation may be occurring downgradient of the tailings piles, it has not demonstrated the mechanism by which this is occurring, or shown that it will permanently prevent groundwater seepage into Railroad Creek above proposed cleanup levels.

6.5.3.5 Remediation Levels

As discussed in Sections 6.3.1 and 6.3.3, Alternatives 11M and 14 do not propose the use of remediation levels. Intalco refers to remediation levels in discussing Alternative 13M, but the Agencies believe Intalco uses this term to refer to proposed site-specific risk-based cleanup levels as noted above in Section 6.3.2.3.

6.5.4 Summary of Compliance with the MTCA Other Requirements and Action-Specific Requirements

Based on the analysis provided above, Alternatives 11M and 14 would both satisfy the Other Requirements for remedy selection under MTCA, but with some differences as summarized below. However, Alternatives 11M and 14 satisfy the MTCA Action-Specific Requirements in the same way.

Overall, the Agencies consider Alternative 14 to better satisfy the MTCA requirements than Alternative 11M as summarized below.

Although the removal of waste rock and impacted soils on Honeymoon Heights under Alternative 11M is more permanent than *in situ* treatment under Alternative 14; Alternative 14, overall, relies on permanent solutions to the maximum extent practicable more than Alternative 11M. Alternative 11M would rely more on mechanical systems that require more maintenance for water treatment (compared to a gravity flow-through system for Alternative 14); would require more maintenance and more difficult maintenance of the cap over the tailings and waste rock piles compared to Alternative 14; and on balance would be less protective than Alternative 14, all at a greater overall cost.

Alternative 11M would have a shorter restoration time frame compared to Alternative 14 for cleanup of the Honeymoon Heights Waste Rock Piles and DSHH. However, this would only be achieved by measures more intrusive than *in situ* treatment, and such measures appear likely to cause more adverse impact than the existing hazardous substance concentrations in these AOIs. The restoration time frame for the remaining AOIs would be the same under both alternatives.

Public concerns will be considered based on comments on the Proposed Plan when it is released for public comment.

6.5.5 Summary of MTCA Comparative Analysis of Alternatives

Alternatives 14 and 11M both satisfy the MTCA threshold criteria; however, Alternative 14 satisfies the MTCA other requirements to a greater degree than does Alternative 11M, as described above in Section 6.5.2. The Agencies conclude that Alternative 14 satisfies the MTCA remedy selection criteria better overall than does Alternative 11M and, therefore, conclude that Alternative 14 is the better alternative.

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TABLES

Table 1 - Summary of Constituents of Concern and Proposed Cleanup Levels

Media of Concern and Area of Interest	Constituent of Concern	Proposed Cleanup Level	Basis
Groundwater and Surface Water Used for Drinking Water: All Areas (ug/L)	Aluminum	16,000	a
	Cadmium	5.00	
	Copper	592	
	Lead	15.0	
	Zinc	4,800	
Surface Water and Groundwater Discharging to Surface Water: All Areas (ug/L)	Aluminum	152	b
	Cadmium (e)	0.090	
	Copper (e)	1.17	
	Iron	1,000	
	Lead (e)	0.540	
	Zinc (e)	11.0	
Soil: Tailings Piles 1, 2, & 3 (mg/kg)	Barium	330	h
	Cadmium	5.5	h
	Copper	85	h
	Lead	161	h
	Molybdenum	18.6	h
	Silver	18.5	h
	Thallium	0.36	g
	Zinc	136	g
Soil: East and West Waste Rock Piles (mg/kg)	Barium	164	g
	Cadmium	14	h
	Chromium	29	h
	Copper	46	h
	Lead	118	h
	Molybdenum	8.8	g
	Silver	3.9	h
	Thallium	0.36	g
	Zinc	136	g
Soil: Honeymoon Heights Waste Rock Piles (mg/kg)	Barium	164	g
	Copper	46	h
	Lead	118	h
	Mercury	0.93	g
	Molybdenum	8.8	g
	Silver	3.9	h
	Thallium	0.36	g
	Zinc	136	g
Soil: Ballfield Area (mg/kg)	Chromium	29	h
	Copper	46	h
	Lead	201	h
	Silver	16.5	h
	Thallium	0.36	g
	Zinc	136	g

Table 1 - Summary of Constituents of Concern and Proposed Cleanup Levels

Media of Concern and Area of Interest	Constituent of Concern	Proposed Cleanup Level	Basis
Soil: Holden Village (mg/kg)	Aluminum	18200	g
	Barium	164	g
	Chromium	29	h
	Copper	112	h
	Lead	124	h
	Silver	3.9	h
	Zinc	136	g
Soil: Windblown Tailings Area (mg/kg)	Barium	232	h
	Copper	85	h
	Lead	139	h
	Molybdenum	8.8	g
	Silver	11.9	h
	Zinc	136	g
Soil: Downslope from Honeymoon Heights (mg/kg)	Aluminum	17600	g
	Arsenic	16	c
	Barium	133	g
	Cadmium	14	h
	Copper	288	h
	Lead	201	h
	Mercury	0.43	g
	Molybdenum	5.5	h
	Selenium	1.4	g
	Silver	3.9	h
	Thallium	0.13	g
	Zinc	177	g
Soil: Lower West Area-East (mg/kg)	Aluminum	17600	g
	Arsenic	16	c
	Barium	133	g
	Cadmium	12	h
	Copper	110	g
	Lead	121	h
	Mercury	0.43	g
	Molybdenum	2.9	g
	Selenium	1.4	g
	Silver	8.5	h
	Thallium	0.13	g
	Zinc	177	g
Soil: Lower West Area-West (mg/kg)	Arsenic	16	c
	Silver	3.9	h

Table 1 - Summary of Constituents of Concern and Proposed Cleanup Levels

Media of Concern and Area of Interest	Constituent of Concern	Proposed Cleanup Level	Basis
Soil: Lagoon (mg/kg)	Aluminum	17586	g
	Barium	133	g
	Cadmium	14	h
	Copper	110	g
	Lead	118	h
	Molybdenum	2.9	g
	Silver	360	f
	Thallium	1	h
	Zinc	177	g
	TPH-Diesel	200	h
	TPH-Heavy Oil	200	h
Soil: Maintenance Yard (mg/kg)	Aluminum	18157	g
	Arsenic	4.8	c
	Barium	164	g
	Cadmium	14	h
	Chromium	42	h
	Copper	70	h
	Lead	118	h
	Molybdenum	8.8	g
	Silver	360	f
	Zinc	136	g
	TPH-Gasoline	100	h
	TPH-Diesel	200	h
	TPH-Heavy Oil	200	h
Soil: SRA (mg/kg)	Aluminum	18157	g
	Barium	164	g
	Cadmium	14	h
	Chromium	42	h
	Copper	70	h
	Lead	118	h
	Molybdenum	8.8	g
	Silver	360	f
	Thallium	1	h
	Zinc	136	g

Table 1 - Summary of Constituents of Concern and Proposed Cleanup Levels

Media of Concern and Area of Interest	Constituent of Concern	Proposed Cleanup Level	Basis
Sediment (mg/kg)	Aluminum	58,000	i
	Cadmium	1.10	
	Chromium	95.0	
	Copper	80.0	
	Iron	40,000	
	Lead	340	
	Manganese	1,800	
	Mercury	0.280	
	Nickel	60.0	
	Silver	2.00	
	Zinc	130	

Notes:
(a) Proposed cleanup level based on state or federal drinking water standards or cleanup levels protective of the drinking water pathway; see Table 6.
(b) Proposed cleanup level based on state or federal surface water quality criteria or background, if higher; see Table 4.
(c) Proposed cleanup level based on human health risk (MTCA Method B) (set at background); see Table 8
(d) Proposed cleanup level based on human health risk (MTCA Method A); see Table 8.
(e) Proposed cleanup based on hardness-dependent ARAR assuming 7 mg/L; see Table 4.
(f) Proposed cleanup level based on human health risk (MTCA Method B); see Table 8.
(g) Proposed cleanup level based on ecological risk (set at background); see Table 9.
(h) Proposed cleanup level based on ecological risk; see Table 9.
(i) Proposed cleanup level based on freshwater sediment TBCs; see Table 11
(j) Sampling data not currently available for Former Mill Building area; constituents of concern and cleanup levels will be identified by Agencies when data are available.
(k) Proposed cleanup levels for soil were identified using data from Tables 8 and 9 as follows: The proposed human health-based cleanup level for each constituent and AOI is the lowest human-health-based potential chemical-specific ARAR or TBC or the background level of the corresponding background area, whichever is greater. The proposed ecological-based cleanup level for each constituent and AOI is the site-specific ecological risk-based level or the background level of the corresponding background area, whichever is greater. For media/areas with both human health and ecological exposure pathways, the cleanup level is based on the lower of the lowest ecological or human health criteria identified as described above, or background, if higher.
(l) Cleanup levels presented for soil do not include those constituents whose concentrations are less than background.
(m) Proposed cleanup levels for published and calculated values typically shown to two or three significant figures. Final cleanup levels will be determined at the time of the Record of Decision

Table 2 - Areas of the Site with Groundwater Concentrations that Exceed Drinking Water Criteria

Constituents of Concern (ug/L)	Drinking Water Criteria (c)	Ballfield Area		Honeymoon Heights Waste Rock Piles		Mine Portal		Lower West Area		East and West Waste Rock Piles (including Mill Building Area)		Tailings Pile 1		Tailings Pile 2		Tailings Pile 3		Windblown Tailings Area		Downstream From Tailings Pile 3		Holden Village	
		Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Aluminum	16,000	nd	nd	16,800	4,580	6,065	nd	5,140	1,290	6,890	1,790	61,600	43,500	804,000	3,960	17,300	6,760	nd	60.0	3,040	14,300	50.0	100
Cadmium	5.00	3.20	0.400	38.3	22.4	48.5	8.00	32.6	35.1	73.4	63.0	32.3	11.7	2,030	3.08	11.3	3.73	nd	nd	0.915	0.940	0.300	nd
Copper	592	10.0	nd	7,370	4,600	2,960	28.0	2,860	2,140	5,690	7,560	944	179	4,050	24.9	465	29.1	nd	1.00	24.9	64.2	3.00	3.20
Iron	--	nd	nd	130	480	202	nd	3,670	2,810	196	710	917,700	836,000	741,000	146,000	83,700	198,000	50.0	nd	781	16,700	330	80.0
Lead	15.0	nd	nd	7.25	8.92	28.2	1.00	7.11	8.00	8.27	13.0	3.07	nd	42.3	52.0	37.8	66.7	--	--	0.212	nd	nd	2.60
Zinc	4,800	30.0	11.0	4,800	2,530	8,840	2,980	4,720	4,900	9,270	8,960	4,940	5,500	510,000	294	823	278	18.0	34.0	131	167	77.3	10.0

Notes:

(a) Constituent concentrations from Table 7.

(b) Shaded cells indicate exceedance of drinking-water based criteria (does not include exceedance of non-health-based secondary MCLs)

(c) Drinking water-based criteria presented in Table 6.

(d) Arsenic and nickel concentrations in groundwater were identified in the SFS as exceeding drinking water criteria in some areas of the Site. Updated statistical analyses (see Table 7, footnote d), along with additional groundwater data collected through spring 2009, indicate that these constituents do not exceed drinking water standards.

-- Not analyzed or not applicable

nd = Non-detect.

Table 3 - Areas of the Site with Soil Concentrations That Exceed Human Health Criteria

Constituents of Concern (mg/kg)	Tailings Piles 1, 2, & 3	East & West Waste Rock Piles	Honeymoon Heights Waste Rock Piles	Ballfield Area	Holden Village	Windblown Tailings Area	Area Downslope of Honeymoon Heights	Lower West Area--East	Lower West Area--West	Lagoon	Maintenance Yard	Surface Water Retention Area
Aluminum	15,900	16,400	18,100	17,900	20,300	15,700	18,400	20,100	16,300	33,500	23,900	20,234
Arsenic	--	--	--	--	--	--	**20.0**	**20.0**	**26.0**	5.00	**60.0**	--
Barium	459	409	344	82.0	185	192	238	352.0	66.0	343	717	660
Cadmium	**19.5**	**4.77**	3.00	1.40	1.60	0.690	**5.30**	**130**	1.70	**184**	**21.6**	**8.03**
Chromium	14.7	56.9	17.0	26.0	32.0	18.0	21.0	24.0	26.0	21.0	33.0	26.9
Copper	**865**	**1,350**	**1,450**	72.0	260	118	**1,680**	**6,230**	80.0	**24,100**	**3,160**	**1,980**
Lead	65.1	224	1,910	16.0	52.0	37.0	77.0	644	13.0	746	1,070	141
Mercury	0.303	0.499	**3.40**	0.320	0.042	0.310	1.90	1.10	0.320	--	--	0.530
Molybdenum	20.0	17.0	22.0	2.30	2.90	19.0	17.0	53.0	2.20	74.0	16.0	21.1
Selenium	6.64	4.67	6.90	0.450	0.780	1.90	2.40	**10.0**	0.360	--	--	6.83
Silver	3.59	3.25	8.20	0.720	0.860	1.30	3.30	11.0	0.700	**27.0**	5.00	7.31
Thallium	0.81	0.631	1.50	0.600	0.160	0.240	0.730	0.970	0.100	**3.00**	nd	1.20
Zinc	2,070	934	522	155	225	138	1,010	**17,300**	132	**23,700**	3,240	736
Gasoline-Range Hydrocarbons	--	--	--	--	--	--	--	--	--	nd	**1,200**	--
Diesel-Range Hydrocarbons	--	--	--	--	--	--	--	--	--	917	**12,000**	--
Heavy Oil-Range Hydrocarbons	--	--	--	--	--	--	--	--	--	1,120	**9,800**	--

Notes:

(a) Constituent concentrations from Table 10.

(b) Shaded cells indicate that value exceeds site-specific background concentration and human health-based soil criteria for the direct contact and/or ingestion pathway.

(c) Bolded values indicate that value exceeds site-specific background concentration and human health-based soil criteria for protection of groundwater.

(d) Site-specific background concentrations and soil criteria used for comparison are presented in Table 8.

-- Not analyzed or not applicable

nd = Non-detect.

Table 4 - Potential Chemical-Specific ARARs and Background Concentrations for Surface Water

Constituents of Concern (ug/L)	Water Quality Standards For Surface Waters of The State of Washington WAC 173-201A		Section 304 of the Clean Water Act National Recommended Water Quality Criteria (EPA 2006)				National Toxics Rule 40 CFR 131.36(b)(1)				State of Washington Model Toxics Control Act Method B Cleanup Levels WAC 173-340-730	Maximum Contaminant Levels (f)	Background Concentrations (d)
	Protection of Aquatic Organisms		Protection of Aquatic Organisms		Protection of Human Health		Protection of Aquatic Organisms		Protection of Human Health		Protection of Human Health	Protection of Human Health	
	Acute	Chronic	Acute	Chronic	Consumption of Water and Organism	Consumption of Organism Only	Acute	Chronic	Consumption of Water and Organism	Consumption of Organism Only	Fish Ingestion	Drinking Water	
Aluminum	--	--	750	87	--	--	--	--	--	--	--	--	152
Cadmium	0.206	0.143	0.151	0.038	--	--	0.206	0.143	--	--	20.0	5.00	0.08
Copper	1.39	1.17	(c)	(c)	1,300	--	1.39	1.17	--	--	2,660	1,300	1.14
Iron			--	1,000	300(e)	--	--	--	--	--	--	--	154
Lead	3.26	0.127	3.26	0.127		--	3.26	0.13	--	--	--	15.0	0.47
Zinc	12.0	11.0	12.3	12.4	7,400	26,000	12.0	11.0	--	--	16,500	--	12.3

Notes:

(a) Values represent dissolved concentrations for cadmium, copper, lead, zinc, and total concentrations for aluminum and iron.

(b) Underlined values require hardness correction specific to the sample data. The values presented in this table are based on a hardness of 7 mg/L CaCO3.
This value represents 10th percentile of fall sampling data from background stations RC-6 and RC-11 per Water Quality Program Permit Writer's Manual,
Ecology Publication Number 92-109, Revised July 2008.

(c) The Aquatic Life Ambient Freshwater Quality Criteria—Copper 2007 Revision (EPA-822-R-07-001), was published in the Federal Register on February 22, 2007, but to date there are insufficient data to provide a basis for predicting acute and chronic copper concentrations for Railroad Creek. The Agencies anticipate that additional information will be available to establish cleanup levels at the time of the ROD. Proposed cleanup levels are set at background levels.

(d) Background values determined using data from all years and seasons in a URS database query on 9/1/09 from the following stations: CC-1, Company Creek, HC-1, HC-2, HC-3, HC-4, Holden Creek, RC-6, RC-11, SF Agnes Creek, and Tenmile Creek. Following WAC 173-340-709(2), for lognormally distributed data sets, background was defined as the upper 90th percentile or four times the 50th percentile, whichever was lower. For normally distributed data sets, background was defined as the upper 80th percentile or four times the 50th percentile, whichever was lower. Background datasets were assumed to be lognormally distributed unless it could be demonstrated otherwise. Calculations were performed using MTCAStat.

(e) This value based on secondary MCL (aesthetics). According to the SFS (Table 4, footnote [g]), surface water criteria based on secondary MCLs will not be enforced. Secondary MCLs are not used to develop cleanup levels.

(f) Values shown are lowest values of state or federal Maximum Contaminant Levels (MCLs) or non-zero MCL Goals from Table 6.

(g) Shaded cells identify lowest potential chemical-specific ARAR, *or* background concentration (if higher).

-- Not established or not applicable

Table 5 - Concentrations of Constituents of Concern in Surface Water

Constituents of Concern (ug/L)	Proposed Cleanup Levels	Railroad Creek Upstream from Site RC-6		Railroad Creek Adjacent to Lower West Area-East RC-4		Copper Creek Diversion at Confluence with Railroad Creek CC-D1		Copper Creek at Confluence with Railroad Creek CC-2		Railroad Creek at Downstream Margin of Tailings Pile 3 RC-2		Railroad Creek Downstream from Site at Confluence of Tenmile Creek RC-5		Railroad Creek Mouth at Lake Chelan RC-3	
		Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Aluminum	152	121	60.0	185	50.0	nd	--	153	30.0	190	96.0	246	120	198	70.0
Cadmium	0.090	0.055	0.080	0.625	0.140	2.57	nd	nd	nd	0.381	0.130	0.580	0.120	0.206	0.100
Copper	1.17	0.920	0.500	34.4	3.90	155	nd	0.397	1.20	16.9	1.40	22.9	1.60	8.82	1.20
Iron	1,000	138	120	117	100	nd	--	84.6	50.0	720	1,180	2,300	1,440	471	440
Lead	0.540	0.256	0.900	0.365	0.400	0.200	nd	0.300	0.300	0.284	0.300	0.314	nd	0.252	0.200
Zinc	11.0	9.13	16.0	67.1	20.0	372	nd	13.0	nd	67.3	30.0	98.0	30.0	36.4	20.0

Notes:

(a) Values of aluminum and iron represent total concentrations.

(b) Values for cadmium, copper, lead, and zinc represent dissolved concentrations.

(c) Data to create this table obtained from URS database query on 09/01/09.

(d) Spring data represent samples collected in May, June, or July; fall data represent all other months.

(e) Consistent with the statistical approach for evaluating compliance with cleanup levels for groundwater presented in WAC 173-340-720(9), concentrations shown represent the upper one-sided 95 percent confidence limit (95 UCL) on the mean constituent concentration. In cases where the 95 UCL exceeds the maximum detected concentration, or where existing data are insufficient to calculate the 95 UCL, the maximum detected constituent concentration is shown. The 95 UCL was calculated using EPA's ProUCL statistical software package, version 4.00.04, using both censored and uncensored data. In order to obtain 95 percent coverage of the mean on some sample sets, ProUCL recommended percentile is greater than 95 percent due to high percentage of non-detects and/or high skewness of data distribution.

(f) Data represent sampling rounds conducted from 1996 through spring of 2009; not all stations were sampled during each round and not all constituents were analyzed during each round.

(g) Shaded cells indicate that value exceeds proposed surface water cleanup levels identified in Table 1.

nd = All sample results were non-detect.

-- Not analyzed

Table 6 - Potential Chemical-Specific ARARs for Groundwater

Constituents of Concern (ug/L)	Federal MCLGs (b)	Federal MCLs (c)	State MCLs (d)	MTCA Method A (e)	MTCA Method B (f)
Aluminum	--	--	--	--	16,000 (g)
Cadmium	5.00	5.00	5.00	5.00	8.00
Copper	1,300	1,300	1,300	--	592
Iron	--	--	--	--	--
Lead	zero	15.0	15.0	15.0	--
Zinc	--	--	--	--	4,800

Notes:

(a) Sufficient data are not available to calculate groundwater background.

(b) Maximum Contaminant Level Goals (MCLGs) for non-carcinogens. Non-zero MCLGs are potentially relevant and appropriate. 40 CFR 141.50 and 141.51 and Drinking Water Standards and Health Advisories Office.

(c) Maximum Contaminant Levels (MCLs). 40 CFR 141.62 and Drinking Water Standards and Health Advisories, Office of Water, US EPA, EPA 822-B-00-001, Summer 2000.

(d) WAC 246-290-310. State of Washington Primary MCLs.

(e) WAC 173-340-900, Table 720-1. MTCA Method A.

(f) WAC 173-340-720. MTCA Method B Groundwater cleanup levels. For carcinogenic constituents, the value presented is the lower of the non-carcinogenic and carcinogenic level calculated using Equations 720-1 and 720-2. Information from CLARC 3.1 was used unless otherwise noted.

(g) Calculated using reference dose (RfD) from EPA Region 9 Preliminary Remediation Goals table, October 2004.

(h) Shaded cells identify lowest potential chemical-specific ARAR.

-- Not established or not applicable.

Table 7 - Concentrations of Constituents of Concern in Groundwater

Constituents of Concern (ug/L)			Honeymoon Heights Waste Rock Piles		Mine Portal		Combined Lower West Area		East and West Waste Rock Piles (including Mill Building Area)		Tailings Pile 1	
			Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
	Proposed Cleanup Levels	Monitoring Wells/Seeps	A-1, SP-12, SP-14, SP-23	SP-14, SP-23	P-5	P-5	MW-1, MW-2, MW-3, MW-4, MW-4D, MW-4S, SP-9, SP-11, HBKG-1, SP-10, SP-16, SP-22, SP-24, SP-25	MW-1, MW-3, MW-4D, MW-4S, SP-16, HBKG-1	SP-15, SP-28, SP-6, SP-7, SP-8	SP-7, SP-15	CC-1D, CC-1S, PW-1, SP-1, SP-19, SP-2, TP1-1A, TP1-1D, TP1-2A, TP1-2D, TP1-4A, TP1-4B, TP1-5A, TP1-6A	SP-2, TP1-1A, TP1-1D, TP1-2A, TP1-2D, TP1-3A, TP1-4A, TP1-5A, TP1-6A
Aluminum	152		16,800	4,580	6,070	nd	5,140	1,290	6,890	1,790	61,600	43,500
Cadmium	0.090		38.3	22.4	48.5	8.00	32.6	35.1	73.4	63.0	32.3	11.7
Copper	1.17		7,370	4,600	2,960	28.0	2,860	2,140	5,690	7,560	944	179
Iron	1,000		130	480	202	nd	3,670	2,810	196	710	918,000	836,000
Lead	0.540		7.25	8.92	28.2	1.00	7.11	8.00	8.27	13.0	3.07	nd
Zinc	11.0		4,800	2,530	8,840	2,980	4,720	4,900	9,270	8,960	4,941	5,500

Table 7 (continued) - Concentrations of Constituents of Potential Concern in Groundwater

Constituents of Concern (ug/L)	Proposed Cleanup Levels	Monitoring Wells/Seeps	Tailings Pile 2		Tailings Pile 3		Downstream From Tailings Pile 3	
			Spring	Fall	Spring	Fall	Spring	Fall
			PZ-1A, PZ-1B, PZ-3A, SP-3, SP-4, TP2-04A, TP2-07A, TP2-08A, TP2-11A, TP2-11B, TP2-1D, TP2-4A, TP2-4B, TP2-5A, TP2-8A, TP2-8B	PZ-1B, PZ-2A, PZ-3A, SP-3, TP2-11A, TP2-1D, TP2-4A, TP2-8A	PZ-6A, SP-17, SP-18, SP-5, TP3-10, TP3-11, TP3-4, TP3-6A, TP3-8, TP3-9	PZ-4B, PZ-5A, PZ-6A, TP3-10A, TP3-6A, TP3-8, TP3-9	DS-1, DS-10, DS-2, DS-3D, DS-3S, DS-4D, DS-4S, DS-5, DS-6D, DS-6S, DS-7D, DS-7S, DS-8S, DS-9D, DS-9I, DS-9S, NRC-3D, NRC-3I, NRC-3S, SP-21	DS-1, DS-2, DS-3D, DS-3S, DS-4D, DS-4S, DS-5, DS-6D, DS-6S, DS-7D, DS-7S, NRC-3D, NRC-3I, NRC-3S, SP-21
Aluminum	152		804,000	3,960	17,300	6,760	3,040	14,300
Cadmium	0.090		2,030	3.08	11.3	3.73	0.915	0.940
Copper	1.17		4,050	24.9	465	29.1	24.9	64.2
Iron	1,000		741,000	146,000	83,700	198,000	781	16,700
Lead	0.540		42.3	52.0	37.8	66.7	0.212	nd
Zinc	11.0		510,000	294	823	278	131	167

Notes:

Groundwater includes data from monitoring wells, springs/seeps, and mine portal drainage. Sampling stations for each area and season are listed.

(a) Values represent dissolved concentrations.

(b) Data to create this table obtained from URS database query on 09/01/09.

(c) Spring data represents samples collected in May, June, or July; fall data represents all other months.

(d) Consistent with the statistical approach for evaluating compliance with cleanup levels for groundwater presented in WAC 173-340-720(9), concentrations shown represent the upper one-sided 95 percent confidence limit (95 UCL) on the mean constituent concentration. In cases where the 95 UCL exceeds the maximum detected concentration, or where existing data are insufficient to calculate the 95 UCL, the maximum detected constituent concentration is shown. The 95 UCL was calculated using EPA's ProUCL statistical software package, version 4.00.04, using both censored and uncensored data. In order to obtain 95 percent coverage of the mean on some sample sets, ProUCL recommended percentile is greater than 95 percent due to high percentage of non-detects and/or high skewness of data distribution.

(e) Data represent sampling rounds conducted from 1996 through spring of 2009; not all stations were sampled during each round and not all constituents were analyzed during each round.

(f) Shaded cells indicate that value exceeds groundwater cleanup levels identified in Table 1.

nd = All sample results were non-detect.

-- Not analyzed.

Table 8 - Potential Chemical-Specific ARARs and Background Concentrations for Soil

Constituents of Concern (mg/kg)	Human Health-Based Levels				Site-Specific Background Concentrations (g)	
	MTCA Method A Soil Cleanup Levels (a)	MTCA Method B Soil Cleanup Levels				
		Soil Ingestion (b)	Soil Ingestion and Dermal Contact (b)	Groundwater Protection (c)	Mixed Conifer Background Area (BGMC)	Riparian Background Area (BGR)
Aluminum	--	--	--	--	18,200	17,600
Arsenic	20.0	0.670	0.620	0.034	4.80	16.0
Barium	--	5,600	5,000	925	164	133
Cadmium	2	80.0	74.0	0.69	3.30	1.80
Chromium (f)	2,000	120,000	110,000	2,000	24.0	38.0
Copper	--	2,960	2,700	260	45.0	110
Lead	250	--	--	3,000	14.0	25.0
Mercury	2	24.0	18.0	2.1	0.930	0.430
Molybdenum	--	400	360	--	8.80	2.90
Selenium	--	400	360	5.3	12.0	1.40
Silver	--	400	360	13.7	0.650	0.600
Thallium	--	5.60	5.00	1.6	0.360	0.130
Zinc	--	24,000	22,000	6,000	136	177
Gasoline-Range Hydrocarbons	30.0/100 (d)	--	--	30/100 (d)	--	--
Diesel-Range Hydrocarbons	2,000	--	--	2,000	--	--
Heavy Oil-Range Hydrocarbons	2,000	--	--	2,000	--	--

Notes:

(a) WAC 173-340-740(2), WAC 173-340-900 (Table 740-1). Model Toxics Control Act (MTCA) Method A.

(b) WAC 173-340-740(3). MTCA Method B unrestricted land use soil cleanup standards. The values presented are from Table 8 of the SFS and represent the lower of the non-carcinogenic and carcinogenic level calculated using Equations 740-1 and 740-2 for ingestion only and Equations 740-4 and 740-5 for ingestion and dermal contact.

(c) WAC 173-340-747 provides for the derivation of soil concentrations for groundwater protection that may be used to establish Method B soil cleanup levels. These values are from Table 8 of the SFS, except for gasoline-, diesel- and heavy oil-range hydrocarbons, which are from WAC 173-340-900, Table 740-1. As described in Section 2.4 of the SFS, these values would not form the basis of proposed cleanup levels at the Site, in accordance with WAC 173-340-740(6)(f).

(d) 100 mg/kg is applicable when no benzene is present in soil and the total of BTEX is less than 1 percent of the gasoline mixture, otherwise 30 mg/kg is applicable.

(e) Based on total PCBs.

(f) Regulatory values for chromium based on total or trivalent form. Background concentrations based on total chromium.

(g) Site-specific background soil concentrations from draft TEE. BGR values are applicable to soils in Lower West Area (East & West), Lagoon, and Areas Downslope of Honeymoon Heights. BGMC values are applicable to all other areas.

-- Not established or not applicable

Table 9 - Ecological Risk-Based Soil Concentrations Protective of Terrestrial Receptors

Constituents of Concern (mg/kg)	Tailings Piles 1, 2, & 3	East & West Waste Rock Piles	Honeymoon Heights Waste Rock Piles	Ballfield Area	Holden Village	Windblown Tailings Area	Area Downslope from Honeymoon Heights	Lower West Area East	Lower West Area West	Lagoon	Maintenance Yard	Surface Water Retention Area	Site Specific Background Concentrations	
													Mixed Conifer Background Area (BGMC) (f)	Riparian Background Area (BGR) (f)
Aluminum	4,369	69	69	4,600	4,571	4,666	4,822	4,694	4,767	50 (c)	50 (c)	50 (c)	18,200	17,600
Arsenic	18 (a)	18 (a)	18 (a)	18 (a)	18 (a)	18 (a)	18 (a)	18 (a)	18 (a)	18 (a)	18 (a)	18 (a)	4.80	16.0
Barium	330 (b)	102	102	227	131	232	106	122	49	102 (e)	102 (e)	102 (e)	164	133
Cadmium	5.5	14	14	8	16	9	14	12	5	14 (e)	14 (e)	14 (e)	3.30	1.80
Chromium	29	29	29	29	29	42 (c)	29	29	29	42 (c)	42 (c)	42 (c)	24.0	38.0
Copper	85	46	46	46	112	85	288	39	24	70 (a)	70 (a)	70 (a)	45.0	110
Lead	161	118	118	201	124	139	201	121	201	118 (e)	118 (e)	118 (e)	14.0	25.0
Mercury	0.1 (d)	0.1 (d)	0.1 (d)	0.1 (d)	0.1 (d)	0.1 (d)	0.1 (d)	0.1 (d)	0.1 (d)	0.1 (d)	0.1 (d)	0.1 (d)	0.930	0.430
Molybdenum	18.6	2.3	2.3	0.3	0.7	6	5.5	1.2	0.8	2 (c)	2 (c)	2 (c)	8.80	2.90
Selenium	0.5 (a)	0.31	0.31	0.44	0.5 (a)	0.5 (a)	0.5 (a)	0.5 (a)	0.5 (a)	0.3 (e)	0.3 (e)	0.3 (e)	12.0	1.40
Silver	18.5	3.9	3.9	16.5	3.9	11.9	3.9	8.5	3.9	560 (a)	560 (a)	560 (a)	0.650	0.600
Thallium	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1 (c)	1 (c)	1 (c)	0.360	0.130
Zinc	120 (b)	120 (b)	120 (b)	120 (b)	120 (b)	120 (b)	120 (b)	120 (b)	120 (b)	120 (b)	120 (b)	120 (b)	136	177
TPH-Gasoline	100 (d)	100 (d)	100 (d)	100 (d)	100 (d)	100 (d)	100 (d)	100 (d)	100 (d)	100 (d)	100 (d)	100 (d)	--	--
TPH-Diesel	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	--	--
TPH-Heavy Oil	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	200 (d)	--	--

Notes:

See Appendix E for development of terrestrial risk-based values.

Values derived using literature-based TRVs and site-specific bioconcentration factors, except where footnoted (See Section 2.4.1 and Appendix E).

(a) Value based on EPA Eco-SSL plant value.

(b) Value based on EPA Eco-SSL invertebrate value.

(c) Value based on MTCA plant EISC (WAC 173-340, Table 749-3)

(d) Value based on MTCA invertebrate EISC (WAC 173-340, Table 749-3).

(e) Value based on MTCA wildlife EISC (WAC 173-340, Table 749-3).

(f) Site-specific background soil concentrations from draft TEE. BGR values are applicable to soils in Lower West Area (East and West), Lagoon, and Areas Downslope of Honeymoon Heights. BGMC values are applicable to all other areas.

Table 10 - Concentrations of Constituents of Concern in Soil

Constituents of Concern (mg/kg)	Tailings Piles 1, 2, & 3	East & West Waste Rock Piles	Honeymoon Heights Waste Rock Piles	Ballfield Area	Holden Village	Windblown Tailings Area	Area Downslope from Honeymoon Heights	Lower West Area East	Lower West Area West	Lagoon	Maintenance Yard	Surface Water Retention Area
Aluminum	15,900	16,400	18,100	17,900	20,300	15,700	18,400	20,100	16,300	33,500	23,900	20,200
Arsenic	--	--	--	--	--	--	20.0	20.0	26.0	5.00	60.0	--
Barium	459	409	344	82.0	185	192	238	352	66.0	343	717	660
Cadmium	19.5	4.77	3.00	1.40	1.60	0.690	5.30	130	1.70	184	21.6	8.03
Chromium	14.7	56.9	17.0	26.0	32.0	18.0	21.0	24.0	26.0	21.0	33.0	26.9
Copper	865	1,350	1,450	72.0	260	118	1,680	6,230	80.0	24,100	3,160	1,980
Lead	65.1	224	1,910	16.0	52.0	37.0	77.0	644	13.0	746	1,070	141
Mercury	0.303	0.499	3.40	0.320	0.042	0.310	1.90	1.10	0.320	--	--	0.530
Molybdenum	20.0	17.0	22.0	2.30	2.90	19.0	17.0	53.0	2.20	74.0	16.0	21.1
Selenium	6.64	4.67	6.90	0.450	0.780	1.90	2.40	10.0	0.360	--	--	6.83
Silver	3.59	3.25	8.20	0.720	0.860	1.30	3.30	11.0	0.700	27.0	5.00	7.31
Thallium	0.810	0.631	1.50	0.300	0.160	0.240	0.730	0.970	0.100	3.00	nd	1.20
Zinc	2,070	934	522	155	225	138	1,010	17,300	132	23,700	3,240	736
Gasoline-Range Hydrocarbons	--	--	--	--	--	--	--	--	--	nd	1,200	--
Diesel-Range Hydrocarbons	--	--	--	--	--	--	--	--	--	917	12,000	--
Heavy Oil-Range Hydrocarbons	--	--	--	--	--	--	--	--	--	1,120	9,800	--

Notes:
-- Not analyzed
nd = All sample results were non-detect.

(a) Data to create this table obtained from Appendix A of the draft TEE (ERM 2009a) except for petroleum hydrocarbon data for the Lagoon and Maintenance Yard which is from URS database query dated 09/01/09.

(b) Consistent with the statistical approach for evaluating compliance with cleanup levels for soil presented in WAC 173-340-740(7), concentrations shown represent the upper one-sided 95 percent confidence limit (95 UCL) on the mean constituent concentration. In cases where the 95 UCL exceeds the maximum detected concentration, or where existing data are insufficient to calculate the 95 UCL, the maximum detected constituent concentration is shown. The 95 UCL was calculated using EPA's ProUCL statistical software package, version 4.00.04, using both censored and uncensored data.

(c) No soil data are available for the Former Mill Building area.

(d) Shaded cells indicate concentrations exceed proposed cleanup levels (See Table 1). Non-shaded cells indicate concentrations that do not exceed proposed cleanup levels or analyte is not a constituent of concern for particular area.

Table 11 - Potential To Be Considered Chemical-Specific Criteria for Sediments

Constituent (mg/kg)	Northwest Regional Sediment Evaluation Framework (d, e)		Literature Sediment Quality Values
	SL1	SL2	
Aluminum	--	--	58,000 (a)
Beryllium	--	--	--
Arsenic	20.0	51.0	--
Cadmium	1.10	1.50	--
Chromium	95.0	100	--
Copper	80.0	830	--
Iron	--	--	40,000 (b)
Lead	340	430	--
Manganese	--	--	1,800 (c)
Mercury	0.280	0.750	--
Nickel	60.0	70.0	--
Silver	2.00	2.50	--
Zinc	130	400	--

Notes:

-- Not established or not applicable.

Shaded cells identify lowest potential TBC.

(a) Ingersoll et al., 1996.

(b) Persaud et al., 1993.

(c) Cubbage et al., 1997.

(d) US Army Corps of Engineers et al., 2006.

(e) Interim freshwater sediment quality guidelines. Lower screening level (SL1) corresponds to a concentration below which adverse effects to benthic organisms would not be expected. Upper screening level (SL2) corresponds to a concentration at which minor adverse effects may be observed in the more sensitive groups of benthic organisms.

Table 12 - Concentrations of Constituents of Concern in Sediments

Constiuents of Concern (mg/kg)	Railroad Creek Sediment Stations																Range of Concentrations in Lucerne Bar Sediments
	355	356	367	RC-1	347	BKG 1/2	350	RC-2	345	DG-1	351	352	353	MP-7	354	RC-3	
Aluminum	86,000	87,000	78,000	10,400	83,000	11,300	34,000	8,540	78,000	9,380	89,000	75,000	88,000	13,300	76,000	7,890	9,400 to 19,000
Beryllium	1.0	1.0	1.0		1.0	0.08	1 U		1.0	0.07	1.0	1.0	1.0		1.0		--
Cadmium	0.5	0.09	2.0	nd	2.0	0.9	nd	nd	0.6	1.1	0.06	0.5	nd	0.9	0.6	0.5	0.4 to 3.9
Chromium	79	36	97		85	17	18		70	4.4	44	93	52		74		--
Copper	74	12	37	29	240	77	200	101	140	184	26	130	13	147	150	59	46 to 308
Iron	63,000	47,000	99,000	15,700	71,000	17,000	150,000	19,000	50,000	20,600	66,000	71,000	40,000	26,300	60,000	14,800	15,400 to 52,800
Silver	nd	nd	nd		nd	0.64	1.2		0.17	0.73	0.067	0.11	0.45		0.01		--
Zinc	180	110	130	62	270	110	250	113	280	126	110	230	82	216	330	144	131 to 580

Notes:
(a) Values are from Table 11 in SFS.
(b) Shaded cells indicate concentrations exceed proposed cleanup levels (See Table 1).
-- indicates constituent was not analyzed in the sample.
nd = Non-detect

Table 13 - Proposed Points of Compliance

Media	Proposed Points of Compliance (a)
Soil	Under MTCA, soil cleanup levels and points of compliance are established separately for human exposure via direct contact, the protection of groundwater, and the protection of terrestrial ecological receptors [WAC 173-340-740]. The MTCA point of compliance for soil based on human exposure via direct contact is from the surface of the soil to 15 feet below the ground surface. However, capping and/or institutional controls will be established at various locations at the Site to prohibit excavation and other activities to eliminate the direct contact exposure pathway for humans. For the terrestrial receptors, a point of compliance for soils will be established based on risk to terrestrial ecological receptors. This point of compliance will be the biologically active zone, which is assumed to extend to a depth of 6 feet, or a site-specific depth based on a demonstration that an alternative depth is appropriate per WAC 173-340-7490(4)(a). Soil cleanup to protect downgradient groundwater, surface water, and sediment is required wherever soils exceed criteria and are not within a groundwater containment area [WAC 173-340-740(1)(d)].
Surface Water	The point of compliance for surface water cleanup levels is the point or points where the release enters the surface waters, unless Ecology has authorized a mixing zone [WAC 173-340-730(6)]. MTCA does not allow a mixing zone for groundwater discharges into surface water [WAC 173-340-720(8)(d)(i)(C)].
Groundwater	CERCLA and the NCP provide that groundwater should be returned to its beneficial use within a reasonable timeframe whenever practicable. When restoration of groundwater is not practicable, it is necessary to prevent further migration of the plume and to prevent exposure to the contaminated groundwater [40 CFR 300.430(a)(2)]. The NCP provides that groundwater cleanup levels should generally be attained throughout the contaminated plume. However, the NCP recognizes that groundwater may remain contaminated within a waste management area, and groundwater cleanup levels attained at and beyond the edge of the waste management area (55 Fed Reg 8712, 8753, March 8, 1990). MTCA requires the point of compliance for groundwater be throughout the Site, from the uppermost level of the saturated zone to the lowest depth that could potentially be affected. MTCA requires that groundwater cleanup levels be attained in all groundwater from the point of compliance to the outer boundary of the hazardous substance plume [WAC 173-340-720(8)]. MTCA allows a conditional point of compliance for groundwater for limited circumstances where it is not practicable to meet the cleanup level throughout the site within a reasonable restoration time frame (see note b). MTCA requires that the conditional point of compliance shall be as close as practicable to the source, and may be in surface water as close as technically possible to the point(s) where groundwater flows into the streams all across the Site. MTCA does not allow a mixing zone for groundwater discharges into surface water [WAC 173-340-720(8)(d)(i)(C)].

Notes:
(a) Points of compliance refer to the locations at the Site where proposed cleanup levels must be met.
(b) The DFFS found that it is not practicable to meet the proposed groundwater cleanup levels throughout the Site within a reasonable restoration time frame.

Table 14 - Terrestrial Ecological Hazard Quotients for Soil

Constituents of Concern	Receptor	Tailings Piles 1, 2, & 3	East & West Waste Rock Piles	Honeymoon Heights Waste Rock Piles	Ballfield Area	Holden Village	Windblown Tailings Area	Area Downslope from Honeymoon Heights	Lower West Area East	Lower West Area West	Lagoon	Maintenance Yard	Surface Water Retention Area
Aluminum	Plants					3		3	3		650	500	400
	Invertebrates					-		-	-		-	-	-
	Wildlife					4		4	4		-	-	-
Arsenic	Plants							1	1	1		3	
	Invertebrates							0.3	0.3	0.4		1	
	Wildlife							0.2	0.3	0.1		0.5	
Barium	Plants	1	1	1		0.4	0.4	0.5	1		1	1	1
	Invertebrates	1	1	1		1	1	1	1		1	2	2
	Wildlife	1	4	3		1	1	2	3		3	7	6
Cadmium	Plants	1	0.1					0.2	4		6	1	0.3
	Invertebrates	0.1	0.03					0.04	1		1	0.2	0.1
	Wildlife	4	0.3					0.4	10		10	2	1
Chromium	Plants		1		1	1						1	1
	Invertebrates		1		1	1						1	1
	Wildlife		2		1	1						0.5	0.4
Copper	Plants	8	2	3	1	2	1	6	200		300	50	30
	Invertebrates	10	30	30	2	2	1	6	50		300	40	30
	Wildlife	4	6	7	0.4	1	1	5	70		100	20	9
Lead	Plants	0.1	0.03	4	0.002	0.1	0.1	0.01	1		7	9	1
	Invertebrates	0.1	2	20	0.01	0.05	0.02	0.02	0.3		0.5	1	0.1
	Wildlife	0.4	2	20	0.1	0.4	0.3	0.4	5		7	9	1
Mercury	Plants			1				1	0				
	Invertebrates			30				20	10				
	Wildlife			1				0	0				
Molybdenum	Plants	1	7	10			3	3	40		40	8	
	Invertebrates	-	-	-			-	-	-		-	-	
	Wildlife	0.4	2	3			1	1	10		10	2	
Selenium	Plants							5	20				
	Invertebrates							1	2				
	Wildlife							1	6				
Silver	Plants	0.006	0.006	0.015	0.001	0.002	0.002	0.006	0.02	0.001	0.05	0.009	0.01
	Invertebrates	-	-	-	-	-	-	-	-	-	-	-	-
	Wildlife	0.2	1	2	0.04	0.2	0.1	1	1	0.2	-	-	-
Thallium	Plants	0.07	0.06	0.14				0.1	0.1		3		1
	Invertebrates	-	-	-				-	-		-		-
	Wildlife	40	60	200				70	100		-		-
Zinc	Plants	10	6	3	1	1	1	6	100		100	20	5
	Invertebrates	20	8	4	1	2	1	8	100		200	30	6
	Wildlife	5	3	1	0.3	1	0.4	1	50		70	9	2
TPH-Gasoline	Plants											-	
	Invertebrates											10	
	Wildlife										-	0.2	
TPH-Diesel	Plants										-	-	
	Invertebrates										5	60	
	Wildlife										0.2	2	
TPH-Heavy Oil	Plants										-	-	
	Invertebrates										6	50	
	Wildlife										0.2	2	

Notes:

Blank cells indicate that EPC of constituent is less than background value and/or is not a constituent of concern for the particular area of interest; HQ not calculated.

– No ecological screening level available for this receptor.

(a) Shaded cells indicate hazard quotient is greater than 1. Hazard quotients (HQs) were calculated by dividing constituent concentrations (see Table 10) by levels considered protective of terrestrial ecological receptor (see Appendix E). HQs are reported to one significant figure as suggested by EPA (2004).

Table 15 - Summary Comparison of Alternatives 11M, 13M, and 14[1]

Alternative 11M	Alternative 13M	Alternative 14
Groundwater Containment and Collection for Treatment		
Use fully penetrating barrier for containment and collection for treatment all groundwater below WMAs: a) the Lower West area and Tailings Pile 1: and b) Tailings Piles 2 and 3.	Use fully penetrating barrier for containment and collection for treatment all groundwater below the Lower West area and Tailings Pile 1. Collect for treatment a portion of groundwater below Tailings Pile 2 that flows into the former Railroad Creek Channel. No containment or collection for treatment of the remainder of impacted groundwater below Tailings Pile 2 or Tailing Pile 3, except as part of an unspecified future contingent action.	Use fully penetrating barrier for containment and collection for treatment all groundwater below WMAs: a) the Lower West area and Tailings Pile 1; and b) Tailings Piles 2 and 3. The groundwater containment barrier around Tailings Pile 2 and Tailings Pile 3 could be modified or may not need to be constructed if Intalco can demonstrate that contaminated groundwater will remain contained within the WMA and that an alternative approach, such as monitored natural attenuation, is effective at reducing groundwater concentrations to below proposed cleanup levels at the point(s) where groundwater discharges to Railroad Creek.
Railroad Creek		
Remove ferricrete, enhance existing rip rap, and monitor sediment quality over time.	Realign a portion of the channel to the north to avoid having to move the toe of the tailings piles, thus isolating ferricrete in the former channel. Use the former channel to be used for collection or conveyance of groundwater to treatment.	Similar to or the same as Alternative 13M. The extent of realignment may be extended farther west to avoid the need to move the toe of Tailings Pile 1.

[1] Summary does not include institutional controls which are similar for all alternatives.

Alternative 11M	Alternative 13M	Alternative 14
Copper Creek		
Modify channel to improve resistance to erosion and scour.	Modify channel to improve resistance to erosion and scour, and extend to intersect relocated Railroad Creek channel.	Similar to or the same as Alternative 13M.
Copper Creek Diversion		
Replace existing hydroelectric outfall channel with lined channel or culvert to Railroad Creek to avoid contact with tailings.	Similar to or the same as Alternative 11M.	Similar to or the same as Alternative 11M.
Wetland East of Tailings Pile 3		
Wetlands could be restored following elimination of groundwater impacts from Tailings Pile 3.	Wetlands would become the site of a new groundwater treatment system, than would require mitigation under various ARARs.	Similar to or the same as Alternative 13M.
Tailings Piles 1, 2, and 3		
Close and cap in accordance with the presumptive requirements of Limited Purpose Landfill regulations and other ARARs. Regrade all slopes for stability, including moving toe of slope away from Railroad and Copper Creeks as needed for construction of: ■ Groundwater barrier; ■ Groundwater collection trench; ■ Maintenance access road; and ■ Toe buttress. Cap (2-feet of soil with geomembrane assumed for cost estimating). Cap would require long-term maintenance to protect integrity of membrane.	Close and cap in accordance with the performance requirements of Limited Purpose Landfill regulations. Regrade north-facing slopes for stability, including construction of a toe buttress. Relocate Railroad Creek to avoid moving toe of slope adjacent to creek. Cap (6 to 12-inches of soil, gravel, slash, and/or amended tailings), and revegetated.	Close and cap in accordance with the performance requirements of Limited Purpose Landfill regulations and other ARARs. Regrade all slopes for stability, including moving toe of slope away from Copper Creek as needed for construction of: ■ Groundwater barrier; ■ Groundwater collection trench; ■ Maintenance access road; and ■ Toe buttress. Cap (2-feet of soil assumed for cost estimating) and revegetate.

Alternative 11M	Alternative 13M	Alternative 14
Tailings Piles 1, 2, and 3 (Continued)		
Construct upgradient diversion swale/french drain to divert stormwater run-on. Limited purpose landfill on top for sludge.	Construct upgradient diversion swale/french drain to divert stormwater run-on. Limited purpose landfill on top for sludge.	Construct upgradient diversion swale/french drain to divert stormwater run-on. Limited purpose landfill on top for sludge.
East and West Waste Rock Piles		
Close and cap in accordance with the presumptive requirements of Limited Purpose Landfill regs and other ARARs. Regrade slopes for stability. Excess waste rock would be placed on top of piles or relocated to tailings piles. Cap (2-feet of soil with geomembrane assumed for cost estimating). Cap would require long-term maintenance to protect integrity of membrane. Construct upgradient diversion swale/french drain to divert stormwater run-on.	Close and cap in accordance with the performance requirements of Limited Purpose Landfill regs. Regrade slopes for stability. Excess waste rock would be relocated to former mill building site or tailings piles. Cap with 6- to 12-inches of soil and revegetate. Construct upgradient diversion swale/french drain to divert stormwater run-on.	Close and cap in accordance with the performance requirements of Limited Purpose Landfill regs and other ARARs. Regrade slopes for stability. Excess waste rock would be placed on top of piles or relocated to tailings piles. Cap (2-feet of soil assumed for cost estimating) and revegetate. Construct upgradient diversion swale/french drain to divert stormwater run-on.
Honey Moon Heights Waste Rock Piles		
Remove waste rock for consolidation into tailings piles prior to capping. Collect and treat seeps SP-12 and SP-23 downslope of waste rock piles. Monitor groundwater to determine if additional groundwater collection for treatment is needed.	No action on waste rock piles. Collect and treat seeps SP-12 and SP-23 downslope of waste rock piles.	Use *in situ* treatment to raise pH to reduce mobility and bioavailability of hazardous substances. Collect and treat seeps SP-12 and SP-23 downslope of waste rock piles. Monitor groundwater to determine if additional groundwater collection for treatment is needed.
Impacted Areas Downslope of HHWRP		
Remove impacted soils and consolidate into tailings piles prior to capping.	No action.	Use *in situ* treatment to raise pH to reduce mobility and bioavailability of hazardous substances.

Alternative 11M	Alternative 13M	Alternative 14
Ballfield Area		
Remove impacted soils from areas with low habitat value and consolidate into tailings piles prior to capping. Use *in situ* treatment to raise pH to reduce mobility and bioavailability of hazardous substances.	No action.	Similar to or the same as Alternative 11M.
Holden Village		
Use *in situ* treatment to raise pH to reduce mobility and bioavailability of hazardous substances.	No action.	Similar to or the same as Alternative 11M.
Lower West Area		
Remove impacted soils from areas with low habitat value and consolidate into tailings piles prior to capping. Use *in situ* treatment to raise pH to reduce mobility and bioavailability of hazardous substances.	No action.	Similar to or the same as Alternative 11M.
Lagoon Area		
Remove impacted soils and consolidate into tailings piles prior to capping, and backfill excavation.	Remove impacted soils and consolidate into tailings piles prior to capping. Incorporate excavation into groundwater treatment facility.	Similar to or the same as Alternative 13M.
Windblown Tailings Area		
Use *in situ* treatment to raise pH to reduce mobility and bioavailability of hazardous substances.	Remove (or cap) impacted soils in area of creek realignment. No action in remainder of area.	Remove impacted soils in area of creek realignment. Use *in situ* treatment to raise pH to reduce mobility and bioavailability of hazardous substances.
Maintenance Yard		
Cap with concrete or asphalt paving.	Cap with concrete or an impermeable liner & gravel	Cap with concrete or asphalt paving.

Alternative 11M	Alternative 13M	Alternative 14
Former Mill Building		
Demolish building as needed to remove soils and processing residuals for consolidation in Tailings Piles prior to capping. The disturbed area would be stabilized to prevent long-term erosion, and revegetated. Construct upgradient diversion swale/french drain to divert stormwater run-on.	Demolish building superstructure. Remove contaminated materials and/or cap with waste rock and 6-inches of soil, and revegetate. Construct upgradient diversion swale/french drain to divert stormwater run-on.	Demolish building as needed to remove soils and processing residuals for consolidation in Tailings Piles prior to capping. The disturbed area would be stabilized to prevent long-term erosion, and revegetated. Construct upgradient diversion swale/french drain to divert stormwater run-on.
Ventilator Portal Surface Water Retention Area		
Remove impacted soils and consolidate into tailings piles prior to capping, and backfill excavation.	Similar to or the same as Alternative 11M.	Similar to or the same as Alternative 11M.
Groundwater Treatment Facilities		
Single treatment facility located north of Railroad creek and east of tailings Pile 3 would rely on mechanical pumping influent. Treatment accomplished by pH adjustment and sedimentation, subject to enhancement based on treatability and performance testing.	Two treatment systems, one in Lower West Area and the other east of Tailings Pile 3 and south of Railroad creek, both rely on gravity flow. Treatment accomplished by pH adjustment and sedimentation, subject to enhancement based on treatability and performance testing.	Similar to or the same as Alternative 13M.

J:\Jobs\476915\Deliverables\ASFS\Tables\Table 15 - Compare Alts 11M, 13M, 14.doc

FIGURES

Site Location and Project Vicinity Map

Note: Base map prepared from Microsoft Streets and Trips 2005.

N

0 7.5 15

Approximate Scale in Miles

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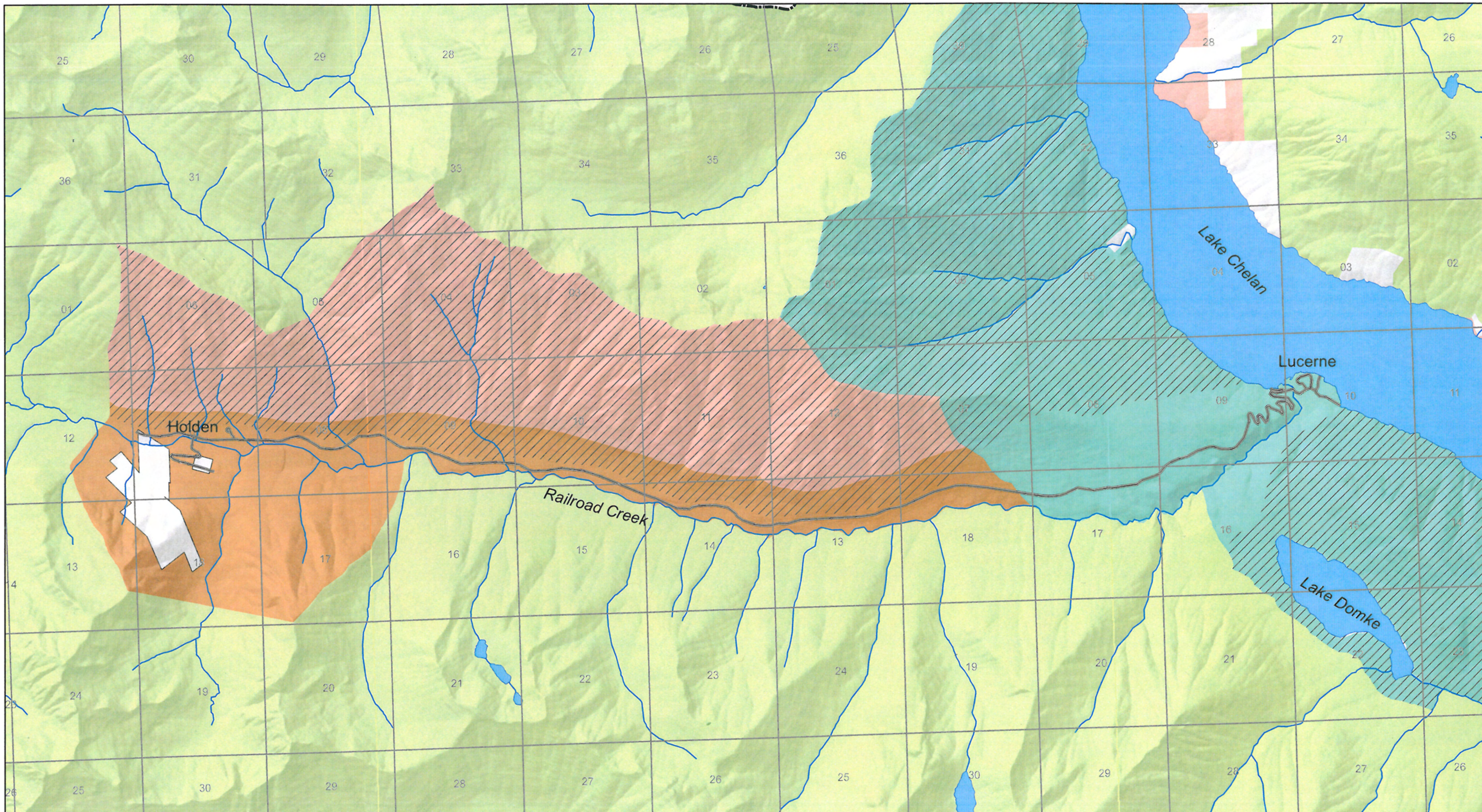
4769-15 ***6/10***

Figure 1

ASFS

Land Use Map

Northwest Forest Plan Allocations for Holden Mine Area



Administratively Withdrawn

Congressionally Withdrawn (Glacier Peak Wilderness Area)

Late Successional Reserve (LSR)

Matrix

Private and Other (Including Patented Mining Claims)

Roadless Area

Note: Matrix area includes other areas administratively withdrawn from mineral entry.

0 0.75 1.5

Scale in Miles

N

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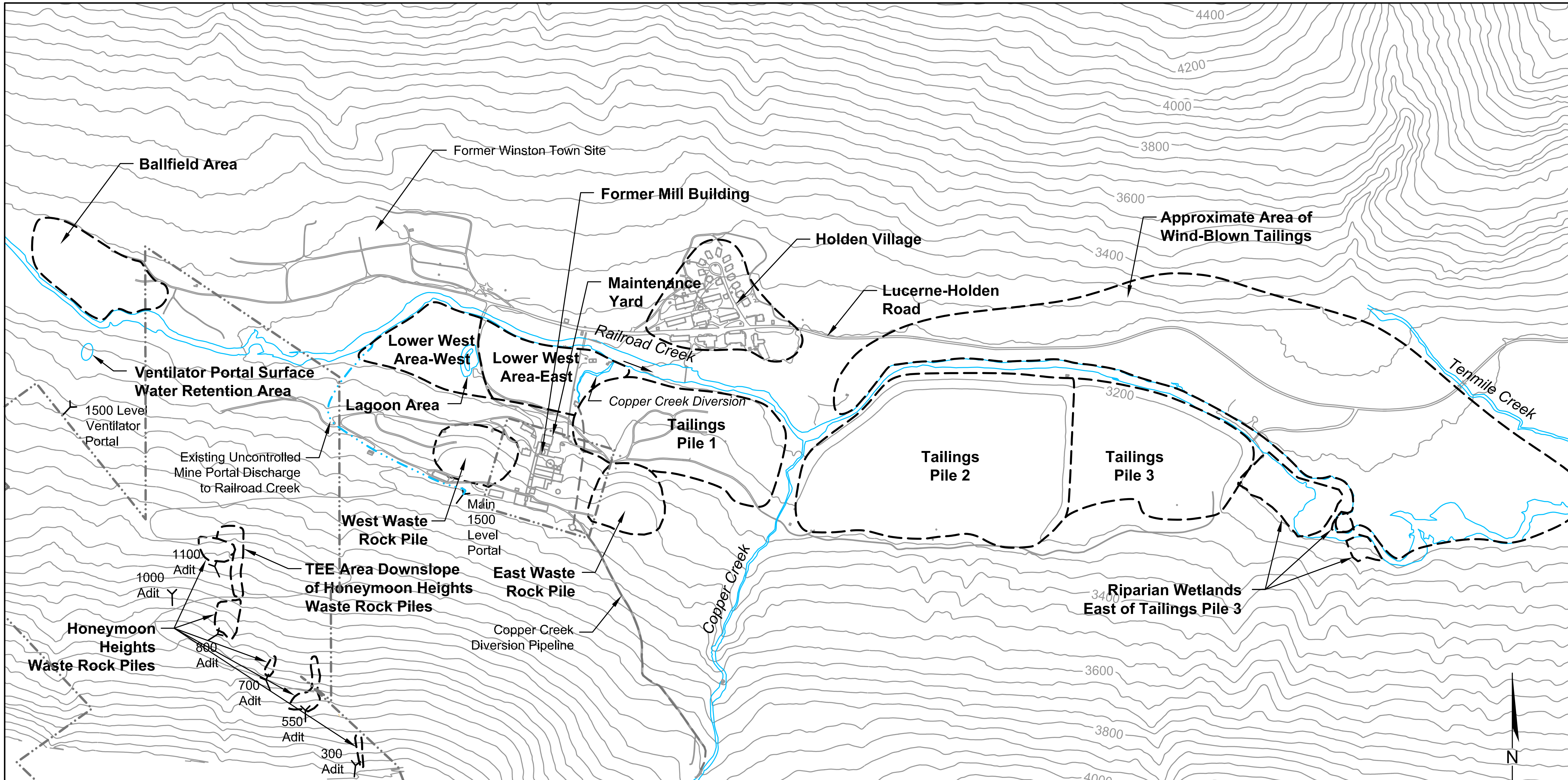
Figure 2

ASFS

476915ASFS-AB.mxd EAL 03/30/10

Principal Site Features



Source: Base map from URS (2004). Various features from DRI, DFFS, Draft TEE Report, and airphoto interpretation by Forest Service.

Patented Mining Claim

Note: Contour interval is 50 feet.

0 660 1320
Scale in Feet

HARTCROWSER

4769-15 ***6/10***

Figure 3

ASFS

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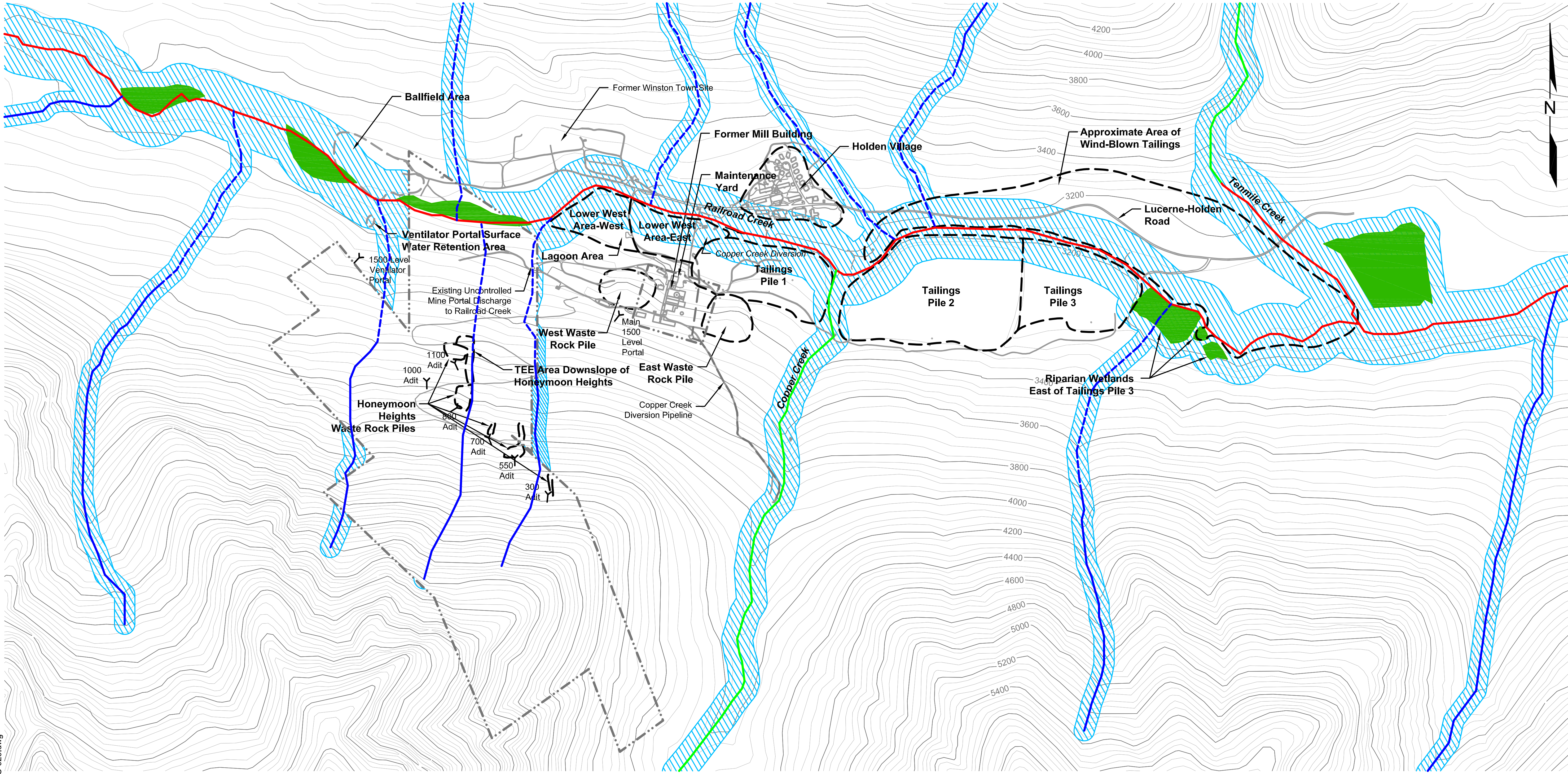
Riparian Reserve Map



***Source**: Streams and wetlands from Forest Service GIS Data (2010) and airphoto interpretation by Forest Service.*

- Fish Bearing - 300-Foot Buffer
- Permanenetly Flowing NON Fish Bearing - 150-Foot Buffer
- Intermittent NON Fish Bearing - 100-Foot Buffer
- Subsurface Stream?
- Riparian Reserve
- Wetlands >1 Acre - 150-Foot Buffer Each Bank
- Patented Mining Claim

0 1000 2000
Scale in Feet

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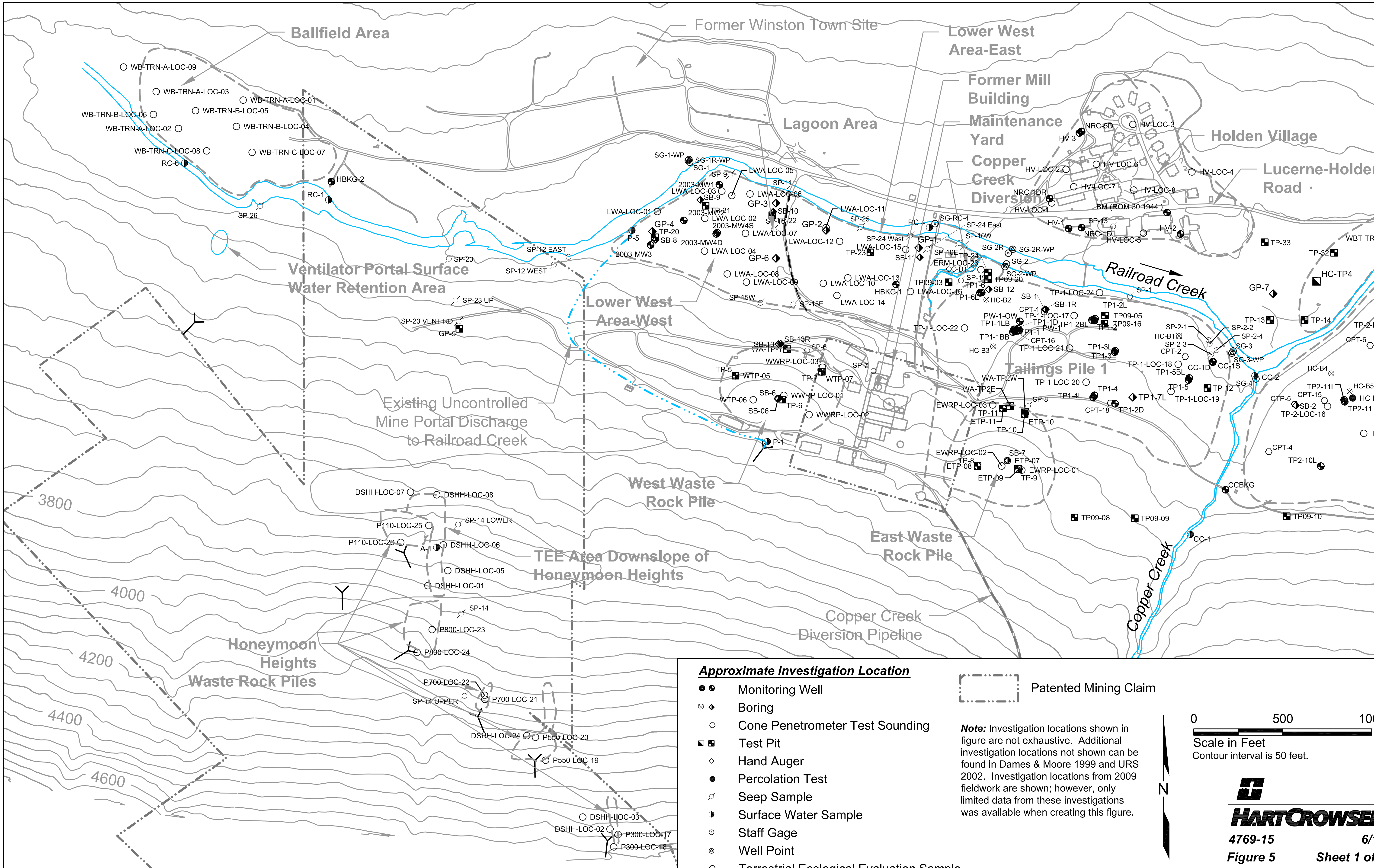
Figure 4
ASFS

Investigation Locations - Area West of Copper Creek



Approximate Investigation Location

◉	Monitoring Well
⊠ ◆	Boring
○	Cone Penetrometer Test Sounding
◩	Test Pit
◇	Hand Auger
●	Percolation Test
⌀	Seep Sample
◑	Surface Water Sample
⊙	Staff Gage
⊗	Well Point
○	Terrestrial Ecological Evaluation Sample (Soil, Invertebrate, or Plant Tissue)

Patented Mining Claim

Note: Investigation locations shown in figure are not exhaustive. Additional investigation locations not shown can be found in Dames & Moore 1999 and URS 2002. Investigation locations from 2009 fieldwork are shown; however, only limited data from these investigations was available when creating this figure.

N

0 500 1000
Scale in Feet
Contour interval is 50 feet.

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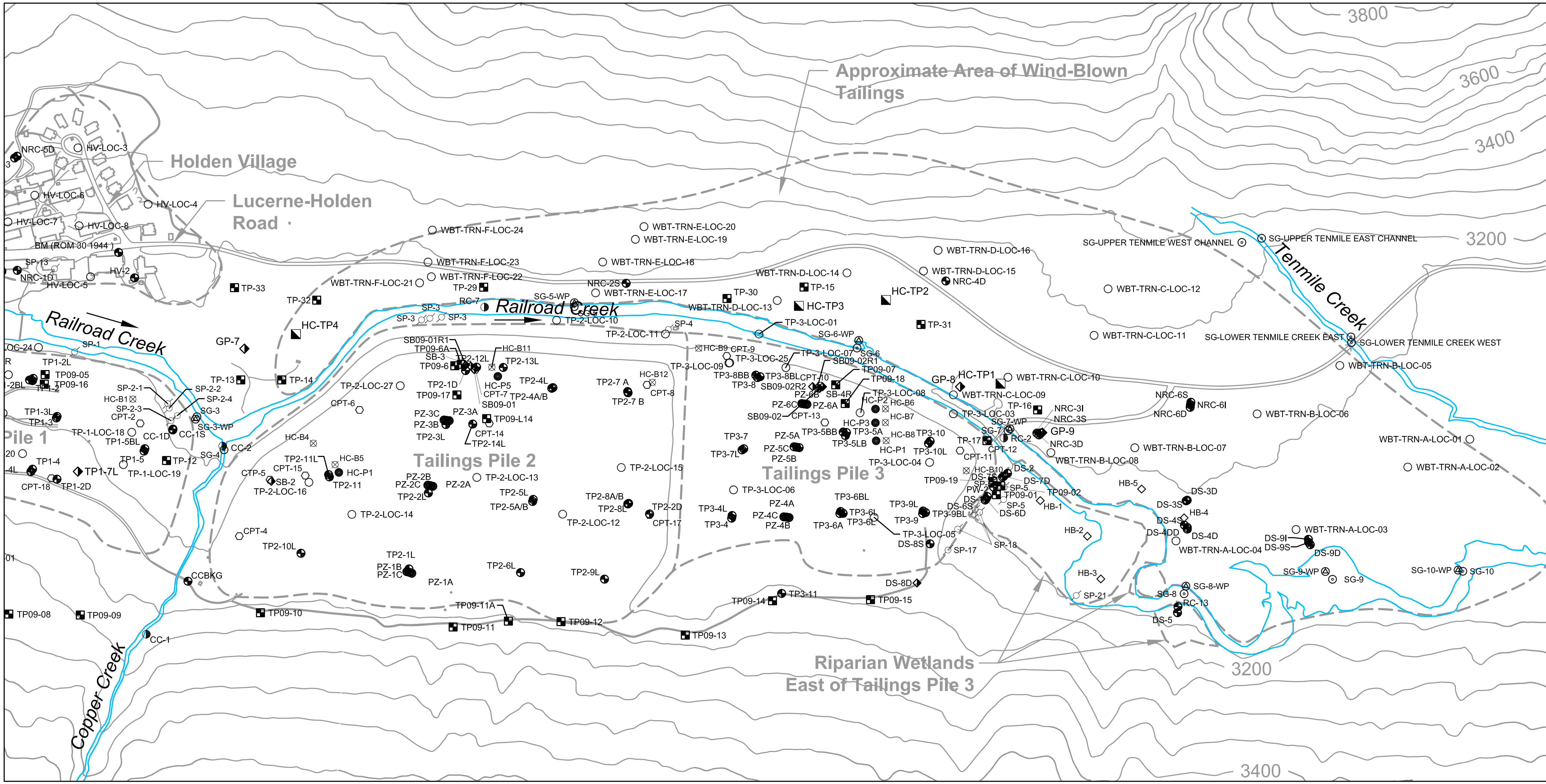
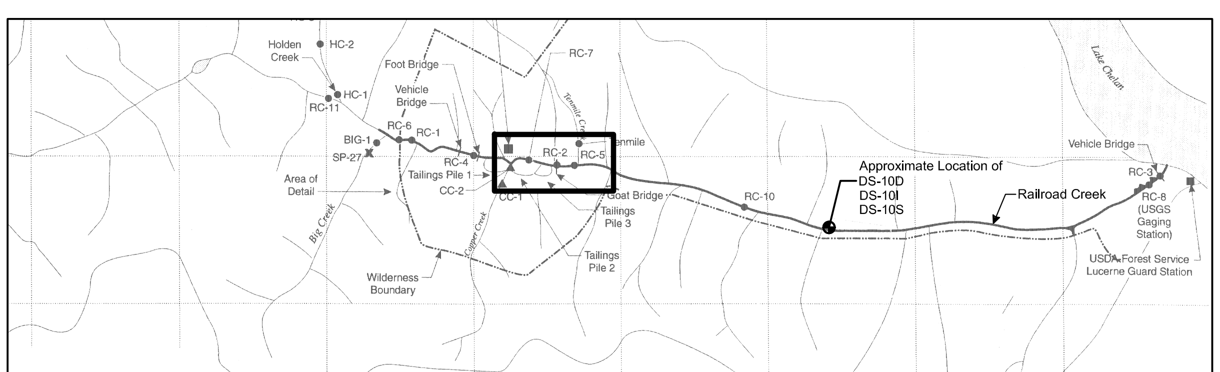
4769-15 ***6/10***
Figure 5 ***Sheet 1 of 3***
ASFS

Investigation Locations - Area East of Copper Creek





0 10000 20000
Approximate Scale in Feet

Approximate Investigation Location

- Monitoring Well
- Boring
- Cone Penetrometer Test Sounding
- Test Pit
- Hand Auger
- Percolation Test
- Seep Sample
- Surface Water Sample
- Staff Gage
- Well Point
- Terrestrial Ecological Evaluation Sample (Soil, Invertebrate, or Plant Tissue)

Note: Investigation locations shown in figure are not exhaustive. Additional investigation locations not shown can be found in Dames & Moore 1999 and URS 2002. Investigation locations from 2009 fieldwork are shown; however, only limited data from these investigations was available when creating this figure.

N

0 500 1000
Scale in Feet
Contour interval is 50 feet.

HARTCROWSER
4769-15 ***6/10***
Figure 5 ***Sheet 2 of 3***
ASFS

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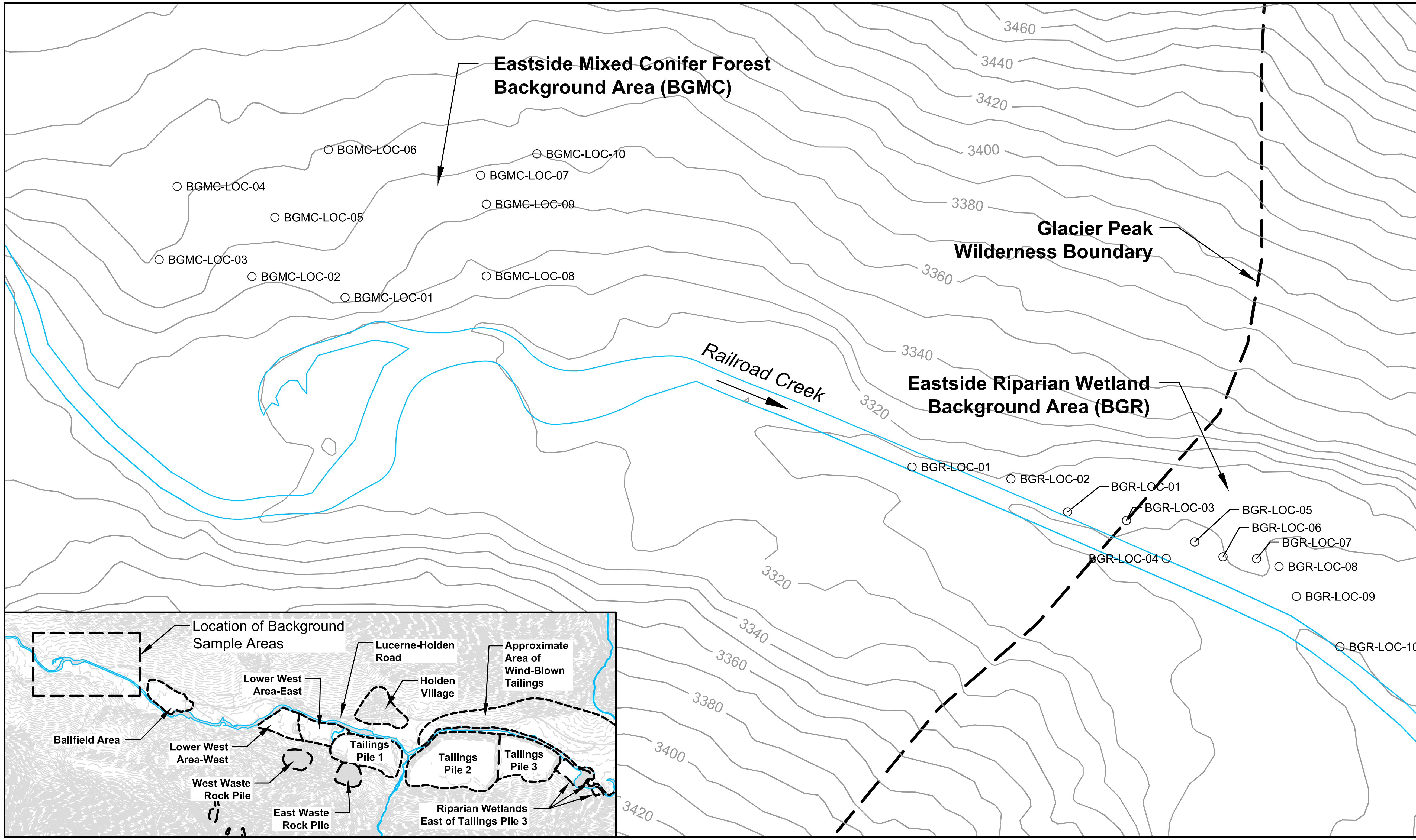
Investigation Locations - TEE Background Samples



***Source**:* Base map from URS (2008).

BGR-LOC-01 ○ Background Sample Location and Number

Note: Contour interval is 10 feet.

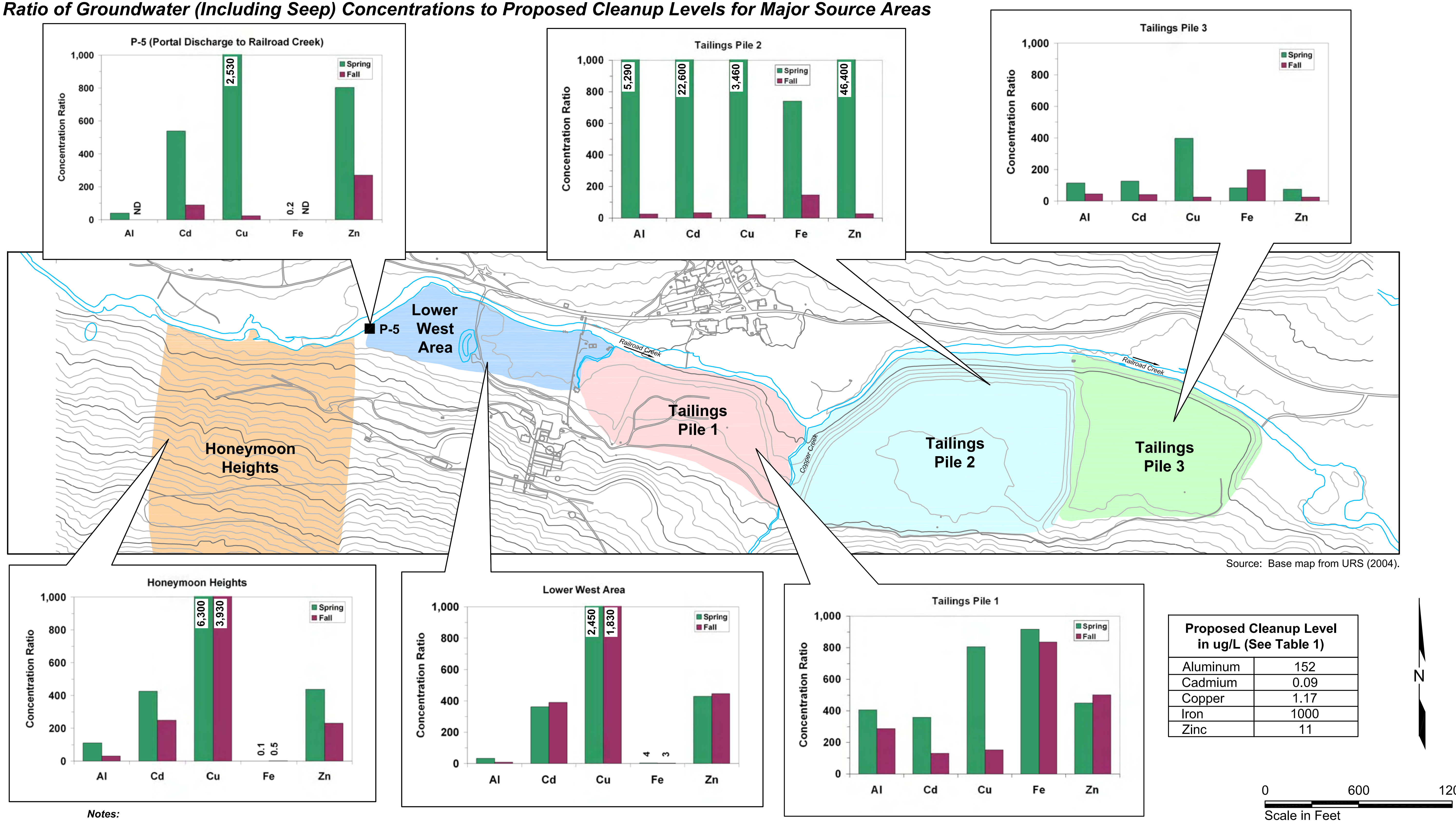
0 150 300
Scale in Feet

N

HARTCROWSER
4769-15 6/10
Figure 5 Sheet 3 of 3
ASFS

EAL 06/8/10 476915ASFS-003.dwg

Ratio of Groundwater (Including Seep) Concentrations to Proposed Cleanup Levels for Major Source Areas



Source: Base map from URS (2004).

Proposed Cleanup Level in ug/L (See Table 1)	
Aluminum	152
Cadmium	0.09
Copper	1.17
Iron	1000
Zinc	11

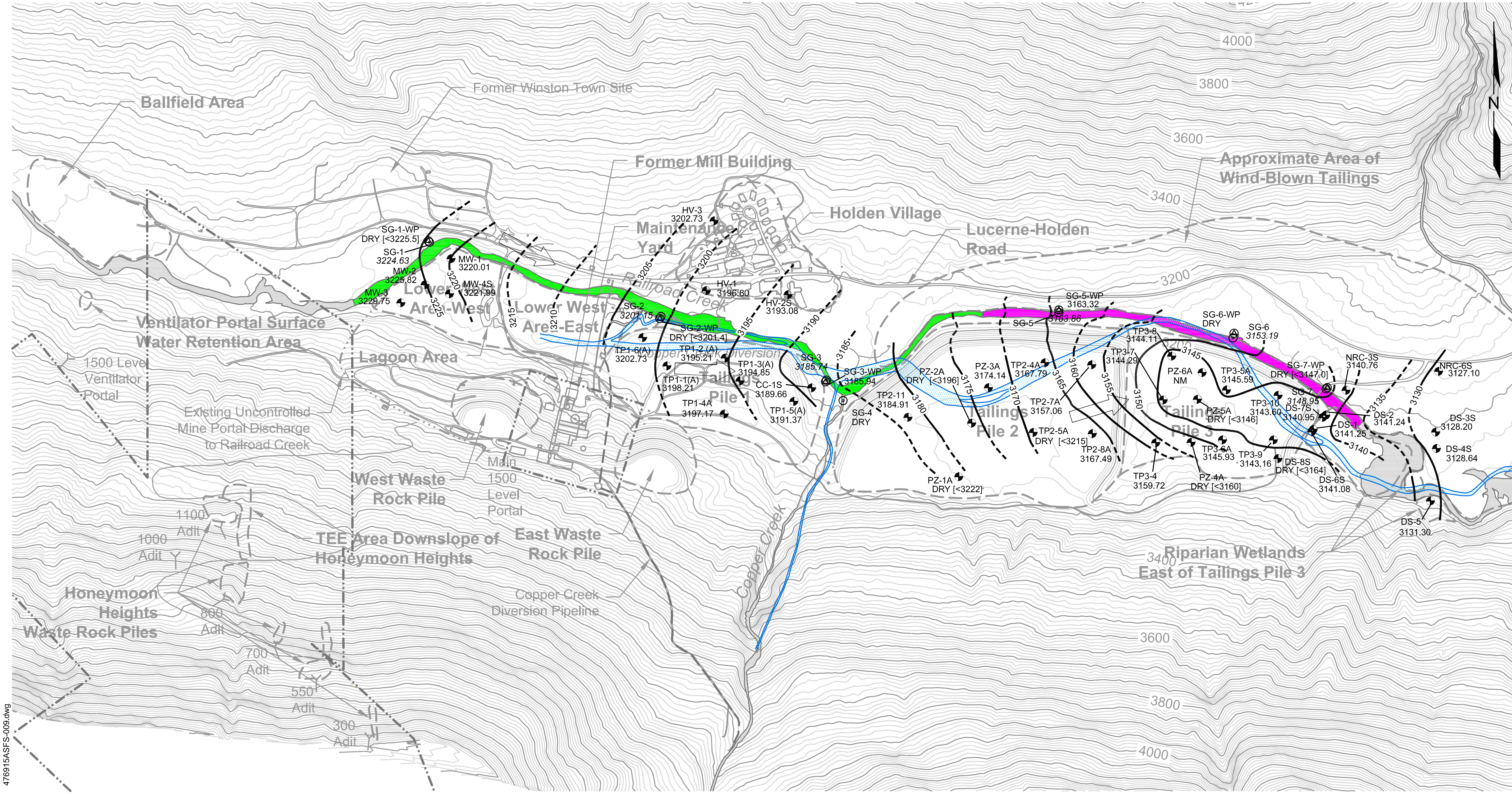
Notes:

1. Plots show the ratio of the constituent concentrations shown in Table 7 to the proposed cleanup levels shown in Table 1. Concentration Ratio = Constituent Concentration/Proposed Cleanup Level.
2. Additional details on the determination of constituent concentrations are noted on Table 7.
3. Additional details on proposed cleanup levels are provided in the text and noted on Table 1.
4. Vertical scales of plots vary. The numerical values of any ratios that exceed the vertical scale of the plot are noted.
5. "ND" indicates all sample results were non-detect.
6. Al = Aluminum, Cd = Cadmium, Cu = Copper, Fe = Iron, and Zn = Zinc.
7. Lead data is not shown because available data may not be representative due to inconsistent analyses for lead concentrations.

EAL 06/8/10 476915ASFS-005.dwg

HARTCROWSER
4769-15 *6/10*
Figure 6
ASFS

Groundwater Elevations and Generalized Flow Map - October 2008



476915ASFS-009.dwg
EAL 06/15/10

Legend

- Monitoring Well
- Well Point
- 3190.9 Groundwater Elevation, feet above mean sea level
- Groundwater Contour, feet above mean sea level (Dashed Where Inferred)
- Staff Gage
- *3125.52* Surface Water Elevation, feet above mean sea level
- NM Not Measured
- Estimated Extent of Gaining Reach of Railroad Creek
- Estimated Extent of Losing Reach of Railroad Creek
- Creek Channels in 1937 Based on Howe Sound Map
- Groundwater Flow Direction

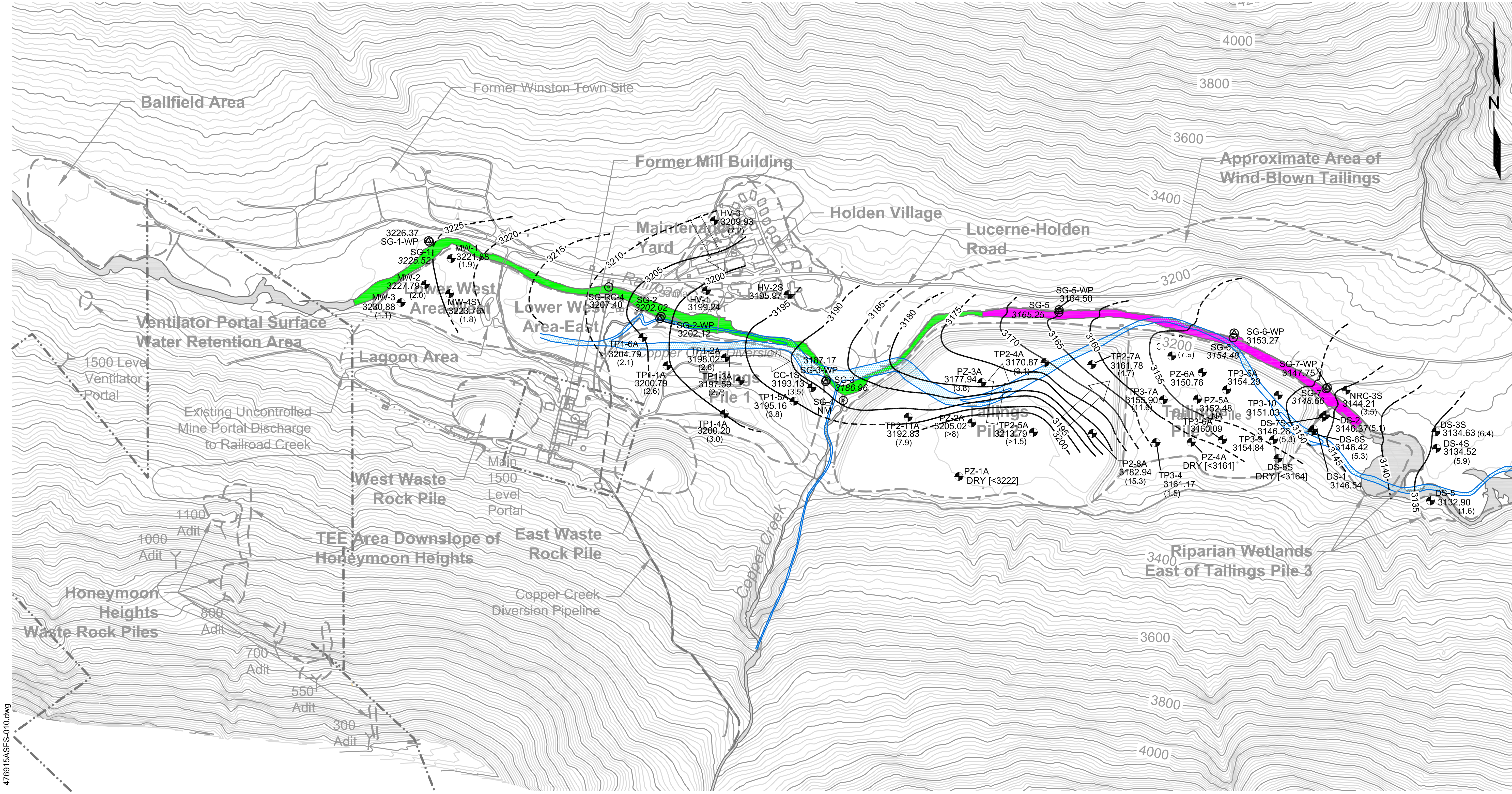
0 600 1200
Scale in Feet

Source: Prepared from Figures E2-16 and D3-1, Draft Alternative 13M Evaluation Report, ERM and URS, 2009.

HARTCROWSER

4769-15 *6/10*
Figure 7 *Sheet 1 of 2*
ASFS

Groundwater Elevations and Generalized Flow Map - July 2008



Legend

- Monitoring Well
- Well Point
- 3190.9 Groundwater Elevation, feet above mean sea level
- Groundwater Contour, feet above mean sea level (Dashed Where Inferred)
- Staff Gage
- *3125.52* Surface Water Elevation, feet above mean sea level
- NM Not Measured
- Estimated Extent of Gaining Reach of Railroad Creek
- Estimated Extent of Losing Reach of Railroad Creek
- Creek Channels in 1937 Based on Howe Sound Map
- Groundwater Flow Direction

0 600 1200
Scale in Feet

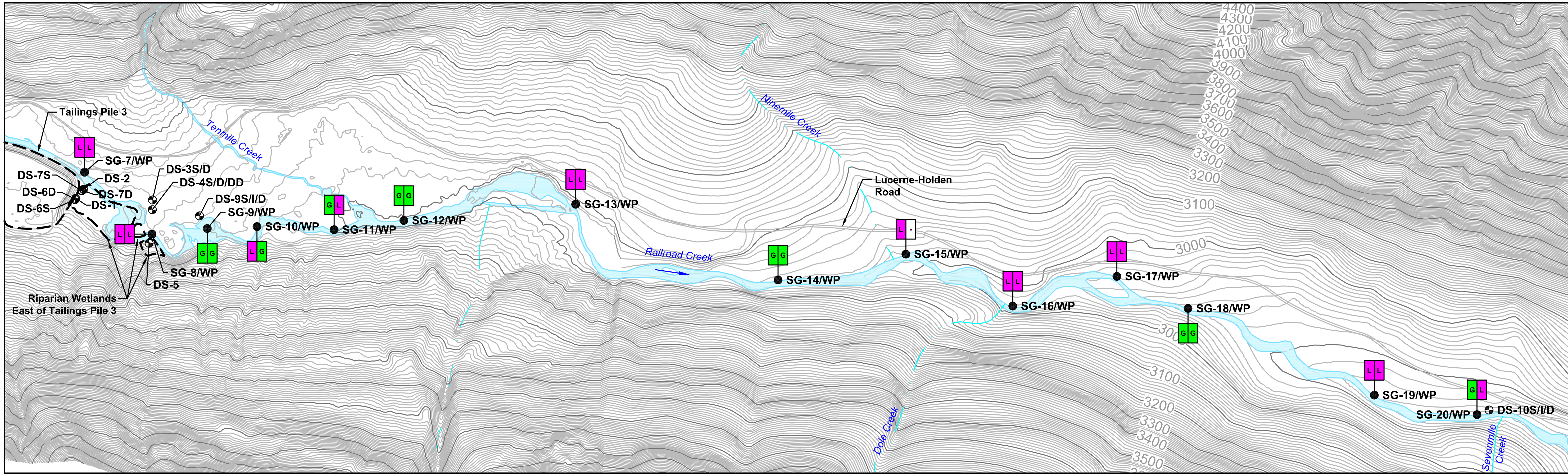
Source: Prepared from Figures E2-16 and D3-1, Draft Alternative 13M Evaluation Report, ERM and URS, 2009.

EAL 06/15/10 476915ASFS-010.dwg

HARTCROWSER

4769-15 *6/10*
Figure 7 *Sheet 2 of 2*
ASFS

Groundwater Concentrations and Railroad Creek Stream Conditions East of Tailings Pile 3



Stream Conditions at Stream Gage/Well Point Pair

G Gaining
L Losing
- N/A (See Note 7)
Spring — G L — Fall
DS-10S/I/D Monitoring Well/Well Cluster
SG-7/WP Stream Gage/Well Point Pair

Source: Base map from URS (2009).

	Constituent (ug/L)	DS-1	DS-2	DS-3S	DS-3D	DS-4S	DS-4D	DS-4DD	DS-5	DS-6S	DS-6D	DS-7S	DS-7D	DS-9S	DS-9I	DS-9D	DS-10S	DS-10I	DS-10D	SG-9-WP	SG-10-WP	SG-11-WP	SG-12-WP	SG-13-WP	SG-18-WP	SG-20-WP
Spring 2009	Aluminum	50 U	10,900	50 U	50 U	50 U	50 U	--	50 U	50 U	50 U	1,940	50 U	50 U	9,730	50 U	50 U	50 U	50 U	--	--	--	--	--	--	--
	Cadmium	0.3	1.7	0.2 U	0.2	0.2 U	0.2 U	--	0.2 U	0.3	0.4	1.2	0.2 U	0.2 U	3	0.2 U	0.2 U	0.2 U	0.2 U	--	--	--	--	--	--	--
	Copper	3.2	42.2	0.5	0.5 U	0.5 U	0.5 U	--	0.5 U	0.3	0.5 U	19.7	0.5 U	0.5 U	16.5	0.5 U	0.5 U	0.5 U	0.5 U	--	--	--	--	--	--	--
	Iron	50 U	100	50 U	50 U	50 U	50 U	--	50 U	50 U	50 U	50 U	50 U	50 U	10,800	50 U	50 U	50 U	50 U	--	--	--	--	--	--	--
	Zinc	36	168	12	15	11	13	--	4 U	4 U	4 U	125	4 U	4 U	440	13	4 U	4 U	4 U	--	--	--	--	--	--	--
Fall 2009	Aluminum	50 U	33,700	50 U	50 U	50 U	70	50 U	50 U	410	50 U	630	50 U	50 U	4,860	50 U	50 U	50 U	50 U	50 U	1,500	60	50 U	200	50	50 U
	Cadmium	0.3	2.5	0.2	0.2	0.2 U	0.2 U	0.2 U	0.2 U	1.9	0.4	0.2 U	0.2 U	0.2 U	1.4	0.2 U	0.2 U	0.2 U	0.2 U	2.03	4.45	1.64	4.8	3.1	0.87	0.26
	Copper	3	104	0.5 U	0.5 U	0.5 U	0.5	0.5 U	0.5 U	13.4	0.5 U	0.5 U	0.5 U	0.5 U	9.5	0.5 U	0.5 U	0.5 U	0.5 U	2.3	10.2	0.7	2.7	3	0.9	0.5
	Iron	50 U	117,000	50 U	50 U	50 U	50 U	50	50 U	22,400	50 U	356,000	50 U	50 U	240	50 U	270	50 U	50 U	50 U	50 U	20,100	4,460	160	330	90
	Zinc	40	258	17	15	24	17	39	9	46	4 U	53	4 U	12	180	4 U	4 U	4 U	4 U	22.5	138	6.5	5	6	3	2

EAL 6/8/10 476915ASFS-013.dwg

Notes:
1. Stream conditions determined from paired well points and stream gages measured in June 2009 (spring) and October 2009 (fall), as reported by URS in the draft Hydrogeological Technical Memorandum Addendum, dated February 24, 2010.
2. S/I/D indicate monitoring well clusters screened at shallow, intermediate, and deep relative depths, respectively.
3. -- Data not available.
4. U - Constituent not detected; reporting limit shown.
5. Shaded cells indicate detected concentration exceeds proposed cleanup level.
6. No groundwater concentration data available for SG-7-WP, SG-8-WP, SG-14-WP through SG-17-WP, and SG-19-WP.
7. N/A - Stream gaining/losing condition could not be determined because water elevations below field instrument measurement elevations.
8. Lead data is not shown because available data may not be representative due to inconsistent analyses for lead concentrations.

Proposed Cleanup Level in ug/L (see Table 1)	
Aluminum	152
Cadmium	0.09
Copper	1.17
Iron	1,000
Zinc	11

0 1000 2000
Scale in Feet

N

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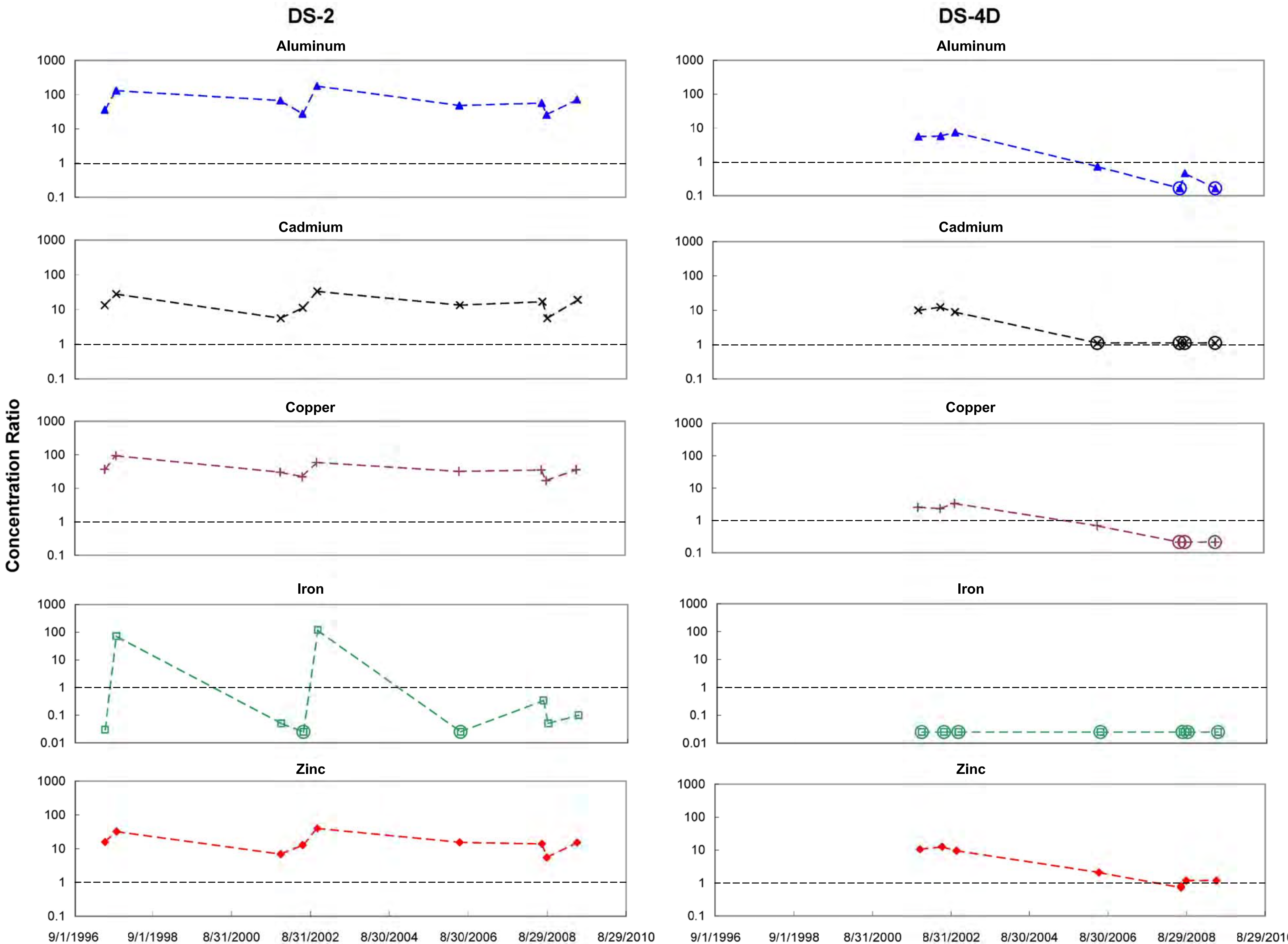
4769-15 ***6/10***
Figure 8
ASFS

Ratio of Groundwater Concentrations to Proposed Cleanup Levels Over Time in Wells DS-2 and DS-4D



Proposed Cleanup Level in ug/L (See Table 1)	
Aluminum	152
Cadmium	0.09
Copper	1.17
Iron	1000
Zinc	11

Notes:

1. Plots show the ratio of the constituent concentrations to the proposed cleanup level. Concentration Ratio = Constituent Concentration/Proposed Cleanup Level.
2. Dissolved constituent concentrations measured in groundwater were used to calculate concentration ratios.
3. Circled data points indicate the constituent was not detected in the sample, and a concentration of one-half the detection limit is shown.
4. Constituent concentration data obtained from URS data base query on 9/1/09.
5. Lead data is not shown because available data may not be representative due to inconsistent analyses for lead concentrations.

EAL 6/8/10 476915ASFS-028.dwg

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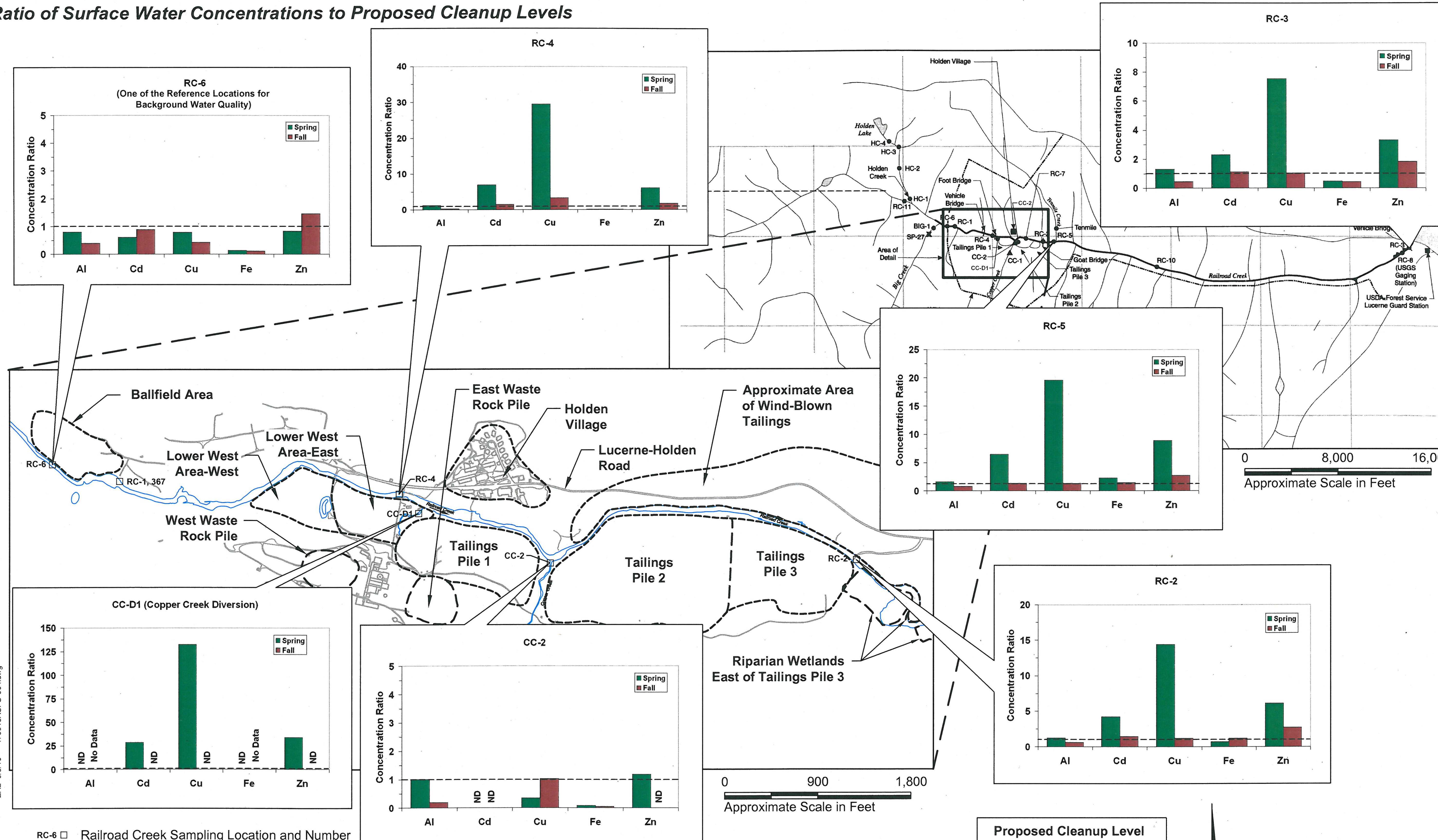
4769-15 *6/10*

Figure 9

ASFS

Ratio of Surface Water Concentrations to Proposed Cleanup Levels



RC-6 □ Railroad Creek Sampling Location and Number

Notes:
1. Plots show the ratio of the constituent concentrations shown in Table 5 to the proposed cleanup levels shown in Table 1. Concentration Ratio = Constituent Concentration/Proposed Cleanup Level.
2. Additional details on the determination of constituent concentrations are noted on Table 5.
3. Additional details on proposed cleanup levels are provided in the text and noted on Table 1.
4. Vertical axis scales of plots vary. Horizontal dashed line identifies a concentration ratio of one in all plots.
5. "ND" indicates all samples were non-detect. "No Data" indicates samples were not analyzed for constituent.
6. Plots reflect constituent concentrations in grab samples taken from surface water under fully or partially mixed conditions and do not represent conditions at MTCA-defined conditional point(s) of compliance.
7. Al = Aluminum, Cd = Cadmium, Cu = Copper, Fe = Iron, and Zn = Zinc.
8. Lead data is not shown because available data may not be representative due to inconsistent analyses for lead concentrations.

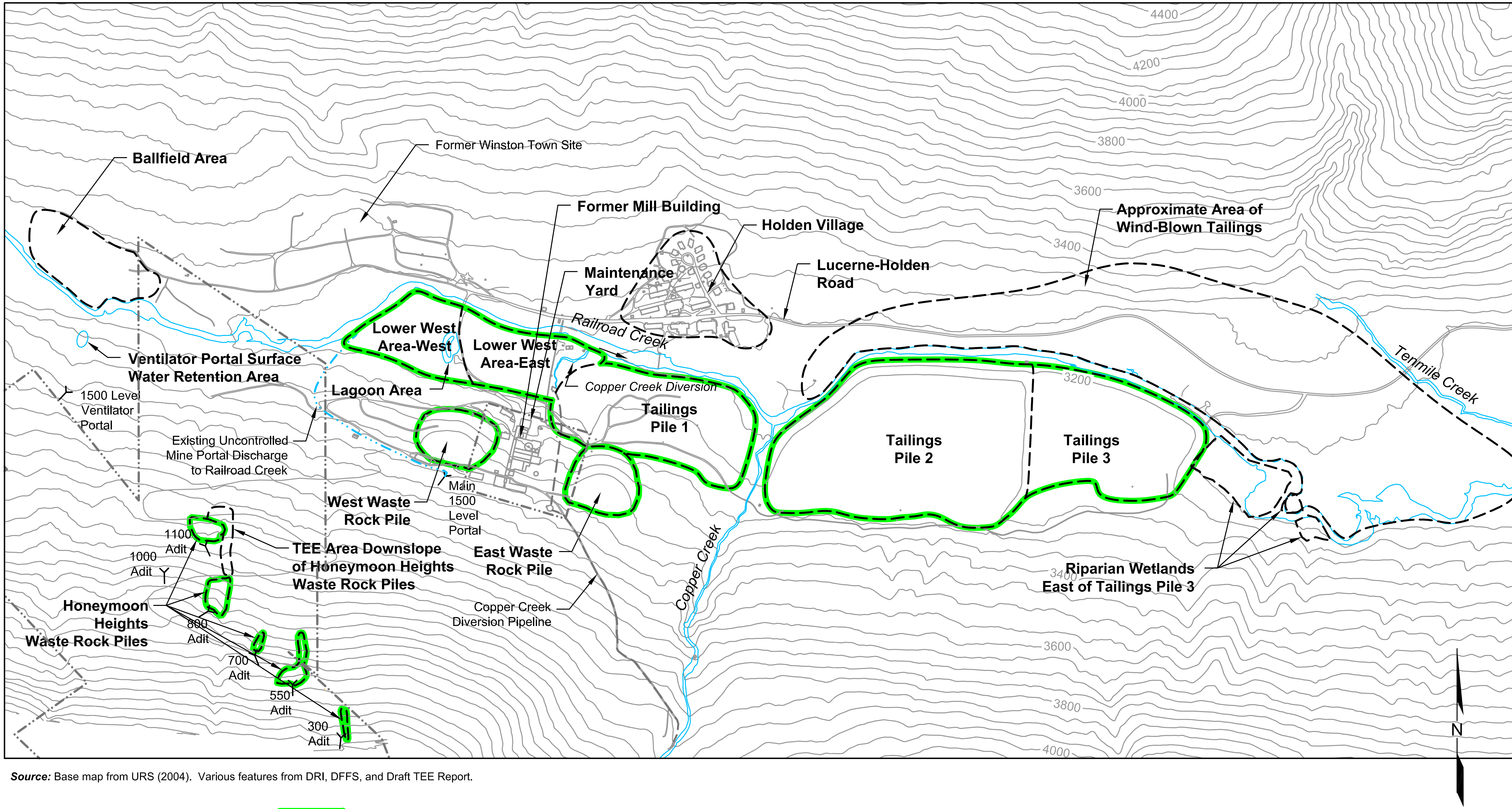
Proposed Cleanup Level in ug/L (See Table 1)	
Aluminum	152
Cadmium	0.09
Copper	1.17
Iron	1000
Zinc	11

N

HARTCROWSER
4769-15 6/10
Figure 10
ASFS

EAL 6/8/10 476915ASFS-004.dwg

Proposed Waste Management Areas



476915ASFS-002.dwg

EAL 06/8/10

Source: Base map from URS (2004). Various features from DRI, DFFS, and Draft TEE Report.

Patented Mining Claim

Approximate Limits of Potential Waste Management Areas under Alternatives 11M and 14.

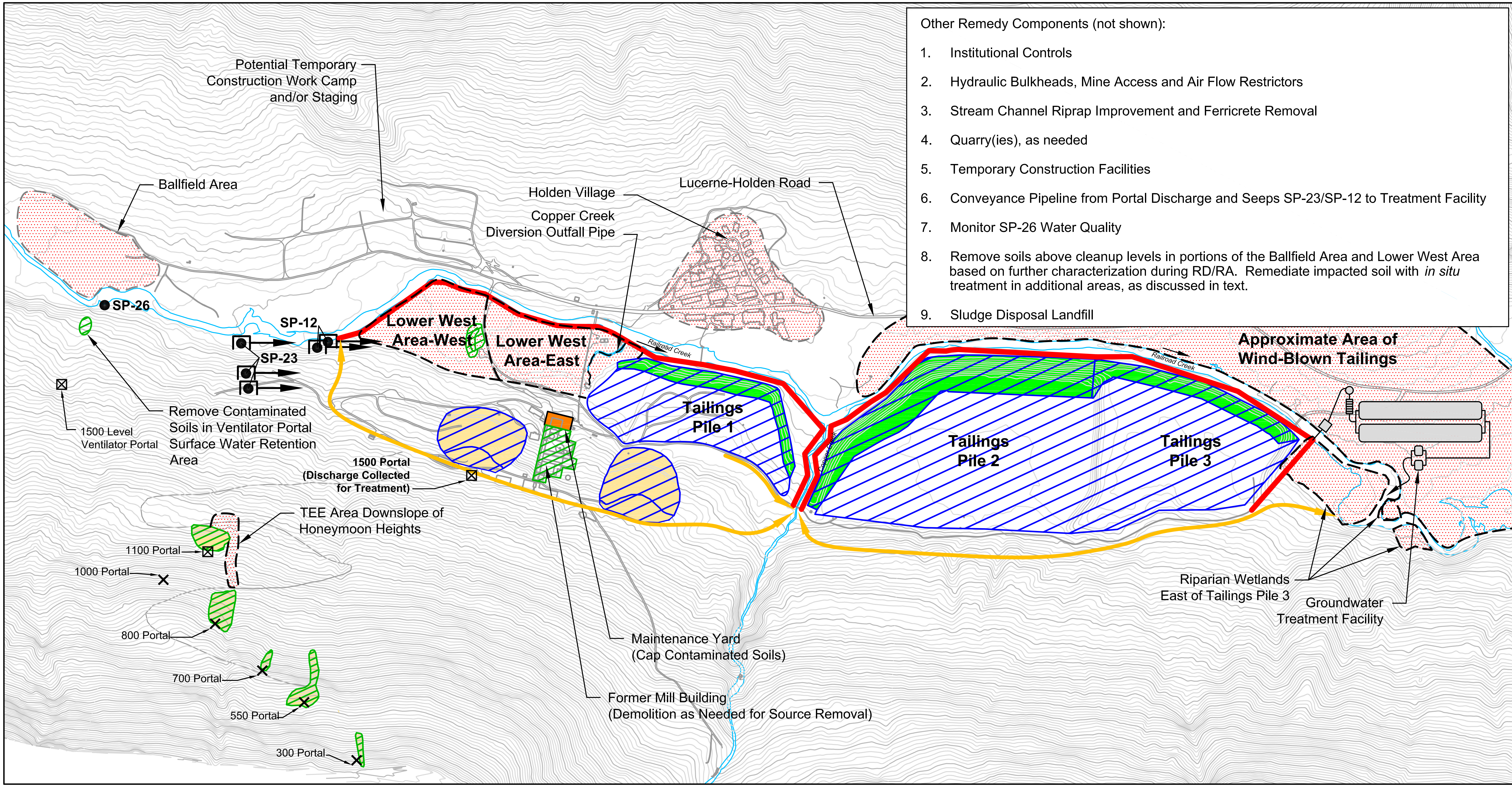
Note: Contour interval is 50 feet.

0 660 1320
Scale in Feet

HARTCROWSER

4769-15 *6/10*
Figure 11
ASFS

Principal Components of Alternative 11M



Source: Base map prepared from LiDAR topographic survey provided by URS 2004

- Capping Contaminated Soils
- Regrade Tailings and Waste Rock Piles, and Cap with 2 Feet of Soil and Geomembrane
- Move Toe of Tailings Pile Slopes away from Creek as Part of Regrading
- Removal of Contaminated Soils or Waste Rock
- Waste Rock Piles
- Approximate Extent of *In Situ* Treatment Areas
- SP-4 ● Seep Sampling Location and Number
- ⊠ Portal to be Closed with Hydrostatic Bulkhead
- ✕ Portal to be Closed with Air Flow Restrictions
- Groundwater Barrier Wall and Collection System
- Upgradient Runoff Diversion Ditch
- Discrete Seep Collection System

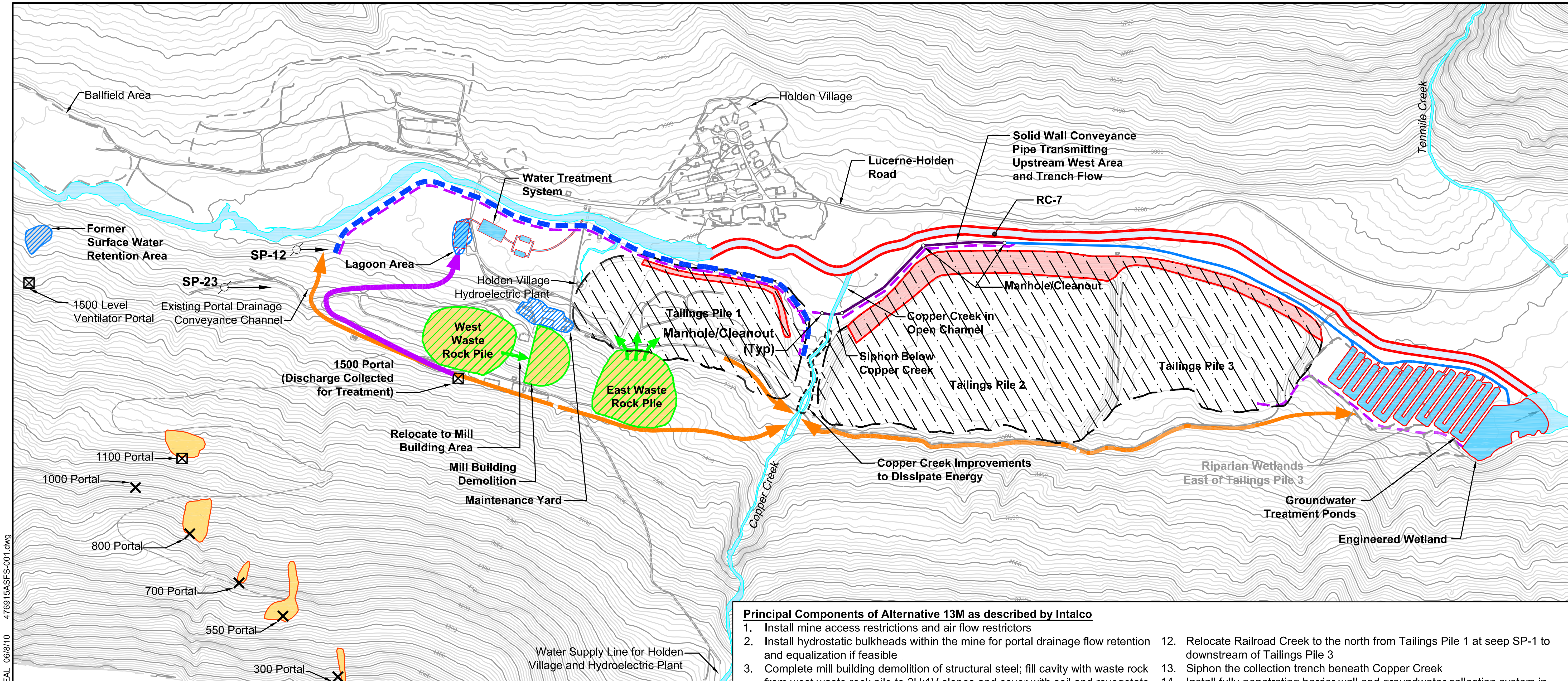
0 600 1,200
Scale in Feet

N

HARTCROWSER
4769-15 *6/10*
Figure 12
ASFS

EAL 6/8/10 476915ASFS-011.dwg

Principal Components of Alternative 13M



EAL 06/8/10 476915ASFS-001.dwg

Principal Components of Alternative 13M as described by Intalco

1. Install mine access restrictions and air flow restrictors
2. Install hydrostatic bulkheads within the mine for portal drainage flow retention and equalization if feasible
3. Complete mill building demolition of structural steel; fill cavity with waste rock from west waste rock pile to 2H:1V slopes and cover with soil and revegetate
4. Remove contaminated materials in the lagoon area and former surface water retention area and pave maintenance yard
5. Construct landfill on top of tailings piles for disposal of excavated impacted soils
6. Bench and regrade Tailings Piles 1, 2, and 3 side slopes (2H:1V)
7. Cover top surfaces of tailings piles with gravel/soil/wood slash. Cover tailings pile side slopes with soil. Revegetate and install surface water drainage features
8. Regrade east and west waste rock pile side slopes (2H:1V), relocate waste rock removed during regrading to mill building area and tailings piles, cover remaining portions with soil and revegetate
9. Stabilize Copper Creek channel and improve channel to dissipate energy
10. Install water diversion swales upgradient of tailings and waste rock piles
11. Provide discrete collection of portal drainage and seeps SP-23 and SP-12
12. Relocate Railroad Creek to the north from Tailings Pile 1 at seep SP-1 to downstream of Tailings Pile 3
13. Siphon the collection trench beneath Copper Creek
14. Install fully-penetrating barrier wall and groundwater collection system in Lower West Area and around north and east sides of Tailings Pile 1
15. Collect near-surface groundwater and seeps in existing Railroad Creek channel in unlined collection trench from Copper Creek downstream to approximately RC-7
16. Construct two low energy water treatment systems: one in the west area to treat collected portal drainage and seeps SP-23 and SP-12; one in the east area to treat remaining collected site water
17. Construct landfill on top of tailings piles for disposal of sludge from water treatment system

Legend

- Waste Rock Piles
- Regrade and Cover Waste Rock Piles with Soil
- Removal or Covering of Contaminated Soils
- Regrade Tailings Pile Slopes
- Cover with Soil on Top of Surface and on Slope
- Waste Rock Pile Relocation
- Portal Drainage Conveyance Trench
- Upgradient Runoff Diversion Trench
- Fully-Penetrating Barrier Wall and Open Collection Trench
- Portal to be Closed with Hydrostatic Bulkhead
- Portal to be Closed with Air Flow Restrictors
- SP-23 Discrete Seep Collected for Treatment Via Gravity Conveyance
- Existing Creeks
- Approximate Limits of Railroad Creek Realignment with Lining/Barrier System
- Unlined Collection or Conveyance Trench
- Lined Conveyance Channel or Treatment Trench with Drop Structures as needed
- Solid Wall Conveyance Pipe

N

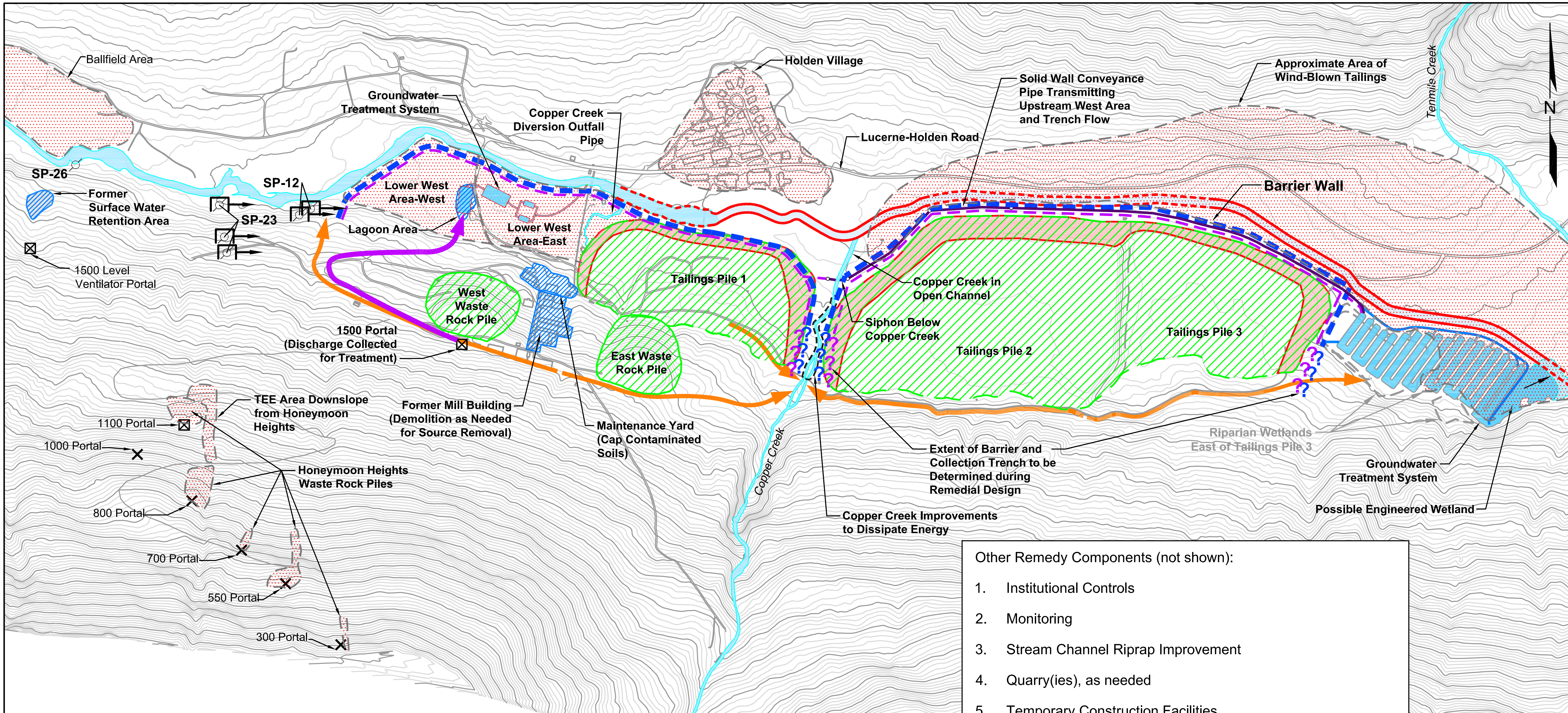
Note:
Railroad Creek streambanks are based on U.S. Forest Service data provided March 1998, which appears to be consistent with aerial photograph interpretation of stream flood banks.

0 600 1200
Scale in Feet

HARTCROWSER
4769-15 6/10
Figure 13
ASFS

Source: ERM and URS (2009).

Principal Components of Alternative 14



Other Remedy Components (not shown):

1. Institutional Controls
2. Monitoring
3. Stream Channel Riprap Improvement
4. Quarry(ies), as needed
5. Temporary Construction Facilities
6. Conveyance Pipeline from Portal Discharge and Seeps SP-23/SP-12 to Treatment Facility
7. Monitor SP-26 Water Quality
8. Remediate impacted soil with *in situ* treatment in additional areas, as discussed in the text.
9. Sludge Disposal Landfill

Legend

- Regrade and Cap Tailings and Waste Rock Piles
- Removal or Cap Contaminated Soils
- Regrade Tailings Pile Slopes
- Approximate Extent of *In Situ* Treatment Areas
- Upgradient Runoff Diversion Trench
- Fully-Penetrating Barrier Wall and Open Collection Trench
- Portal Discharge Conveyance Trench
- Portal to be Closed with Hydrostatic Bulkhead
- Portal to be Closed with Air Flow Restrictors
- SP-23 Seep Collection for Treatment
- Existing Creeks
- Railroad Creek Realignment (Actual limits to be determined during remedial design)
- Unlined Collection or Conveyance Trench
- Lined Conveyance Channel or Treatment Trench with Drop Structures as needed
- Solid Wall Conveyance Pipe

Source: Prepared from AutoCAD file "Alt 13M Contingent.dwg", created by URS, 06/24/09.

0 600 1200
Scale in Feet

EAL 06/8/10 476915ASFS-008.dwg

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Figure 14
ASFS

APPENDIX A
ESTIMATED COSTS FOR ALTERNATIVES 11M, 13M, AND 14

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CONTENTS (Continued)

TABLES

APPENDIX A
ESTIMATED COSTS FOR ALTERNATIVES 11M, 13M, AND 14

1.0 INTRODUCTION

This Appendix presents preliminary cost estimates for three proposed alternatives for cleanup of the former Holden Mine Site (Site).[1] Both CERCLA and MTCA include provisions for considering the cost of a proposed remedy, provided that the cleanup actions being compared first satisfy the threshold criteria for remedy selection (see Section 6.1 of the ASFS).

- Cost is a primary balancing criteria used for remedy selection under CERCLA. CERCLA requires that the selected remedy "shall be cost effective, provided that it first satisfies the threshold criteria" [40 CFR § 300.430(f)(1)(ii)(D)].

- MTCA considers cost in the remedy selection process as part of the analysis to determine whether an alternative uses permanent solutions to the maximum extent practicable [WAC 173-340-360(3)].

The cost estimates discussed herein were used as part of the Agencies' comparison of Alternatives 11M, 13M, and 14. Alternatives 11M and 14 both satisfy the CERCLA and MTCA threshold requirements and Alternative 13M does not satisfy the threshold requirements, as discussed in Section 6 of the ASFS. Although Alternative 13M does not satisfy the threshold requirements for selection of a permanent remedy, it has been included in this Appendix for comparison purposes.

Intalco presented cost estimates for Alternatives 11 and 13M (URS 2009) that relied in large part on previous estimates prepared by both the Agencies and Intalco, but also had significant differences from the prior estimates (Hart Crowser 2005, Forest Service 2007, URS 2004b, URS 2005a, and URS 2005b).

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[1] These estimates are referred to as preliminary because they were prepared during the feasibility study (FS) stage, prior to remedial design (RD). Design will enable greater specificity on details of the remedy and actual costs may differ from costs estimated during the FS. EPA guidance (EPA 2000) suggests the level of certainty of estimates prepared during the FS should be within a range of - 30 percent to + 50 percent of the final cost of implementing the remedial action, including long-term operation and maintenance. Estimated costs for each alternative need to have comparable levels of certainty in order to be compared.

The estimates presented herein rely in part on URS (2009) as well as prior estimates. Since the approach and methods used by both the Agencies and Intalco is similar, many details that were described in Appendix B of the SFS are not repeated here.

This Appendix includes a discussion of the areas where the Agencies estimates and Intalco's estimates are similar, and where they differ.

Intalco addressed Alternative 11 (not Alternative 11M[2]) and did not address Alternative 14 (URS 2009). As a result the Agencies prepared estimates for Alternatives 11M, 13M, and 14 that are discussed herein. The Agencies' estimate for some aspects of Alternative 11M was revised from their 2007 estimate for Alternative 11, based on consideration of comments that Intalco included as notes in the URS (2009) spreadsheets.

Total estimated costs for each alternative were based on the sum of the capital costs and anticipated future costs for the remedy, as discussed later. Total costs for each alternative in 2010 dollars (rounded to three significant figures) are summarized below.

	Alternative 11M	**Alternative 13M**	**Alternative 14**
Estimated Capital Cost	$88,500,000	$56,400,000	$76,100,000
Net Present Value of Long-Term Operations, Maintenance and Monitoring[3]	$31,800,000	$23,400,000	$30,700,000
Total Estimated Cost:	$120,000,000	$79,800,000	$107,000,000

Additional detail showing costs for the major components of each alternative are presented in Table A-1. The Agencies' estimates of detailed costs for Alternatives 11M, 13M, and 14 are included in Tables A-2 through A-4, respectively. A comparison of estimated costs for long-term operations, maintenance, and monitoring (OMM) is presented in Table A-5.

[2] Intalco was unaware of the Agencies development of 11M at the time that Intalco prepared its cost estimates.

[3] The Net Present Value in the summary table presented above was calculated using a discount rate of 7 percent, and a period of 50 years.

2.0 BASIS FOR ESTIMATED COSTS

These cost estimates were prepared by updating previous cost estimates that used 2005 as the base year for most elements, since this represents a common basis for previous cost estimates prepared by the Agencies and Intalco (Hart Crowser 2005, Forest Service 2007, URS 2004b, URS 2005a, URS 2005b, and URS 2009b). Costs for individual remedy components discussed in this appendix refer to base year costs (2005 dollars) except where the text specifically says the costs have been converted to 2010 dollars. As part of the current Agency cost estimates, the aggregate of the 2005-based costs were converted to 2010 dollars using the Engineering News Record construction cost index (ENR 2010) as discussed later.[4]

2.1 Remedy Construction Cost Elements

Construction costs basically fall into two categories: capital costs and non-capital costs. Capital costs consist of direct costs (construction labor, materials, and equipment) and indirect costs (Contractor's overhead, profit, construction coordination and administration). Non-capital construction costs include engineering design, construction administration, and project management.

These cost estimates relied on quantity estimates for each component of the major direct cost elements to define the extent of work required and the types of labor, equipment, and materials needed to complete construction of that element. The elements in the current estimates are mostly similar to those presented in the SFS, but include two significant new components:

- New geotechnical data and analysis initiated by Intalco showed that buttresses constructed of rock, compacted soil, and/or compacted tailings would be needed to assure stability of the regraded tailings pile slopes.[5] Analysis also showed that geotextile reinforcing would be needed for stability of landfill caps that include a geomembrane (i.e., Alternative 11M).

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[4] The Agencies assume that most remedy construction would be accomplished in the period 2013 through 2015. Construction of some remedy components could be deferred until later or may not be needed, based on results of monitoring. Also some remedy construction such as mine entry and bulkhead construction may begin sooner. The potential effect of schedule changes on the estimated construction cost has not been specifically addressed (except as discussed in Section 7 as part of Contingent Costs). Future changes in construction commodity and labor prices over time presents a similar degree of uncertainty for three alternatives.

[5] Buttresses were not found to be needed to stabilize the regraded waste rock piles.

- *In situ* soil treatment is proposed for Alternatives 11M and 14M based on new analysis of the effect of hazardous substances in soils on terrestrial ecological receptors and the anticipated environmental impact of other approaches to cleanup some areas.

The current estimates also reflect new estimates of the volume of groundwater that would be collected for each of the three alternatives, based on the groundwater flow model Intalco developed in 2009. Concentrations of hazardous substances in the collected groundwater, and the volume of sludge produced by water treatment were also reassessed.

2.2 Future Costs for Operations, Maintenance and Monitoring

Future OMM consists of ongoing or periodic recurring costs that occur as long as the remedy is needed. Geochemical analysis discussed in Appendix E of the DFFS indicate groundwater treatment at Holden may need to continue for hundreds of years (URS 2004a). Long-term costs include:

- The annual cost of operations and maintenance for the groundwater collection, conveyance and treatment system;
- Monitoring performance of the remedy to determine whether it is protective of human health and the environment, and complies with ARARs;
- Costs for Agencies' oversight of the remedy; and
- Future capital costs to replace treatment system equipment as it wears out over time.

The net present value (NPV) of future costs to implement the remedy is the amount that is needed today to set aside sufficient funds in an interest-bearing account to cover anticipated future costs. Use of the NPV to express future costs in current dollars is a standard method for financial evaluation of long-term projects.

Intalco's estimate of long-term OMM costs for Alternatives 11 and 13M are based on an analysis of NPV over a period of 30 years. The Agencies used 50 years, since this provides a more realistic estimate for costs that are anticipated to extend over very long periods (i.e., for hundreds of years), as indicated by Figure B-1 in the SFS.[6] The NPV for long-term OMM costs was calculated for

[6] As indicated in the SFS, the NPV of future costs is reasonably represented by calculations based on 50 years, since the change in present value over time after 50 years is very small (a depiction of this change on a graph would be referred to as an asymptotic condition). As a result, the Agencies' NPV estimate is expected to cover the OMM costs that are currently anticipated to

each alternative using a discount rate of 7 percent based on current federal guidance.[7]

2.3 Contingent Costs

At the time a feasibility study estimate is prepared, there are generally unknown factors that may affect the final cost either positively or negatively, referred to as contingencies. The types of contingent costs that apply to both capital and OMM costs are discussed in EPA (2000) and Appendix B of the SFS. Estimated contingent costs for each alternative are discussed in Section 7.

2.4 Construction Inflation

Inflation during the period of time from the present to the end of construction has not been specifically accounted for in this estimate. As part of updating prior estimates to use in the current estimates, the Agencies converted 2005 costs into 2010 costs using the construction cost indices (CCI) published by Engineering News Record (ENR 2010) for Seattle.

Changes in construction costs over time are typically different from other measures of inflation or deflation, for example the consumer price index. The CCI published by ENR is broadly used in engineering cost estimates for construction, since it is based on factors including local prices for commodities such as Portland cement and lumber, union wages for construction laborers and skilled workers, as well as changes in the national average price for other materials. At the time this estimate was prepared, the ratio of 2010 CCI to 2005 CCI for this area was 1.059 which represents a 5.9 percent increase in average construction costs between 2005 and 2010.

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occur over a period of hundreds of years. In contrast, Intalco's use of a 30-year period for calculation probably underestimates the NPV required by about 15 percent, in addition to the effect of the other items omitted in Intalco's OMM estimate (e.g., periodic equipment replacement and maintenance to control vegetation to protect integrity of the membrane cap over the solid waste and sludge landfill cells after closure, see Sections 5.1.6 and 5.2.7 of this Appendix).

[7] The discount rate used herein was selected for the purpose of comparing remedial alternatives on the premise that the long term cost of the cleanup would be borne by the responsible party (Intalco). EPA Guidance (EPA 2000) notes that the FS remedial alternative cost estimate is a starting point and adjustments may be made based on Agency requirements. This may include adjusting or eliminating the discount rate. For example, a lower discount rate will likely be used to establish financial assurance for completion of the remedy. The purpose of such the financial assurance is to ensure that cleanup could be completed by the Agencies, if necessary.

3.0 SUMMARY OF MAJOR COST COMPONENT DIFFERENCES BETWEEN ALTERNATIVES

Alternative 13M is described in ERM and URS (2009) and Section 5.2 of the ASFS. Alternatives 11M and 14 are described in Sections 5.1 and 5.3 of the ASFS. Elements of each alternative that have a substantial effect on their overall cost are summarized below. Other components of these alternatives that are not summarized below are less likely to have a substantial cost impact on the comparison of alternatives, either because these components are similar from one alternative to another or because their cost is low relative to other components.

3.1 Alternative 11M

The components of Alternative 11M are substantially the same as Intalco used in its Alternative 11 estimate, with these notable exceptions:

- Alternative 11M includes *in situ* treatment in the Lower West Area, Ballfield Area, Holden Village, and the Wind-Blown Tailings Area;

- Alternative 11M includes consolidation of impacted soils from portions of the Ballfield Area and Lower West Area; and

- The Agencies estimated cost for tailings pile slope regrading and buttress construction follows the approach Intalco used for its Alternative 13M estimate, and thus differs substantially from Intalco's Alternative 11 estimate, as discussed later.

Alternative 11M includes regrading the slopes of Tailings Pile 1, Tailings Pile 2, Tailings Pile 3; moving the toe of the slopes back from Railroad and Copper Creeks; and constructing a stabilizing toe berm along the perimeter of the regraded tailings pile slopes. Moving the toe of the tailings piles away from Railroad Creek is a key area where the cost of Alternative 11M differs from Alternatives 13M and 14, which rely instead on moving Railroad Creek.

The cost of Alternative 11M also differs significantly from Alternatives 13M and 14 because Alternative 11M includes consolidation of the Honeymoon Heights Waste Rock Piles and the impacted soils downslope of these waste rock piles. Also the tailings waste rock pile caps proposed for Alternative 11M would consist of soil combined with a geomembrane to satisfy the presumptive cover requirements for closure of limited purpose landfills [WAC 173-350-400(e)(ii)]. The tailings and waste rock pile caps for Alternatives 13M and 14 would not include a geomembrane, and would instead be designed to meet the performance criteria for landfill covers rather than the presumptive cover requirements.[8]

Alternative 11M includes containment, collection, and treatment of the portal drainage, seeps downslope of Honeymoon Heights, and groundwater (including seeps) from the Lower West Area and the tailings piles. Groundwater containment and collection would be achieved with fully penetrating barrier walls around the Lower West Area and Tailings Pile 1 and around Tailings Pile 2 and Tailings Pile 3. The configuration of the Alternative 11M groundwater barrier and collection system is the same as Alternative 14, but differs from Alternative 13M.

Alternative 11M relies on a single groundwater treatment system located east of Tailings Pile 3 and north of Railroad Creek, whereas Alternatives 13M and 14 both have two treatment facilities.

Finally, Alternative 11M includes removal of ferricrete from Railroad Creek to improve aquatic habitat, which is not part of Alternatives 13M or 14.

3.2 Alternative 13M

Alternative 13M includes long-term monitoring but does not include any other remedial action in the Lower West Area, the Ballfield Area, Holden Village, the Wind-blown Tailings Area, the Honeymoon Heights Waste Rock Piles, and the impacted areas downslope of the Honeymoon Heights Waste Rock Piles.

Alternative 13M includes regrading the slopes of the tailings and main East and West waste rock piles, and constructing a toe buttress using quarried rock and compacted tailings to improve stability of the tailings. Alternative 13M includes capping the tailings and waste rock piles with a six to twelve inch cover consisting of soil, gravel, and wood slash.[9]

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[8] Intalco found that geotextile reinforcing would also be required to achieve stable slopes for a cap that included a geomembrane (URS and ERM 2009, Appendix C). This geotextile reinforcing is included in the cost estimate for A-11M, but Intalco's analysis suggests it would not be needed for Alternatives 13M or 14.

[9] Intalco proposed consideration of two other cover configurations in a memorandum to the Agencies subsequent to submitting its Alternative 13M cost estimates (URS 2010). The cost for Intalco's proposed alternative covers is not addressed in this appendix.

Alternative 13M includes relocating a portion of Railroad Creek north of the tailings piles to provide room for groundwater containment and collection, and to reduce risk of future instability from impacting Railroad Creek.[10] Alternative 13M includes Copper Creek channel improvements to reduce the risk of undermining or eroding the adjacent tailings piles slopes, but does not include pulling the toe of these tailings piles back away from Copper Creek.

The Agencies' estimate for Alternative 13M includes containment, collection, and treatment of the portal drainage and seeps downslope of Honeymoon Heights. Groundwater (including seeps) from the Lower West Area and Tailings Pile 1 would be contained and collected for treatment using a fully penetrating barrier wall. Alternative 13M does not include any containment, collection or treatment of groundwater impacted by Tailings Pile 2 and Tailings Pile 3, but Intalco said this could be evaluated as a contingent measure if needed to protect Railroad Creek.

Collected groundwater would be conveyed to two treatment facilities under Alternative 13M, one located in the Lower West Area and the other in the wetlands east of Tailings Pile 3 on the south side of Railroad Creek.

Intalco's cost for Alternative 13M does not include cost for mitigation of impacts to wetlands that will likely be required as a result of stream relocation and construction of the groundwater treatment systems. Costs for such mitigation cannot reasonably be estimated until remedial design is complete, and the extent of impacts is better understood.

Finally, Alternative 13M does not include removal of ferricrete from Railroad Creek, since the creek relocation is assumed to eliminate exposure of aquatic organisms to ferricrete deposited in the former creek channel. The new channel would be designed to prevent infiltration of groundwater impacted by releases from the tailings piles, which is assumed to prevent future formation of ferricrete in the creek channel.

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[10] Intalco's drawings (e.g., Figures 3-1 and 3-14 of ERM and URS (2009) show the relocated reach of Railroad Creek extends east from about the middle of the north side of Tailings Pile 1 downstream past the east side of Tailings Pile 3. Observations at the Site suggest it would also be necessary to extend the relocated reach west of the middle of Tailings Pile 1 to avoid having to pull the toe of the tailings pile slope away from the creek in order to provide room to construct the groundwater barrier wall and collection system; however, this has not been addressed by Intalco or in the Agencies' cost estimate.

3.3 Alternative 14

Alternative 14 components were drawn from Alternatives 11M and 13M.

The Agencies' estimate for Alternative 14 relies on *in situ* treatment and institutional controls to address the Honeymoon Heights Waste Rock Piles, impacted areas downslope of the Honeymoon Heights Waste Rock Piles, Holden Village, and the Wind-Blown Tailings Area, and a combination of removal of impacted soils and *in situ* treatment to address the Lower West Area and Ballfield Area. This is similar to Alternative 11M, except that Alternative 14 does not include removal of waste rock from Honeymoon Heights or removal of impacted soils downslope of the Honeymoon Heights Waste Rock Piles.

Alternative 14 includes capping the tailings and waste rock piles with a soil cover that would satisfy the performance standards for limited purpose landfill covers [WAC 173-350-400(e)(i)]. Details of this cap would need to be developed during remedial design (RD); for cost estimating purposes the Agencies assumed this cap would consist of two feet of soil and self-sustaining native vegetation.

Alternative 14 includes relocation of Railroad Creek, and regrading and buttressing the slopes of the tailings piles as proposed for Alternative 13M. Alternative 14 includes channel improvements to Copper Creek, but unlike Alternative 13M Alternative 14 also includes regrading and pulling the tailings pile slopes away from Copper Creek.

The Agencies estimate for Alternative 14 includes containment, collection, and treatment of the portal drainage, seeps downslope of Honeymoon Heights, and groundwater (including seeps) from the Lower West Area and below Tailings Pile 1, Tailings Pile 2, and Tailings Pile 3. Groundwater containment and collection would be achieved with two fully penetrating barrier walls; one around the Lower West Area and Tailings Pile 1, and one around Tailings Piles 2 and 3. As a contingent measure, Alternative 14 includes the potential for modifying the design (e.g., use of a partially penetrating barrier) or possibly not constructing the groundwater barrier downstream of Tailings Piles 2 and 3, in the event that monitoring shows that groundwater achieves cleanup levels downstream of Tailings Pile 3 without it. The potential costs implications of this contingency are discussed in Section 7.

Alternative 14 includes two treatment systems, as proposed for Alternative 13M. The collected groundwater would be conveyed to a treatment facility located in the Lower West Area (west treatment system) and to a treatment facility located east of Tailings Pile 3 (east treatment system), both south of Railroad Creek. The two treatment systems may be operated in series, depending on results of treatability studies.

Like Intalco's estimate for Alternative 13M, the Agencies' estimate for Alternative 14 does not include cost for mitigation of impacts to wetlands that will likely be required as a result of stream relocation and construction of the groundwater treatment systems. Costs for such mitigation cannot reasonably be estimated until remedial design is complete, and the extent of impacts is better understood.

Alternative 14 does not include removal of ferricrete from Railroad Creek, since the creek relocation is anticipated to eliminate exposure of aquatic organisms to ferricrete deposited in the former creek channel. The new channel would be designed to prevent infiltration of groundwater impacted by releases from the tailings piles, which is assumed to prevent future formation of ferricrete in the creek channel.

4.0 AREAS WHERE THE AGENCIES' COST ESTIMATES ARE SIMILAR TO INTALCO'S COST ESTIMATES

This section discusses major components of different alternatives that have similar estimated costs. Section 5.0 discusses components with significantly different estimated costs for major components.

4.1 Comparison of the Agencies' Estimate and Intalco's Estimate for Alternative 11(M)

The Agencies' estimate for Alternative 11M was developed by modifying the 2007 estimate for Alternative 11 that was described in the SFS, and incorporating information developed by Intalco in 2008 and 2009. Estimated costs were generally similar for the areas listed below.

4.1.1 Job Setup and Construction Infrastructure

The Agencies adopted Intalco's 2009 estimate of costs for upgrading the barge loading and unloading facilities on Lake Chelan.

4.1.2 Upgradient Diversions and Access Roads

Run-on diversion swales and access roads upgradient of the tailings and waste rock piles were generally similar, but were based on somewhat different ditch lengths and unit costs.

4.1.3 Mine Mill and Maintenance Yard

The Agencies adopted Intalco's 2009 costs for demolition of the remnant mill structure, and for construction of hydraulic bulkheads in the 1500 Level Main Portal and Ventilator Portal. Maintenance yard paving costs varied between the Agencies' and Intalco's estimates for Alternative 11 due to differing concrete and base course unit prices.

4.1.4 Groundwater Containment, Collection, and Conveyance

The Agencies adopted Intalco's estimates for construction of groundwater barrier walls, which are the largest single component of this cost area.

4.1.5 Waste Rock Piles

Estimates prepared by Intalco and the Agencies differed somewhat in unit costs for regrading and capping, and in the quantity of waste rock involved. However, the final estimates for this element were similar.

4.1.6 Tailings Pile Regrading and Capping

Regrading to provide stable tailings pile slopes under Alternative 11M would involve an estimated 1,000,000 cubic yards (as estimated by the Agencies) compared to the previous estimate of 588,000 cubic yards the Agencies estimated for Alternative 11, and 960,000 cubic yards as estimated by Intalco. The increase in volume from that described in the SFS results from the need to move additional tailings to enable buttress construction, which was determined to be needed based on new geotechnical information Intalco developed in 2008-2009. Intalco found that buttresses would need to be constructed along the toe of the tailings pile slopes in order to provide seismic stability. Buttress construction would require excavation of a larger volume of tailings than was anticipated in 2007.

4.1.7 Lagoon and Surface Water Retention Area (SRA)

Costs for this component are essentially the same in both the Agencies' and Intalco's estimates.

4.1.8 Contractor Markups

The Agencies and Intalco had somewhat different approaches to estimating Contractor markups on direct construction costs, but these resulted in similar costs expressed on a percentage basis. Markups include the Contractor's overhead and profit (OH&P), and what are referred to as Division 1 costs that include insurance, submittal preparation, on-site engineering and surveying during construction, etc.

Intalco assumed OH&P and Division 1 markups would both be 10 percent of the direct cost of construction for Alternative 11, whereas the Agencies followed the approach used in the SFS with 12 percent for OH&P, and 8 percent for Division 1 costs for Alternative 11M.

The Agencies differed from Intalco on costs for the remaining components of Alternative 11M.

4.2 Comparison of the Agencies' Estimate and Intalco's Estimate for Alternative 13M

The Agencies also evaluated Intalco's costs for Alternative 13M to assess whether it could be used as the basis for estimating some costs for Alternative 14. The Agencies generally accepted Intalco's estimated costs for the components listed below.

4.2.1 Upgradient Diversions and Access Roads

The Agencies and Intalco used somewhat different ditch lengths and unit costs but overall costs for run-on diversion swales and access roads were similar.

4.2.2 Mine, Mill Building & Maintenance Yard Actions

As noted for Alternative 11M, the Agencies generally accepted Intalco's cost estimates for these components.

4.2.3 Groundwater Containment, Collection, and Conveyance

Construction of the barrier walls was the largest single component of these costs. The Agencies generally accepted the construction approach, materials, and costs used in Intalco's estimate.

Intalco's estimate assumed the groundwater barrier and collection system on the east side of Tailings Pile 1 was 237 feet shorter than what Intalco assumed would be needed for Alternative 11. Intalco did not provide any groundwater modeling or other justification for the reduced barrier and collection system length used for Alternative 13M. The difference makes this component of Alternative 13M appear to be nearly a million dollars less costly that the same component of Alternative 11M. The Agencies note that design of the barrier and collection system will need to be based on more complete analysis during RD than Intalco has provided to date.

4.2.4 Waste Rock Piles

The Agencies accepted Intalco's estimated costs for regrading and capping the main East and West Waste Rock for Alternative 13M. However, the Agencies note that Intalco has not demonstrated that the proposed six-inch vegetated soil cover Intalco proposed for the waste rock piles will satisfy ARARs.

4.2.5 Tailings Pile Regrading

The Agencies accepted Intalco's estimated costs for regrading and capping the tailings piles for Alternative 13M. However, the Agencies note that Intalco has not demonstrated that the proposed six-inch vegetated cover of soil/gravel and wood slash that Intalco proposed for the tailings piles will satisfy ARARs.

4.2.6 Toe Buttress

The Agencies accepted Intalco's estimated cost for the Alternative 13M toe buttress for purposes of comparison with other Alternatives.

The Agencies note that Intalco based its buttress design on the inferred presence of a dike that was constructed to contain initial placement of the tailings, and that Intalco assumed all weak and potentially liquefiable soils were removed prior to construction of the dike. Intalco has provided limited historic information to support these inferences, but has not found any physical confirmation that the dike is present and, if present, that it is not underlain by potentially liquefiable soils.[11] Stability analysis by the Agencies that indicate the presence of weak soils below the dike, or the absence of the dike, indicate a much larger buttress will be needed than was assumed by Intalco, and this would cost about $1.3 million more than Intalco estimated. Thus, Intalco's estimate in this area likely does not represent the actual cost of construction that would be needed. The Agencies note that final buttress design during RD will need to include the effect of weak soils below the toe of the tailings piles, based on currently available information.

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[11] Notably, no evidence of the dike was observed during work in 2006 to repair erosion damage at the toe of Tailings Pile 1. Also, test pit explorations completed in 2008/2009 indicate weak and potentially liquefiable soils are present beneath the current toe of the tailings piles in at least some locations.

4.2.7 Surface Water Remediation

The Agencies accepted Intalco's estimate for surface water remediation costs.

4.2.8 Lagoon and Surface Water Retention Area (SRA)

The Agencies and Intalco had essentially the same estimated costs for these components.

5.0 AREAS WHERE THE AGENCIES' AND INTALCO'S COST ESTIMATES DIFFER SIGNIFICANTLY

There are a number of significant assumptions in any cost estimate, and differences in assumptions made by the Agencies and Intalco have a pronounced effect on the relative magnitude of the estimates. The primary areas where the Agencies' estimated costs differ from Intalco's are discussed below.

5.1 Contrasts Between the Agencies' Estimate and Intalco's Estimate for Alternative 11(M)

As discussed in the ASFS, Alternative 11M was based on Alternative 11, and thus there are similarities in the Agencies' Alternative 11M estimate and Intalco's Alternative 11 estimate. However, there are also significant differences that are discussed in the following sections.

5.1.1 Job Setup/Mobilization, Construction Infrastructure, and Duration

The Agencies and Intalco have different assumptions on the average number of workers that will be involved in construction, and used different approaches to estimate costs for construction labor and supervision.

- The Agencies' estimate is based on an aggregate of 18,900 worker days (average of about 42 workers) of camp operation costs, while Intalco estimated 41,444 worker days (average of about 65 workers). The difference in cost for housing and per diem is $1.36 million compared to $2.98 million for the Agencies' and Intalco's estimates respectively.

- The Agencies included labor costs for construction supervision for a site superintendent and three foremen for the entire project duration at an estimated cost of $913,000. Intalco omitted this cost on the premise that it is covered in Contractor overhead and markups that are included in the estimate.

- Intalco's estimate included an additional $580,000 for worker overtime it said would otherwise be unaccounted for. The Agencies used labor rates that included overtime pricing based on 10-hour work days and 6 days of work per week.

- Intalco assumed mobilization and demobilization for construction at a rate of 7.4 percent of total direct construction costs or $4.0 million; whereas, the Agencies assumed 6.5 percent ($3.6 million).

The aggregate difference in the items discussed above resulted in the Agencies' estimate for job setup and construction infrastructure being about $1 million less than estimated by Intalco.

5.1.2 Groundwater Treatment Facilities

The Agencies updated their Alternative 11 estimate of the volume of groundwater that would be collected and treated under Alternative 11M using the groundwater model developed by Intalco (ERM and URS 2009, Appendix E). The estimated volume of water that would be collected and treated annually for Alternative 11M is about 624 million gallons per year (MGY) compared to 600 MGY previously estimated for Alternative 11. The estimated volume of sludge produced as a by-product of treatment was also reassessed, using new average concentrations for hazardous substances in the collected groundwater. The Agencies reassessed the size and capacity of the Alternative 11 treatment system components and estimated costs using the same approach and unit prices used for Alternative 11 in the SFS.

The resulting Agencies' cost estimate for the Alternative 11M groundwater treatment system ($2.1 million) was about $440,000 over the previous Agency estimate for Alternative 11, whereas Intalco's estimate for the Alternative 11 treatment system was $2.7 million. The difference in Intalco's estimate for Alternative 11 compared to the Agencies' estimate for Alternative 11M is primarily based on differences in Intalco's assumptions on the amount of site preparation and treatment pond excavation (~$200,000); concrete lining for the treatment ponds (~$100,000); and components such as chemical storage and addition, mixing and aeration, and energy supply (these costs aggregated about $250,000).

5.1.3 Landfills for Disposal of Solid Waste Generated during Cleanup and Groundwater Treatment Sludge

The Agencies' estimate for Alternative 11 in the SFS included construction of two permanent disposal facilities that would be constructed, used, and closed in accordance with Washington's Limited Purpose Landfill regulations (WAC 173-350-400). On-site landfills would be used for disposal of solid waste generated during the cleanup (e.g., excavated soils impacted by hazardous substances, excess waste rock from regrading, mill demolition debris), and for long-term sludge disposal. The Agencies' 2007 Alternative 11 cost estimate assumed the solid waste landfill would be closed at the completion of remedial construction, and that the sludge disposal landfill would be designed to operate for 50 years. After 50 years, the sludge disposal cell would be closed and replaced with a new cell that could also be used for 50 years, and that this would continue for as long as groundwater treatment was required at the Site.

Costs for the two types of landfill are discussed below.

5.1.3.1 Cleanup-Derived Solid Waste Disposal

The SFS included disposal of an estimated 95,000 cubic yards (CY) of cleanup-derived wastes in a landfill constructed on the tailings piles. This landfill included berms constructed of waste rock to contain demolition debris and soils impacted by hazardous substances similar to the tailings and waste rock, and a separate HDPE lined cell for disposal of TPH-contaminated soils. When filled, this landfill would have been capped with the same composite soil and geomembrane proposed for the tailings piles.

For its Alternative 11 estimate, Intalco assumed the solid waste landfill would be separately constructed to contain the impacted soil and residual processing waste from the mill (500 CY), impacted soils from the SRA (400 CY), impacted soils from the Lagoon area (9,000 CY), mill demolition debris (6,900 CY), plus 20,000 CY of other solid waste from remedial construction. Intalco's estimate also included an additional 20 percent contingency on the volume of solid waste for a total capacity of about 44,000 CY.

For the current estimates for Alternatives 11M, the Agencies modified their estimated volume based on the understanding that soils impacted by constituents similar to the tailings and waste rock could be consolidated into the tailings or waste rock piles prior to capping, and separate landfill disposal would only be required for disposal of soils impacted by other types of hazardous substances (e.g., TPH-soils from the lagoon area). The Agencies retained Intalco's estimate of 6900 CY of mill demolition debris, 9,000 CY from the

Lagoon area, and 20,000 CY of other solid waste during remediation that could be generated from operation of the construction camp, heavy equipment and vehicle maintenance, and other potential, currently unidentified sources.

Although existing characterization (hand excavations accomplished for the TEE) is incomplete, the Agencies assumed nominal volumes of 500 CY of tailings- or waste rock-impacted soils would need to be removed from the Ballfield Area, and another 28,000 CY from the Lower West Area.

5.1.3.2 Groundwater Treatment System Sludge Disposal

Assumptions and cost estimates by Intalco and the Agencies differ significantly on management of sludge from the groundwater treatment system. The Agencies' assumptions on sludge generation and handling the sludge described in Appendix F of the SFS were modified for the current estimate by changing the estimated removal of total suspended solids, sulfate, calcium, magnesium, and manganese, as well as decreasing the estimated contribution of unreacted lime used for treatment. The current sludge production estimate for Alternative 11M also differs from the previous Alternative 11 estimate with regard to the estimated groundwater volume and hazardous substance concentrations, based on Intalco's 2009 groundwater flow model.

Estimated costs for sludge handling and disposal differ significantly depending on assumptions on the volume of solids and method of dewatering the sludge at the time of disposal. Both Intalco and the Agencies assumed portions of the treatment system would be taken off line each year for sludge removal when the available storage volume in the treatment system ponds was full of sludge at a nominal density of 4 percent solids. The Agencies assumed that the sludge would be pumped from the treatment system to a landfill for further dewatering. Intalco apparently assumed that the sludge could be dewatered by allowing drainage into the underlying soil. This approach would reduce cost of handling the sludge and the ultimate landfill volume required, but it may not comply with groundwater protection ARARs. Intalco apparently assumed that the sludge would drain to a nominal sludge density of 37 percent solids so that it could be handled with earthmoving equipment instead of by pumping. Although Intalco reported the 37 percent solids was based on experience at the Iron Mountain site (presumably the Iron Mountain CERCLA site in California), details of the time required to drain the sludge, and the quality of the leachate were not provided.

Based primarily on the difference in the volume of sludge that would have to be handled for disposal, the Agencies' estimated cost for the sludge disposal landfill for Alternative 11M varies from about $5.7 million to Intalco's Alternative 11 estimate of $1.7 million. This difference represents a significant potential savings if Intalco's approach can be shown to satisfy ARARs.

The results of the ongoing 2009-2010 pilot testing are anticipated to provide useful information to refine the preliminary stoichiometric and empirical sludge volume estimates used by the Agencies and Intalco.

5.1.4 In Situ Soil Remediation of Off-Site Soils above CULs

Alternative 11M includes *in situ* treatment of some areas where other active cleanup measures such as removal or capping would cause environmental impacts that are unacceptable relative to the objective of reducing risk to terrestrial ecological receptors, including the Ballfield area, portions of the Lower West Area, the Wind-blown Tailings Area, and Holden Village.

Based on review of available technical literature (see Appendix B of the ASFS) the Agencies determined that it would be appropriate to accomplish a treatability study during remedial design, in order to develop the most effective means for accomplishing the *in situ* treatment. Pending completion of the treatability study, the Agencies estimated the cost of manually applying granulated limestone and composted manure [based on the approach reported by Brown et. al. (2009), see Appendix B] using the Means cost indices. The estimated cost for two applications is $360,000, (not including the cost of the treatability study which is considered as part of non-construction capital costs, see below).

The cost for *in situ* treatment for Alternative 11M was not included in the SFS estimate for Alternative 11, or in Intalco's Alternative 11 estimate.

5.1.5 Non-Construction Capital Costs

Non-construction capital costs include the costs for engineering design, construction administration and oversight, and project management, which are typically estimated as a percentage of the construction costs.[12] Intalco estimated the cost of engineering design as fifteen percent of the total estimated

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[12] For conventional construction, these are costs borne by the Owner rather than the General Contractor, who also has costs for design, administration and oversight that are part of the Contractor's Overhead and Division 1 costs. For remediation of the Holden Mine Site, the non-construction capital costs are costs that would be borne by Intalco. Non-construction capital costs may also include the cost for financing construction, which is not included herein.

construction cost, whereas the Agencies used five percent. The five percent value selected by the Agencies is based on reported industry experience (ASCE 2003) for large projects of average complexity. Intalco's spreadsheet cited the same reference with no explanation for the higher value.

Additional non-construction costs were estimated separately for specific elements. The Agencies estimated a cost of $923,000 for baseline monitoring, which is based on the estimate for Alternative 11 presented in the SFS, which was also adopted by Intalco.

The Agencies assumed a cost for *in situ* treatability tests for Alternative 11M of $500,000.

Finally, the SFS included estimated non-construction capital costs for the TEE and groundwater treatment system pilot testing, which were adopted by Intalco for its Alternative 11 estimate. However the Agencies omitted these costs from the Alternative 11M estimate, since Intalco has already completed the TEE and groundwater treatability studies are ongoing as part of the RIFS.

5.1.6 OMM

Intalco estimated the NPV for long-term OMM of Alternative 11 to be $10,600,000, compared to the Agencies estimate for the SFS of $21,000,000 and $30,100,000 for Alternative 11M.[13] The largest differences in the Agencies' and Intalco's estimates for Alternative 11 are due to significant differences in the estimated cost of operations and maintenance over time, lime consumption for treatment, periodic equipment replacement, and vegetation control to protect integrity of the landfill cover membrane after closure. There were also a number of other differences including Intalco's estimated lower cost for monitoring and lower sludge disposal volume requirements compared to the Agencies. The Agencies' OMM estimate increased for Alternative 11M increased substantially over their Alternative 11 estimate due to increased lime consumption based on recalculating the average hazardous substances concentration in groundwater collected for treatment using Intalco's groundwater flow model instead of the previous flow-tube based approach.

[13] Intalco estimated NPV of OMM costs using a thirty year period, whereas the Agencies used fifty years, as discussed in Appendix B of the SFS. The Agencies revised Intalco's values to fifty years to enable comparison presented herein. Costs cited in the text are presented for the base year (2005) dollars unless otherwise noted.

5.2 Contrasts Between the Agencies' and Intalco's Estimates for Alternative 13M

The Agencies' estimate for Alternative 13M generally corresponds to the Alternative 13M estimate prepared by Intalco except for the following items.

5.2.1 Job Setup & Construction Infrastructure

The Agencies do not accept Intalco's assertion that job-site construction supervision is part of the Contractor's project management costs (i.e., part of overhead) and, therefore, concluded Intalco's estimate for this component is too low. The Agencies also believe Intalco underestimated costs for maintaining the Lucerne-Holden Road during and at the end of construction.

5.2.2 Buttress for Tailings Piles

Intalco's geotechnical studies in 2008-2009 identified the need for a buttress to be constructed along the toe of the tailings piles in order to provide stability during an earthquake, where the magnitude of seismic shaking was based on ARARs. Intalco's Alternative 13M geotechnical analysis was based on the assumption that the existing tailings piles were constructed behind a starter dike, and that the weak and potentially liquefiable Zone 4 soils had been removed from below that dike. However, this assumption has not been verified by Intalco's test pits or other observations, and historic documentation is incomplete, as noted in the agencies' comments on Alternative 13M (Forest Service 2010a).

The Agencies found that without the dike and removal of Zone 4 soils, Intalco's buttress design would not provide adequate seismic stability. In order to provide a reasonable basis for cost comparison, the Agencies estimated cost for the Alternative 13M tailings pile buttress based on geotechnical design that did not rely on the dike or the historic removal of the Zone 4 soils. The result was an increase in estimated dike construction cost from Intalco's estimate of about $1.9 million to $3.1 million. The Agencies used the higher value in comparing cost of Alternative 13M to Alternatives 11M and 14.

5.2.3 Groundwater Treatment Facilities

The Agencies and Intalco differed in their assumptions for different components of the groundwater treatment system, but came to essentially the same overall cost for this area. On the one hand, Intalco assumed significantly greater site preparation costs, whereas the Agencies assumed the treatment ponds would need to be lined to satisfy ARARS. There were also other, smaller, differences largely due to different assumptions on the volume of water to be treated and the equipment costs required for treatment.

Since the estimated costs are similar overall, the Agencies did not modify Intalco's estimate for comparison purposes, but also do not consider Intalco's estimate to represent the true cost of an acceptable remedy.

5.2.4 Sludge and Solid Waste Landfills

It appears to the Agencies that Intalco underestimated the volume of sludge that will be generated by water treatment, and therefore underestimated the cost for sludge handling and disposal. It also appears to the Agencies that Intalco underestimated the cost for solid waste disposal as part of the cleanup. As a result, the Agencies estimated cost for these two components of Alternative 13M was about $800,000 more than Intalco's estimate. The Agencies anticipate that groundwater treatment pilot tests by Intalco will provide a better estimate of sludge generation than is currently available. While the actual cost may vary from that estimated, the Agencies have used a consistent approach for estimating sludge disposal costs for all alternatives.

5.2.5 Contractor Markups

Intalco used 10 percent for the contractor overhead and profit line item, as well as 10 percent for the line item that included insurance, Division 1 items, engineering, and surveying by the contractor. The Agencies' estimate for Alternative 13M adopted the same percentages for comparison purposes.

5.2.6 Non-Construction Capital Costs

As noted for Alternative 11, Intalco estimated the cost of engineering design at fifteen percent of construction costs, compared to the Agencies' estimate of five percent. The Agencies included baseline monitoring in the non-construction capital costs for Alternative 13M, {as did both the Agencies and Intalco for Alternative 11(M)]. For the Alternative 13M estimate, Intalco included the baseline monitoring cost as part of the NPV for long term OMM, but did not explain why. The other non-construction capital costs were similar in both estimates.

5.2.7 OMM

The Agencies' and Intalco's estimates for long-term costs differed significantly in the cost estimated for lime consumption, periodic equipment replacement, maintenance to control vegetation to protect integrity of the membrane cap over the solid waste and sludge landfill cells after closure, and net present value of various OMM components. The Agencies estimated NPV for OMM cost for Alternative 13M using the same assumptions as for Alternatives 11M and 14 was $22.1 million, compared to Intalco's value of $13.0 million.

6.0 AGENCIES' COST ESTIMATE ALTERNATIVE 14

This section describes the basis used to develop the Agencies' cost estimates for Alternative 14.

6.1 Job Startup and Construction Infrastructure

Mobilization for a single phase of construction for Alternative 14 was calculated as about 6.5 percent of the total direct construction costs using the same rationale as Alternative 11. The addition of a second phase of construction for the groundwater containment and collection system was estimated to increase the overall mobilization cost by about $1.0 million, based on Intalco's estimate for the mobilization cost for the Alternative 13M contingency.

The Agencies adopted Intalco's cost estimates from Alternative 13M for most of the components used in Alternative 14. In order to compare costs for all the alternatives, the Agencies also used Intalco's approach to estimating overtime costs based on Alternative 13M approach, rather than the approach that was used for Alternative 11M.

Other job startup factors that depend on construction duration (e.g., site supervision, camp worker days, and overtime) were typically estimated using the same approach as Alternative 11. The final Alternative 14 estimate is based on primary remedy construction occurring over a two-year period followed by Contractor demobilization and remobilization after five years to construct the groundwater containment and collection system down stream of Tailings Pile 3.

6.2 Upgradient Run-On Diversions

This component of the Alternative 14 estimate uses the same approach as Intalco's estimate for Alternative 13M, but somewhat different unit prices based on the Agencies' estimate for Alternative 11.

6.3 Mine, Mill and Maintenance Yard

The Alternative 14 cost estimates for this area adopted Intalco's estimated costs for work in the mine (the largest portion of these costs). Costs for other elements including mill demolition, removal of impacted soils, and paving were similar but typically based on updating the Agencies Alternative 11 unit costs.

6.4 Groundwater Containment, Collection, and Conveyance

Costs for this portion of Alternative 14 were also similar to the costs Intalco estimated, with the following exceptions. The Agencies' estimate assumed extending the groundwater barrier south along the east side of Tailings Pile 1 about 240 feet farther than Intalco assumed for Alternative 13M, in order to fully contain groundwater impacted by releases from the tailings pile. Alternative 14 used Intalco's estimated contingent costs for construction of the groundwater barrier and containment system around Tailings Piles 2 and 3. The Agencies estimate also assumed five seep collection points for seeps SB-12 and SB-23 downslope of Honeymoon Heights, whereas Intalco assumed all five locations could be addressed by two collection points farther upslope.

6.5 Waste Rock Piles

The Agencies assumed that excess rock from regrading the waste rock slopes would be consolidated onto the tailings piles prior to capping. For cost estimating purposes, the Agencies assumed the cap would consist of two feet of soil and native vegetation, although final design of the cap has not yet been accomplished.

6.6 Tailings Piles

The cost estimate for regrading and capping the tailings piles for Alternative 14 was based on the area estimated for Alternative 13M (which was less than the Agencies had previously estimated for regrading the tailings under Alternative 11), and the Agencies own unit prices which were similar to the prices Intalco estimated. The Agencies cost estimate assumed the soil cap would consist of two feet of soil and native vegetation, although final design of the cap has not yet been accomplished. The area to be capped was assumed to be the existing nominal footprint of the tailings piles after regrading the outer slopes; the Agencies did not assume any increase in area due to consolidation of impacted soils from other areas of the Site.

6.7 Toe Buttress

The Agencies' estimated cost for the tailings piles toe buttress (including a shear key) was based on the approach presented by Intalco for Alternative 13M, but did not rely on the assumed presence of a starter dike or prior removal of the

Zone 4 soils. The Agencies used the same unit prices for buttress construction that Intalco used.

6.8 Groundwater Treatment Facilities

The Agencies' estimate for the Alternative 14 treatment system was based on the same approach used to develop costs for Alternative 11, increased where needed to accommodate the volume of water to be treated based on Intalco's 2009 groundwater flow model. The Agencies adopted Intalco's estimated cost for the Aquafix ™ system, but adjusted this cost upwards to accommodate the increased flow rate, using the scaling method described in Appendix B of the SFS.

6.9 Sludge and Solid Waste Landfills

The estimated cost for the Alternative 14 followed the same approach and unit costs for the sludge landfill liner and leachate collection system, but a different volume. The sludge volume was increased based on the new estimate of treated water volume and influent hazardous substance concentrations. Also, the Alternative 14 sludge landfill volume does not include the volume of solid waste (e.g., TPH-impacted soils) that was part of the same landfill for Alternative 11; these soils are to be included in the solid waste landfill constructed for the remedy.

The Agencies' cost estimate was based on the volume of sludge disposal developed for Alternative 14 using the same type of approach described in Section 5.1.3.2 of this Appendix. The estimated cost for solid waste disposal was based on an estimated volume of 6,900 CY for debris from the mill demolition, 500 CY residual processing waste from mill cleanup, and 20,000 CY of additional solid waste that may be generated from unspecified sources during remediation, similar to the approach adopted for Alternative 13M.

6.10 Consolidation of Impacted Soils

The Alternative 14 estimate includes the costs for excavation and removal of impacted soils from the Lagoon Area and the former Surface Water Retention Area (SRA), using the same costs as Alternative 13M. Costs for consolidation of impacted soils from the former Ballfield Area (assumed 500 CY) and Lower West Area (assumed 20,000 CY) were estimated using the same approach.

6.11 Surface Water Remediation

Alternative 14 includes improvements to the Copper Creek diversion channel, development of the Lightning Ridge riprap source for riprap, relocation of portion(s) of Railroad Creek, and associated modifications to Copper Creek. The extent of stream relocation was assumed to be the same as for alternative 13M for cost estimating purposes, but this will need to be further assessed during RD as discussed in Section 5.3.3 of the ASFS. The Agencies' Alternative 14 estimate for these components is based on Intalco's estimated costs except for the source of riprap, since Intalco assumed the Tenmile Creek quarry site would be developed.

6.12 In Situ Soil Remediation of Off-Site Soils above CULs

Alternative 14 includes remediation of some areas of the Site using *in situ* treatment, including the Honeymoon Heights Waste Rock Piles and impacted areas downslope, portions of the Lower West Area and the Ballfield Area, Holden Village, and the Wind-Blown Tailings Area, as described in the ASFS. The Agencies' cost estimate assumed the *in situ* treatment cost as described above in Section 5.1.4, although final design based on a treatability study has not yet been accomplished.

6.13 Non-Construction Capital Costs

The Agencies' estimate for non-construction capital costs is similar to the approach presented in the SFS for Alternative 11, except that the Alternative 14 estimate (like the Alternative 11M estimate) included the cost for the in situ treatability study, but did not include costs for the Terrestrial Ecological Evaluation (risk assessment) or the groundwater treatability study, since Intalco has already undertaken these efforts as part of the RI/FS.

6.13.1 OMM

The Agencies' estimate of NPV for long-term OMM of Alternative 14 followed the methods used for Alternative 11. The estimated cost for Alternative 14 is very similar to, but slightly lower than the Agencies estimate for Alternative 11M, due to the reduced need for fuel and equipment maintenance for pumping groundwater as part of Alternative 14 compared to Alternative 11M.

7.0 CONTINGENT COSTS

EPA guidance (EPA 2000) includes a contingent cost allowance for potential cost changes to address areas of uncertainty between actual costs and estimated costs, and between the actual extent of cleanup and the estimated extent. Contingent costs may also refer to the cost change if the proposed scope of the remedy is modified. Appendix B discusses the two main types of contingent costs (scope and bid contingencies) and EPA guidance on the appropriate cost magnitude for each type.

The primary contingency considered in both Alternatives 13M and 14 is the groundwater containment and collection system downgradient of Tailings Pile 3. Intalco estimated the cost for this contingent measure at about $13.5 million in the spreadsheet estimate (URS 2009) prepared for Alternative 13M. This contingency estimate included about $1.9 million for increased mobilization costs, and about $11.6 million in increased construction costs (including camp costs). Intalco included a 30 percent surcharge in this estimate (a contingency on the contingency cost).

The Agencies initially estimated the cost for Alternative 14 on the basis of a nominal three-year construction period, without any remobilization. Except for the potential expense of remobilization, the costs for constructing the groundwater barrier and collection system downgradient of Tailings Piles 2 and 3 are likely to be similar regardless of whether these components are part of a first or second phase of construction. Since Alternative 14 includes implementation of the remedy in two phases, the primary costs for the contingent action (i.e., potential elimination of the downstream barrier wall and collection system) would be to eliminate the cost of this barrier, including the cost for the second mobilization to construct it.[14] The estimated reduction in cost for Alternative 14 due to elimination of the downstream groundwater barrier and collection system would be about $9.6 million.

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[14] The Agencies have not attempted to estimate costs for other Alternative 14 contingent measures other than the potential elimination of the need to construct the downstream barrier. The estimated cost impact of an alternative approach (such as a partially penetrating barrier) is anticipated to be less than the cost of the fully penetrating barrier proposed for Alternative 14. The estimated cost for Alternative 14 and the reduced cost for elimination of the Tailings Pile 3 barrier and collection system, therefore, define the likely range of estimated costs for Alternative 14.

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Table A-1 - Comparison of Agencies' Estimated Costs for Alternatives 11M, 13M, and 14

Item	Alt. 11M	Alt. 13M	Alt. 14
CAPITAL COSTS (2005 Dollars)			
Direct Construction Costs			
Job Setup & Construction Infrastructure	$6,920,000	$6,440,000	$7,860,000
Upgradient Diversions and Access Roads	$194,000	$260,000	$251,000
Mine, Mill, Maintenance Yard Site Remediation	$3,220,000	$3,440,000	$3,180,000
Groundwater Containment, Collection & Conveyance			
West Area (LWA and TP-10	$5,010,000	$4,130,000	$5,040,000
East Area (TP-2 and TP-3)	$6,380,000	$156,000	$6,310,000
Waste Rock Piles	$5,380,000	$1,180,000	$1,340,000
Tailings Piles			
Regrade and Cap	$16,800,000	$3,690,000	$4,070,000
Toe Buttress	$5,260,000	$3,130,000	$3,020,000
Groundwater Treatment Facilities			
East Area	$2,080,000	$2,260,000	$2,120,000
West Area	$0	$1,160,000	$862,000
Landfills	$5,740,000	$1,170,000	$5,920,000
Lagoon Area / SRA / Ballfield / LWA	$738,000	$225,000	$805,000
Surface Water Remediation	$1,170,000		
Railroad Creek Realignment	$0	$7,010,000	$8,500,000
Copper Creek	$0	$679,000	$771,000
Other Surface Water Related	$0	$279,000	$230,000
***In Situ* Soil Treatment**	$723,000	$0	$783,000
Subtotal Direct Construction Costs	$59,600,000	$35,200,000	$51,100,000
Contractor Markups	$11,900,000	$7,040,000	$10,220,000
Total Construction Costs (2005 Dollars)	$71,500,000	$42,200,000	$61,300,000
Non-Construction Capital Costs (2005 Dollars)	$12,100,000	$11,100,000	$10,600,000
TOTAL CAPITAL COSTS (2005 Dollars)	$83,600,000	$53,300,000	$71,900,000
PRESENT WORTH OF POST-CONSTRUCTION OMM COSTS (2005 Dollars)	$30,000,000	$22,100,000	$29,000,000
TOTAL ESTIMATED COST (2005 Dollars)	$114,000,000	$75,400,000	$100,900,000
TOTAL ESTIMATED COST (2010 Dollars)	$120,000,000	$79,800,000	$107,000,000

Note: Conversion of 2005 costs to 2010 costs based on ENR Construction Cost Index.

Table A-2 - Breakdown of Agencies' Cost estimate for Alternative 11M

Item	Quantity	Units	Unit Cost	Subtotal Cost	Subtotal (2005 Costs)
CAPITAL COSTS (2005 Dollars)					
Direct Construction Costs					
Job Setup & Construction Infrastructure					
Mobilize & Demobilize (Material, Equipment, Workers, & Two Winter Shutdowns)	1	ls	$3,550,000	$3,550,000	
Site Supervision (For 3 Construction Seasons)	1	ls	$913,823	$913,823	
Operate Camp (42 people avg.)	18,900	worker day	$72	$1,360,800	
New/Upgrade Construction Bridges	1	ls	$344,407	$344,407	
Road Maintenance (3 Construction Seasons)	1	ls	$560,000	$560,000	
Monitoring Well Installation	1	ls	$66,072	$66,072	
Upgrade Barge Facilities	1	ls	$123,795	$123,795	
Subtotal Job Setup & Construction Infrastructure					*$6,920,000*
Upgradient Diversions and Access Roads					
West Area	1	ls	$110,943	$110,943	
East Area	1	ls	$83,120	$83,120	
Subtotal Upgradient Diversions and Access Roads					*$194,000*
Mine Mill & Maintenance Yard					
Access/Air Flow Restrictions	2	ea	$7,500	$15,000	
1500 Main Portal with Manway (Option B)	1	ls	$1,202,665	$1,202,665	
1500 Vent Portal (Option B)	1	ls	$1,386,220	$1,386,220	
Mill Demolition (Remove Unsafe Superstructure)	1	ls	$394,981	$394,981	
Removal of Residual Processing Waste and Contaminated Soils at Mill Area	500	cy	$51.76	$25,880	
Revegetate Mill Area (After Cleanup)	2	ac	$7,901	$15,802	
Hydroseed Mill Area	2	ac	$3,165	$6,330	
Plant Tree Tubes and Shrubs on Mill Area	2	ac	$2,709	$5,418	
Pave Existing Maintenance Yard	1	ls	$162,764	$162,764	
Subtotal Mine, Mill & Maintenance Yard					*$3,220,000*
Groundwater Containment, Collection & Conveyance					
West Area					
Portal Discharge Pipe to WWTP	1	ls	$163,306	$163,306	
Work Platform Grading and Maintenance Road to SP-23	900	lf	$35.17	$31,653	
Barrier Wall (SB w/ CB in Steep Areas) LWA Wall Sta. 0+00 to 24+70 (Component 1)	1	ls	$2,059,369	$2,059,369	
Barrier Wall (SB w/ CB in Steep Areas) LWA Wall Sta. 24+70 to 37+07 (Component 3)	1	ls	$2,532,468	$2,532,468	
Copper Creek Pipeline Crossing	1	ea	$58,439	$58,439	
Pipe to Treatment Pond	1300	lf	$60.85	$79,105	
LWA & TP-1 Seep Collection and Conveyance	1	ls	$84,545	$84,545	
Subtotal Groundwater Containment, Collection & Conveyance - West					*$5,010,000*
East Area					
Barrier Wall (SB w/ CB in Steep Areas) TP2 Wall Sta. 0+00 to 24+00 (Component 4.1)	1	ls	$2,811,658	$2,811,658	
Barrier Wall (SB w/ CB in Steep Areas) TP3 Wall Sta. 24+00 to 42+50 (Component 5.1)	1	ls	$3,296,626	$3,296,626	
RR Creek Pipeline Crossing	1	ea	$116,878	$116,878	
GW Trench and Seep Collection Pipe along Toe of TP-1, TP-2 and TP-3	8,280	lf	$11.59	$95,965	
Maintenance Road for GW Trench and Seep Collection Pipe	8,280	lf	$7.35	$60,858	
Subtotal Groundwater Containment, Collection & Conveyance - East					*$6,380,000*
Subtotal Groundwater Containment, Collection & Conveyance					*$11,390,000*
Waste Rock Piles					
Regrade Waste Rock Slopes and Haul	158,000	cy	$9.52	$1,504,160	
Place Woody Debris at Mill Area	2	ac	$2,359	$4,718	
Cap Regraded Waste Rock Piles	8.9	ac	$198,489	$1,766,548	
Hydroseed Waste Rock Piles	8.9	ac	$3,165	$28,169	
Honeymoon Heights WR Pile Removal	48,694	cy	$42.68	$2,078,373	
Subtotal Waste Rock Piles					*$5,380,000*

Table A-2 - Breakdown of Agencies' Cost estimate for Alternative 11M

Item	Quantity	Units	Unit Cost	Subtotal Cost	Subtotal (2005 Costs)
Tailings Piles					
TESC	1	ls	$198,483	$198,483	
Regrade Top of Tailings Pile 1	13.6	ac	$26,116	$355,178	
TP1 Regrade	120,071	cy	$4.60	$552,073	
TP2 Regrade	597,057	cy	$6.00	$3,581,686	
TP3 Regrade	284,100	cy	$5.17	$1,468,449	
Cap for Top and Side Slopes	78	ac	$136,081	$10,614,318	
Subtotal Tailings Piles					*$16,800,000*
Toe Buttress					
Excavate for Toe Berm & Shear Key	31,929	cy	$8.85	$282,572	
Shear Key and Toe Berm Rock from Quarry	89,976	cy	$36.41	$3,276,030	
Bedding for Shear Key Rock	7,334	cy	$8.73	$64,022	
Compact Toe Berm Tailings - TP-1	22,000	cy	$5.47	$120,340	
Compact Toe Berm Tailings - TP-2	132,540	cy	$6.89	$913,201	
Compact Toe Berm Tailings - TP-3	101,117	cy	$5.94	$600,633	
Subtotal Toe Buttress					*$5,260,000*
Groundwater Treatment Facilities					
Forest Clearing and Stockpile	9.8	ac	$14,658	$143,484	
Excavate Ponds	85,655	cy	$5.92	$507,075	
Concrete Lining	2,971	cy	$184	$546,605	
Chemical Storage and Addition Facilities	1	ea	$279,000	$279,000	
Mixing and Aeration Facilities	1	ls	$40,000	$40,000	
Filtration Ponds with Media	1	ls	$97,075	$97,075	
Energy Supply	1	ls	$72,760	$72,760	
Stockpile Sand for Treatment System O&M	1	ls	$71,897	$71,897	
Miscellaneous Treatment	1	ls	$97,767	$97,767	
Building for Office/Storage	500	sf	$156	$78,000	
Sludge conveyance from WWTP to TP-2	3,600	lf	$39.75	$143,088	
Subtotal Groundwater Treatment Facilities					*$2,080,000*
Landfills					
Sludge Disposal Landfill	1	ls	$5,717,518	$5,717,518	
Consolidated Cleanup Derived Waste	1	ls	$24,529	$24,529	
Subtotal Landfills					*$5,740,000*
Lagoon Area / SRA / Ballfield / LWA					
Excavate Lagoon Area Impacted Soils	9,000	cy	$18.99	$170,879	
Excavate Ventilator Portal Surface Water Retention Area (SRA) Impacted Soils	400	cy	$20.63	$8,252	
Access Road to Ventilator Portal Retention Area	1,200	lf	$9.50	$11,400	
Abandon Road to Ventilator Portal Retention Area	1,200	lf	$4.40	$5,280	
Excavate and Haul Ballfield Impacted Soil	500	cy	$20.63	$10,315	
Excavate and Haul LWA Impacted Soil	28,000	cy	$18.99	$531,720	
Subtotal Lagoon SRA					*$738,000*
Surface Water Remediation					
Copper Creek Diversion Channel Improvement	350	lf	$83	$29,050	
Ferricrete Removal	1	ls	$115,513	$115,513	
Develop Riprap Source (Lightning Ridge)	1	ls	$75,000	$75,000	
Place Riprap Berm along Creek Channel	12,683	cy	$74.76	$948,144	
Subtotal Surface Water Remediation					*$1,170,000*
***In Situ* Soil Treatment**					
In Situ Soil Treatment	96	ac	$7,551	$722,992	
Subtotal In Situ Soil Treatment					*$723,000*
Subtotal Direct Construction Costs					**$59,600,000**
Contractor Markups					
Contractor's OH&P			12.0%	$7,150,000	
Insurance, Div 1 Items, Contractor's Engr, Surveying			8.0%	$4,770,000	
Subtotal Markups					*$11,900,000*
Total Construction Costs (2005 Dollars)					**$71,500,000**

Table A-2 - Breakdown of Agencies' Cost estimate for Alternative 11M

Item	Quantity	Units	Unit Cost	Subtotal Cost	Subtotal (2005 Costs)
Non-Construction Capital Costs (2005 Dollars)					
Engineering Design			6.0%	$4,290,000	
In Situ Treatability Study	1	ls	$500,000	$500,000	
Construction Administration & Oversight			4.0%	$2,860,000	
Project Management			5.0%	$3,575,000	
Baseline Monitoring (Pre-Construction)	1	ls	$923,000	$923,000	
Total Non-Construction Capital Costs					**$12,100,000**
TOTAL CAPITAL COSTS (2005 Dollars)					**$83,600,000**
PRESENT WORTH OF POST-CONSTRUCTION OMM COSTS (2005 Dollars)				$30,000,000	
TOTAL ESTIMATED COST (2005 Dollars)					**$114,000,000**

Notes:

1. Rounding of significant figures is typically applied only at summary of subtotals, and does not materially affect the overall estimate.

Table A-3 - Breakdown of Agencies' Cost Estimate for Alternative 13M

ITEM	Quantity	Units	Unit Cost	Subtotal Cost	Subtotal (2005 Costs)
CAPITAL COSTS (2005 Dollars)					
Direct Construction Costs					
Job Setup & Construction Infrastructure					
Mobilize & Demobilize	1	ls	$2,402,159	$2,402,159	
Site Supervision (2 seasons)	1	ls	$609,215	$609,215	
Additional Mob/Demob for Barrier	1	ls	$113,173	$113,173	
Physical Access Restrictions	1	ls	$50,000	$50,000	
Operate Camp	24,921	worker day	$72	$1,794,283	
New Construction Bridges	1	ls	$393,798	$393,798	
Upgrade Barge Facilities	1	ls	$128,152	$128,152	
Road Maintenance	1	ls	$529,000	$529,000	
Monitoring well installation	1	ls	$67,012	$67,012	
Unaccounted Overtime Pay	1	ls	$357,767	$357,767	
Subtotal Job Setup & Construction Infrastructure					*$6,440,000*
Upgradient Diversions and Access Roads					
West Area	3,420	lf	$36.93	$126,286	
East Area	4,300	lf	$31.16	$133,990	
Subtotal Upgradient Diversions and Access Roads					*$260,000*
Mine, Mill & Maintenance Yard					
Access/Air-flow Restrictions in Adits	2	ea	$7,500	$15,000	
1500 Main Portal with Manway (Option B)	1	ls	$1,202,665	$1,202,665	
1500 Vent Portal (Option B)	1	ls	$1,386,220	$1,386,220	
Mill Demolition (Remove Unsafe Superstructure)	1	ls	$408,883	$408,883	
Excavation/Relocation of Impacted Soils	500	cy	$45.17	$22,585	
Pave Existing Maintenance Yard - Concrete Slab	694	cy	$304.55	$211,494	
Pave Existing Maintenance Yard - Base Course	833	cy	$54.95	$45,774	
Cover for Impacted Soils	45,000	sf	$3.26	$146,830	
Subtotal Mine, Mill & Maintenance Yard					*$3,440,000*
Groundwater Containment, Collection & Conveyance					
West Area					
Barrier Wall (SB w/ CB in Steep Areas) LWA Wall Sta. 0+00 to 24+70 (Component 1)	1	ls	$2,115,028	$2,115,028	
Barrier Wall (SB w/ CB in Steep Areas) LWA Wall Sta. 24+70 to 34+70 (Component 3a)	1	ls	$1,614,100	$1,614,100	
Copper Creek Pipeline Crossing	1	ea	$89,365	$89,365	
Pipe to Lined Collection Ditch (18" HDPE)	1,200	lf	$74.86	$89,837	
Portal Discharge Pipe to SP-10 (To West Area Treatment for Intalco Alt 3b)	4,400	lf	$30.32	$133,404	
Seep 12 & 23 Collection/Treatment (pipe)	2,000	lf	$35.90	$71,799	
Catch Basins	$2	ea	$10,000	$20,000	
Subtotal Groundwater Containment, Collection, & Conveyance - West Area					*$4,130,000*
East Area					
GW Collection Trench	1	ls	$102,890	$102,890	
Seep SP21 Conveyance Ext	1	ls	$53,189	$53,189	
Subtotal Groundwater Containment, Collection, & Conveyance - East Area					*$156,000*
Subtotal Groundwater Containment, Collection, & Conveyance - All Areas					*$4,286,000*
Waste Rock Piles					
Regrade East Waste Rock Pile Slopes to 2:1 Ex. and Haul. Includes Soil Cover and Plantings. (Component 12)	1	ls	$679,219	$679,219	
Regrade West Waste Rock Pile Slopes to 2:1 Ex. and Haul. Includes Soil Cover and Plantings. (Component 13)	1	ls	$466,996	$466,996	
Place Woody Debris on Waste Rock Piles and Mill Building Area	9.3	ac	$3,192	$29,686	
Subtotal Waste Rock Piles					*$1,180,000*
Tailings Piles					
TESC	1	ls	$196,001	$196,001	
Alt 13M Regrade of TP1 for 2:1 Slopes	43,619	cy	$4.76	$207,614	
Alt 13M Regrade of TP2 for 2:1 Slopes	314,419	cy	$6.21	$1,952,556	
Alt 13M Regrade of TP3 for 2:1 Slopes	29,927	cy	$5.35	$160,130	
Cap	78	ac	$15,051	$1,174,004	
Subtotal Tailings Piles					*$3,690,000*

Table A-3 - Breakdown of Agencies' Cost Estimate for Alternative 13M

ITEM	Quantity	Units	Unit Cost	Subtotal Cost	Subtotal (2005 Costs)
Toe Buttress					
Shear Key and Toe Berm Excavation	17,419	cy	$8.85	$154,177	
Shear Key and Toe Berm Rock from Quarry	41,160	cy	$36.41	$1,498,712	
Shear Key and Toe Berm Rock Harvested from On-Site Locations	34,871	cy	$5.07	$176,825	
Bedding for Shear Key Rock	4,001	cy	$8.73	$34,937	
TP1 Toe Berm Compacted Tailings	16,241	cy	$5.47	$88,778	
TP2 Toe Berm Compacted Tailings	99,327	cy	$6.89	$684,541	
TP3 Toe Berm Compacted Tailings	82,183	cy	$5.94	$488,287	
Subtotal Toe Buttress					*$3,130,000*
Groundwater Treatment Facilities					
East of TP3					
TP3 Pond Clearing	1	ls	$141,987	$141,987	
TP3 Pond Excavation	1	ls	$745,772	$745,772	
TP3 Pond Berm Gravel	1	ls	$163,064	$163,064	
TP3 Wetlands	1	ls	$197,223	$197,223	
Aquafix at TP3	1	ls	$764,139	$764,139	
TP3 Pond Pipelines	1	ls	$102,119	$102,119	
Stockpiled Sand for O&M Maintenance	1	ls	$147,504	$147,504	
Subtotal Groundwater Treatment- East of TP3					*$2,260,000*
West of TP1					
Forest Clearing and Stockpile	2	ac	$16,855	$33,710	
Excavate Ponds	7,387	cy	$12.48	$92,168	
Chemical Storage and Addition Facilities	1	ls	$294,000	$294,000	
Additional Lime Storage (1@35-ton and 1@80 ton silos)	1	ls	$82,550	$82,550	
Mixing and Aeration Facilities	1	ls	$100,000	$100,000	
Energy Supply	1	ls	$200,000	$200,000	
Miscellaneous Treatment (piping & etc.)	1	ls	$203,000	$203,000	
Building for Office/Storage	1	ls	$156,035	$156,035	
Subtotal Groundwater Treatment - West of TP1					*$1,160,000*
Subtotal Groundwater Treatment - All Areas					*$3,420,000*
Landfills					
Impacted Sludge Disposal Cell	1	ls	$800,894	$800,894	
Impacted Soil, Solid Waste and Debris Disposal Cell	1	ls	$371,366	$371,366	
Subtotal Landfill					*$1,170,000*
Lagoon Area / SRA / Ballfield / LWA					
Excavations/Relocation of Lagoon Area Impacted Soils	9,000	cy	$19.65	$176,893	
Excavate Ventilator Portal Detention Area/SRA Impacted Soils	400	cy	$22.05	$8,819	
Access Road to Ventilator Portal Retention Area	1,000	lf	$27.01	$27,014	
Abandon Road to Ventilator Portal	1,000	lf	$12.25	$12,253	
Subtotal Lagoon Area/Former Retention Pond Actions					*$225,000*
Surface Water Remediation					
Railroad Creek Realignment					
Clear New Creek Alignment	1	ls	$215,131	$215,131	
Access Road for New Creek	1	ls	$131,527	$131,527	
Excavate New Creek	1	ls	$2,043,601	$2,043,601	
New Creek Berms & Liner	1	ls	$375,179	$375,179	
New Creek Bedding (1' thick)	1	ls	$137,986	$137,986	
New Creek Riprap from Ten Mile Creek (5' thick) with Bedding (0.5' thick)	1	ls	$2,676,135	$2,676,135	
New Creek Gravel Layer (2' thick)	1	ls	$199,664	$199,664	
Retaining Wall	1	ls	$609,184	$609,184	
Screen Excess Creek Excavation	1	ls	$229,407	$229,407	
Habitat Installation	1	ls	$82,200	$82,200	
Tree Tubes and Shrubs Creek Edges	1	ls	$56,040	$56,040	
Hydroseed	1	ls	$14,407	$14,407	
River Diversion Costs	1	ls	$140,000	$140,000	
Dewatering	1	ls	$100,000	$100,000	
Subtotal Railroad Creek					*$7,010,000*
Copper Creek					
Copper Creek Access Road	1	ls	$40,299	$40,299	
Copper Creek Rehabilitation	1	ls	$89,044	$89,044	
Clear Copper Creek Alignment	1	ls	$11,952	$11,952	
Access Road for Copper Creek	1	ls	$10,522	$10,522	
Excavate New Copper Creek Area	1	ls	$46,316	$46,316	
Copper Creek Berms & Liner	1	ls	$28,326	$28,326	
Copper Creek Bedding	1	ls	$8,776	$8,776	

Table A-3 - Breakdown of Agencies' Cost Estimate for Alternative 13M

ITEM	Quantity	Units	Unit Cost	Subtotal Cost	Subtotal (2005 Costs)
Copper Creek Riprap from Ten Mile Creek with Bedding (0.5' thick)	1	ls	$323,582	$323,582	
Copper Creek River Gravel	1	ls	$4,017	$4,017	
Retaining Wall	0	ls	$0	$0	
Screen Excess Creek Excavation	1	ls	$1,419	$1,419	
Habitat Installation	1	ls	$6,122	$6,122	
Tree Tubes and Shrubs Creek Edges	1	ls	$7,005	$7,005	
Hydroseed	1	ls	$1,801	$1,801	
River Diversion Costs	1	ls	$70,000	$70,000	
Dewatering	1	ls	$30,000	$30,000	
Subtotal Copper Creek Extension					*$679,000*
Other Surface Water Related					
Copper Creek Diversion Channel Improvement	350	lf	$76.11	$26,640	
Develop Riprap Source	1	ls	$252,342	$252,342	
Subtotal Copper Creek Pipeline					*$279,000*
Subtotal All Surface Water Items					*$7,970,000*
Subtotal Direct Construction Costs					**$35,200,000**
Contractor Markups					
Contractor's OH&P			10.0%	$3,520,000	
Insurance, Div 1 Items, Contractor's Engr, Surveying			10.0%	$3,520,000	
Subtotal Markups					*$7,040,000*
Total Construction Costs (2005 Dollars)					**$42,200,000**
Non-Construction Capital Costs (2005 Dollars)					
Engineering Investigation/Design/Planning			15.0%	$6,330,000	
Construction Management			4.0%	$1,688,000	
Project Management			5.0%	$2,110,000	
Baseline Monitoring (Pre-Construction)	1	ls	$923,000	$923,000	
Subtotal Non-Construction Capital Costs					*$11,100,000*
TOTAL CAPITAL COSTS (2005 Dollars)					**$53,300,000**
PRESENT WORTH OF POST-CONSTRUCTION OMM COSTS (2005 Dollars)					**$22,100,000**
TOTAL ESTIMATED COST (2005 Dollars)					**$75,400,000**

Notes:

1. Rounding of significant figures is typically applied only at summary of subtotals, and does not materially affect the overall estimate.

Table A-4 - Breakdown of Agencies' Cost Estimate for Alternative 14

ITEM	Quantity	Units	Unit Cost	Subtotal Cost	Subtotal (2005 Costs)
CAPITAL COSTS (2005 Dollars)					
Direct Construction Costs					
Job Setup & Construction Infrastructure					
Mobilize & Demobilize (First Phase)	1	ls	$2,900,000	$2,900,000	
Mobilize & Demobilize (Second Phase)	1	ls	$1,000,000	$1,000,000	
Site Supervision (3 seasons)	1	ls	$913,823	$913,823	
Operate Camp (3 seasons)	18,900	days	$72.00	$1,360,800	
New Construction Bridges	1	ls	$393,798	$393,798	
Upgrade Barge Facilities	1	ls	$123,795	$123,795	
Road Maintenance (3 seasons)	1	ls	$560,000	$560,000	
Monitoring Well Installation	1	ls	$67,012	$67,012	
Unaccounted Overtime Pay	1	ls	$536,650	$536,650	
Subtotal Job Setup & Construction Infrastructure					*$7,860,000*
Upgradient Diversions and Access Roads					
West Area	3,420	lf	$35.67	$121,992	
East Area	4,300	lf	$30.10	$129,435	
Subtotal Upgradient Diversions and Access Roads					*$251,000*
Mine, Mill & Maintenance Yard					
Access/Air-flow Restrictions in Adits	2	ea	$7,500	$15,000	
1500 Main Portal with Manway (Option B)	1	ls	$1,202,665	$1,202,665	
1500 Vent Portal (Option B)	1	ls	$1,386,220	$1,386,220	
Mill Demolition (Remove Unsafe Superstructure)	1	ls	$394,981	$394,981	
Removal of Residual Processing Waste and Contaminated Soils at Mill Area	500	cy	$43.63	$21,817	
Revegetate Mill Area (After Cleanup)					
Hydroseed Mill Area					
Plant Tree Tubes and Shrubs on Mill Area					
Pave Existing Maintenance Yard - Concrete Slab	694	cy	$184.00	$127,778	
Pave Existing Maintenance Yard - Base Course	833	cy	$42.00	$34,986	
Subtotal Mine, Mill & Maintenance Yard					*$3,180,000*
Groundwater Containment, Collection & Conveyance					
West Area					
Barrier Wall (SB w/ CB in Steep Areas) LWA Wall Sta. 0+00 to 24+70 (Component 1)	1	ls	$2,059,369	$2,059,369	
Barrier Wall (SB w/ CB in Steep Areas) LWA Wall Sta. 24+70 to 37+07 (Component 3)	1	ls	$2,532,468	$2,532,468	
Copper Creek Pipeline Crossing	1	ea	$86,327	$86,327	
Pipe to Lined Collection Ditch (18" HDPE)	1,200	lf	$72.32	$86,783	
Portal Discharge Pipe to SP-10 (To West Area Treatment for Intalco Alt 3b)	4,400	lf	$29.29	$128,868	
Seep 12 & 23 Collection/Treatment (pipe) to WWWTP	2,000	lf	$34.68	$69,357	
Catch Basins to Collect Seeps 12 & 23	5	ea	$10,000	$50,000	
Work Platform Grading and Maintenance Road to SP-23	900	lf	$35.17	$31,653	
Subtotal Groundwater Containment, Collection, & Conveyance - West Area					*$5,040,000*
East Area					
Barrier Wall (SB w/ CB in Steep Areas) Component 4.1 TP2 Wall Sta. 0+00 to 24+00	1	ls	$2,811,658	$2,811,658	
Barrier Wall (SB w/ CB in Steep Areas) Component 5.1 TP3 Wall Sta. 24+00 to 42+50	1	ls	$3,296,626	$3,296,626	
Maintenance Road for GW Trench and Seep Collection Pipe along Toe of TP-2 and TP-3, & EWWTP	6,350	lf	$8.57	$54,426	
GW Collection Ditch along Toe of TP-2, TP-3 & T. Ponds	3,300	lf	$30.12	$99,392	
Seep SP21 Conveyance Ext	1	ls	$51,381	$51,381	
Subtotal Groundwater Containment, Collection, & Conveyance - East Area					*$6,310,000*
Subtotal Groundwater Containment, Collection, & Conveyance - All Areas					*$11,400,000*

Table A-4 - Breakdown of Agencies' Cost Estimate for Alternative 14

ITEM	Quantity	Units	Unit Cost	Subtotal Cost	Subtotal (2005 Costs)
Waste Rock Piles					
Regrade East Waste Rock Pile Slopes to 2:1 Ex. and Haul. Includes Soil Cover and Plantings. Component 12	1	ls	$747,425	$747,425	
Regrade West Waste Rock Pile Slopes to 2:1 Ex. and Haul. Includes Soil Cover and Plantings. Component 13	1	ls	$561,982	$561,982	
Place Woody Debris on Waste Rock Piles and Mill Building Area	9.3	acres	$3,083	$28,677	
Subtotal Waste Rock Piles					*$1,340,000*
Tailings Piles					
TESC	1	ls	$189,337	$189,337	
Alt 13M Regrade of TP1 for 2:1 Slopes	43,619	cy	$4.60	$200,555	
Alt 13M Regrade of TP2 for 2:1 Slopes	314,419	cy	$6.00	$1,886,169	
Alt 13M Regrade of TP3 for 2:1 Slopes	29,927	cy	$5.17	$154,686	
Cap	78	ac	$21,038	$1,640,988	
Subtotal Tailings Piles					*$4,070,000*
Toe Buttress					
Shear Key and Toe Berm Excavation	17,419	cy	$8.55	$148,933	
Shear Key and Toe Berm Rock from Quarry	41,160	cy	$35.17	$1,447,749	
Shear Key and Toe Berm Rock Harvested from On-Site Locations	34,871	cy	$4.90	$170,813	
Bedding for Shear Key Rock	4,001	cy	$8.44	$33,748	
TP1 Toe Berm Compacted Tailings	16,241	cy	$5.28	$85,762	
TP2 Toe Berm Compacted Tailings	99,327	cy	$6.66	$661,265	
TP3 Toe Berm Compacted Tailings	82,183	cy	$5.74	$471,687	
Subtotal Toe Buttress					*$3,020,000*
Groundwater Treatment Facilities					
East of TP-3					
Pond Area Clearing	10	ac	$14,658	$140,725	
Pond Excavation	84,169	cy	$5.92	$498,282	
Aquafix for East Treatment System	1	ls	$769,393	$769,393	
Filtration Ponds with Media	1	ls	$73,827	$73,827	
Stockpiled Sand for O&M	1	ls	$53,066	$53,066	
Concrete Lining for Treatment Ponds	2,476	cy	$184	$455,504	
Sludge Conveyance from GWTP to TP-2	3,200	lf	$40	$127,189	
Subtotal Groundwater Treatment - East of TP3					*$2,120,000*
West of TP-1					
Forest Clearing and Stockpile	0.5	ac	$14,658	$7,134	
Excavate Treatment Ponds with Site Preparation	2,312	CY	$5.92	$13,688	
Concrete Lining for Treatment Ponds	168	CY	$184	$30,974	
Chemical Storage and Addition Facilities	1	LS	$279,000	$279,000	
Mixing and Aeration Facilities	1	LS	$80,000	$80,000	
Filtration Ponds with Media	1	LS	$29,443	$29,443	
Energy Supply	1	LS	$145,520	$145,520	
Miscellaneous Treatment	1	LS	$121,558	$121,558	
Building for Office/Storage	500	SF	$156	$78,000	
Stockpiled Sand for O&M	1	ls	$17,118	$17,118	
Sludge Conveyance from GWTP to TP-2	1,500	lf	$39.75	$59,620	
Subtotal Groundwater Treatment - West of TP1					*$862,000*
Subtotal Groundwater Treatment					*$2,980,000*
Subtotal Groundwater Treatment - All Areas					
Landfills					
Impacted Sludge Disposal Cell	1	ls	$5,549,238	$5,549,238	
Impacted Soil, Solid Waste and Debris Disposal Cell	1	ls	$371,366	$371,366	
Subtotal Landfill					*$5,920,000*
Lagoon Area / SRA / Ballfield / LWA					
Remove Lagoon Area Impacted Soils	9,000	cy	$18.99	$170,879	
Remove SRA Impacted Soils	400	cy	$21.30	$8,519	
Access Road to Ventilator Portal Retention Area	1,000	lf	$26.10	$26,096	
Abandon Road to Ventilator Portal	1,000	lf	$11.84	$11,836	
Excavate and Haul Ballfield Impacted Soil	500	cy	$20.63	$10,315	
Excavate and Haul LWA Impacted Soil	28,000	cy	$20.63	$577,640	
Subtotal Lagoon / SRA / Ballfield / LWA					$805,000

Table A-4 - Breakdown of Agencies' Cost Estimate for Alternative 14

ITEM	Quantity	Units	Unit Cost	Subtotal Cost	Subtotal (2005 Costs)
Surface Water Remediation					
Railroad Creek Realignment					
Clear New Creek Alignment	9	ac	$23,091	$207,816	
Access Road for New Creek	5,000	lf	$25.41	$127,055	
Excavate New Creek	237,602	cy	$8.31	$1,974,118	
New Creek Berms & Liner	1	ls	$362,423	$362,423	
New Creek Bedding	15,802	ls	$8.44	$133,294	
New Creek Riprap from Lightning Ridge	64,446	CY	$66.85	$4,308,217	
New Creek Gravel Layer	22,865	cy	$8.44	$192,876	
Retaining Wall	14,000	sf	$42.03	$588,472	
Screen Excess Creek Excavation	69,853	cy	$3.17	$221,607	
Habitat Installation (Logs and Barbs)	56	lwd	$1,418	$79,405	
Tree Tubes and Shrubs Creek Edges	4	ac	$13,534	$54,135	
Hydroseed	4	ac	$3,479	$13,917	
River Diversion Costs	2	ea	$70,000	$140,000	
Dewatering	1	ls	$100,000	$100,000	
Subtotal Railroad Creek					*$8,500,000*
Copper Creek					
Clear Copper Creek Alignment	1	ac	$23,091	$11,545	
Access Road for Copper Creek	400	lf	$25.41	$10,164	
Excavate New Copper Creek Area	5,385	cy	$8.31	$44,741	
Copper Creek Berms & Liner	1	ls	$27,363	$27,363	
Copper Creek Bedding (1' thick)	1,005	cy	$8.44	$8,477	
Copper Creek Riprap from Lightning Ridge	8,216	cy	$66.85	$549,243	
Copper Creek River Gravel	460	cy	$8.44	$3,880	
Screen Excess Creek Excavation	432	cy	$3.17	$1,371	
Habitat Installation (Logs and Barbs)	4	lwd	$1,478	$5,914	
Tree Tubes and Shrubs Creek Edges	0.5	ac	$13,534	$6,767	
Hydroseed	1	ac	$3,479	$1,740	
River Diversion Costs	1	ls	$70,000	$70,000	
Dewatering	1	ls	$30,000	$30,000	
Subtotal Copper Creek Extension					$771,000
Other Surface Water Related					
Copper Creek Diversion Channel Improvement	350	lf	$73.53	$25,734	
Develop Riprap Source (Lightning Ridge)	1	ls	$75,000	$75,000	
Copper Creek Access Road	1,600	lf	$24.33	$38,929	
Copper Creek Rehabilitation	1	ls	$86,017	$86,017	
Subtotal Other Surface Water Related					$230,000
Subtotal All Surface Water Items					*$9,500,000*
***In Situ* Soil Treatment**					
In Situ Soil Treatment	104	ac	$7,551	$783,399	
Subtotal In Situ Soil Treatment					*$783,000*
Subtotal Direct Construction Costs					**$51,100,000**
Contractor Markups					
Contractor's OH&P			12.0%	$6,132,000	
Insurance, Div 1 Items, Contractor's Engr, Surveying			8.0%	$4,088,000	
Subtotal Markups					*$10,220,000*
Total Construction Costs (2005 Dollars)					**$61,300,000**
Non-Construction Capital Costs (2005 Dollars)					
Engineering Investigation/Design/Planning			6.0%	$3,678,000	
In Situ Treatability Study	1	ls	$500,000	$500,000	
Construction Management			4.0%	$2,452,000	
Project Management			5.0%	$3,065,000	
Baseline Monitoring (Pre-Construction)	1	ls	$923,000	$923,000	
Subtotal Non-Construction Capital Costs					*$10,600,000*
TOTAL CAPITAL COSTS (2005 Dollars)					**$71,900,000**
PRESENT WORTH OF POST-CONSTRUCTION OMM COSTS (2005 Dollars)				$29,030,000	
TOTAL ESTIMATED COST (2005 Dollars)					**$100,900,000**

Notes:

1. Rounding of significant figures is typically applied only at summary of subtotals, and does not materially affect the overall estimate.

Table A-5 - Comparison of Agencies' Estimated OMM Costs and NPV of Future Costs for Alternatives 11M, 13M, 14

Alternative 11M						
ITEM	**Annual Quantity**	**Unit**	**Cost Per Unit**	**Cost in Year 2005 Dollars**	**Years in Which Cost is Incurred**	**Present Worth (2005 Dollars)**
ROUTINE OPERATOR LABOR						
System Operations/Monitoring	0.5	FTE	$80,000	$40,000	1 to 50	$552,000
Equipment Maintenance	0.2	FTE	$100,000	$20,000	1 to 50	$276,000
Project Management/Reporting	0.3	FTE	$140,000	$42,000	1 to 50	$580,000
Subtotal - Routine Operator Labor	*1*					*$1,408,000*
DIRECT COSTS						
Diesel Fuel for Electrical Generators	34,705	gal	$3.66	$127,019	1 to 50	$1,753,000
Lime	2316	ton	$368	$852,288	1 to 50	$11,762,000
Miscellaneous Office Admin for Reports & Subcontracts	1	ls	$23,300	$23,300	1 to 50	$322,000
Subtotal - Consumables						*$13,837,000*
SPECIAL MAINTENANCE ITEMS						
Sludge Removal from Settling Ponds	1	ls	$94,675	$94,675	1 to 50	$1,307,000
Filter Sand Layer Removal	1	ls	$2,439	$2,439	1 to 50	$34,000
Filter Sand Replacement	1	ls	$55,591	$55,591	6,12,18,...	$107,000
Spraying to Control Vegetation on Landfill Cover	1	ls	$66,005	$66,005	1 to 50	$911,000
Landfill Leachate Removal	2	ls	$27,972	$55,944	1 to 50	$772,000
Diversion Swale/Conveyance Ditch Maintenance	15,580	lf	$2.29	$35,678	1 to 50	$492,000
Conveyance Pipe Cleaning (Pigging/Jetting)	11,420	lf	$7.20	$82,224	3,6,9,...	$351,000
Subtotal - Special Maintenance Items						*$3,974,000*
EQUIPMENT/FACILITY REPLACEMENT						
New Sludge Landfill Cell	1	ls	$9,096,938	$9,096,938	50	$309,000
Old Sludge Landfill Cell Cover	1	ls	$7,572,483	$7,572,483	50	$257,000
Riprap Maintenance	1	ls	$154,907	$154,907	10,20,30,...	$155,000
Electrical Generators	1	ls	$111,019	$111,019	20,40	$36,000
Misc. Treatment Components	1	ls	$307,700	$307,700	15,30,45	$167,000
Lime Silo	1	ls	$319,533	$319,533	50	$11,000
Tank Vibrators	1	ls	$40,870	$40,870	20,40	$13,000
Mechanical Lime Addition	1	ls	$204,353	$204,353	20,40	$66,000
Controls, Motor Starters, Transformer, Heater, etc.	1	ls	$471,869	$471,869	10,20,30,...	$471,000
Fuel Tanks (15,000 gal. steel AST)	1	ls	$24,150	$24,150	20,40	$8,000
Aeration Equipment	1	ls	$148,620	$148,620	50	$5,000
GWTP Sludge Removal Equipment (Includes Pipeline)	1	ls	$265,822	$265,822	20,40	$86,000
Water Conveyance Pipelines	1	ls	$863,433	$863,433	50	$29,000
Structures	1	ls	$163,379	$163,379	40	$11,000
Treatment Pond Linings and Media Filters	1	ls	$1,218,905	$1,218,905	50	$41,000
Monitoring Wells	1	ls	$107,994	$107,994	50	$4,000
Subtotal - Equipment/Facility Replacement						*$1,669,000*
SUBTOTAL O&M						*$20,888,000*
ENVIRONMENTAL MONITORING						
Year 1				$732,756	1	
Year 2				$563,233	2	
Year 3				$604,894	3	
Year 4				$445,798	4	
Year 5				$615,321	5	
Present Worth of Environmental Monitoring Costs in Years 1 to 5						$2,449,000
Years 6 to 15					6 to 15	$2,991,000
Years 16 to 30					16 to 30	$1,315,000
Years 31 to 50					31 to 50	$369,000
Subtotal - Environmental Monitoring						*$7,124,000*
AGENCY REVIEW & OVERSIGHT						
Baseline Annual Costs for Years 1 to 5				$157,000	1 to 5	
Additional Costs for 5-Year Annual Review				$89,000	5	
Present Worth of Agency Review & Oversight Costs in Years 1 to 5						$707,000
Years 6 to 15					6 to 15	$864,000
Years 16 to 30					16 to 30	$380,000
Years 31 to 50					31 to 50	$107,000
Subtotal - Agency Review & Oversight						*$2,058,000*
TOTAL PRESENT WORTH OF POST-CONSTRUCTION COSTS (2005 DOLLARS)						**$30,070,000**

Notes:

1. Discount Rate for Present Worth Calculation: 7%

Table A-5 - Comparison of Agencies' Estimated OMM Costs and NPV of Future Costs for Alternatives 11M, 13M, 14

Alternative 13M						
ITEM	**Annual Quantity**	**Unit**	**Cost Per Unit**	**Cost in Year 2005 Dollars**	**Years in Which Cost is Incurred**	**Present Worth (2005 Dollars)**
ROUTINE OPERATOR LABOR						
System Operations/Monitoring	-	-	-	-	-	-
Equipment Maintenance	-	-	-	-	-	-
Project Management/Reporting	-	-	-	-	-	-
WTP Maintenance Personnel	1	FTE	$70,000	$70,000	1 to 50	$966,000
Subtotal - Routine Operator Labor						*$966,000*
DIRECT COSTS						
Diesel Fuel for Electrical Generators	11,975	gal	$3.79	$45,407	1 to 50	$627,000
Lime	1533	ton	$334	$511,948	1 to 50	$7,065,000
Miscellaneous Office Admin for Reports & Subcontracts	1	ls	$25,149	$25,149	1 to 50	$347,000
Subtotal - Consumables						*$8,039,000*
SPECIAL MAINTENANCE ITEMS						
Sludge Removal from Settling Ponds	1	ls	$72,167	$72,167	1 to 50	$996,000
Filter Sand Layer Removal (Removal and replacement in Alt. 13M)	1	ls	$18,415	$18,415	1 to 50	$254,000
Spraying to Control Vegetation on Landfill Cover	1	ls	$46,890	$46,890	1 to 50	$647,000
Diversion Swale/Conveyance Ditch Maintenance	15,090	lf	$2.29	$34,556	1 to 50	$477,000
Conveyance Pipe Cleaning (pigging/jetting)	6,230	lf	$7.20	$44,856	3,6,9,...	$192,000
Subtotal - Special Maintenance Items						*$2,566,000*
EQUIPMENT/FACILITY REPLACEMENT						
New Sludge Landfill Cell	1	ls	$1,308,500	$1,308,500	50	$44,000
Old Sludge Landfill Cell Cover	1	ls	$4,740,682	$4,740,682	50	$161,000
Riprap Maintenance	1	ls	$154,907	$154,907	10,20,30,...	$155,000
Electrical Generators	1	ls	$118,172	$118,172	20,40	$38,000
Misc. Treatment Components	1	ls	$327,525	$327,525	15,30,45	$177,000
Lime Silo	1	ls	$340,121	$340,121	50	$12,000
Tank Vibrators	1	ls	$43,503	$43,503	20,40	$14,000
Mechanical Lime Addition	1	ls	$217,519	$217,519	20,40	$71,000
Controls, Motor Starters, Transformer, Heater, etc.	1	ls	$502,272	$502,272	10,20,30,...	$502,000
Fuel Tanks (15,000 gal steel AST)	1	ls	$25,706	$25,706	20,40	$8,000
Aeration Equipment	1	ls	$158,196	$158,196	50	$5,000
GWTP Sludge Removal Equipment (includes pipeline)	1	ls	$282,949	$282,949	20,40	$92,000
Water Conveyance Pipelines	1	ls	$978,281	$978,281	50	$33,000
Structures	1	ls	$192,670	$192,670	40	$13,000
Treatment Pond Linings and Media Filters	1	ls	$1,381,036	$1,381,036	50	$47,000
Monitoring Wells	1	ls	$158,204	$158,204	50	$5,000
Subtotal - Equipment/Facility Replacement						*$1,377,000*
SUBTOTAL O&M						
ENVIRONMENTAL MONITORING						
Year 1				$732,756	1	
Year 2				$563,233	2	
Year 3				$604,894	3	
Year 4				$445,798	4	
Year 5				$615,321	5	
Present Worth of Environmental Monitoring Costs in Years 1 to 5						$2,449,000
Years 6 to 15					6 to 15	$2,991,000
Years 16 to 30					16 to 30	$1,315,000
Years 31 to 50					31 to 50	$369,000
Subtotal - Environmental Monitoring						*$7,124,000*
AGENCY REVIEW & OVERSIGHT						
Baseline Annual Costs for Years 1 to 5				$157,000	1 to 5	
Additional Costs for 5-Year Annual Review				$89,000	5	
Present Worth of Agency Review & Oversight Costs in Years 1 to 5						$707,000
Years 6 to 15					6 to 15	$864,000
Years 16 to 30					16 to 30	$380,000
Years 31 to 50					31 to 50	$107,000
Subtotal - Agency Review & Oversight						*$2,058,000*
TOTAL PRESENT WORTH OF POST-CONSTRUCTION COSTS (2005 DOLLARS)						**$22,130,000**

Notes:

1. Discount Rate for Present Worth Calculation: 7%

Table A-5 - Comparison of Agencies' Estimated OMM Costs and NPV of Future Costs for Alternatives 11M, 13M, 14

Alternative 14						
ITEM	**Annual Quantity**	**Unit**	**Cost Per Unit**	**Cost in Year 2005 Dollars**	**Years in Which Cost is Incurred**	**Present Worth (2005 Dollars)**
ROUTINE OPERATOR LABOR						
System Operations/Monitoring	0.75	FTE	$80,000	$60,000	1 to 50	$828,000
Equipment Maintenance	0.3	FTE	$100,000	$30,000	1 to 50	$414,000
Project Management/Reporting	0.45	FTE	$140,000	$63,000	1 to 50	$869,000
Subtotal - Routine Operator Labor	*1.5*					*$2,111,000*
DIRECT COSTS						
Diesel Fuel for Electrical Generators	8,845	gal	$3.66	$32,343	1 to 50	$446,000
Lime	2317	ton	$368	$852,656	1 to 50	$11,767,000
Miscellaneous Office Admin for Reports & Subcontracts	1	ls	$23,300	$23,300	1 to 50	$322,000
Subtotal - Consumables						*$12,535,000*
SPECIAL MAINTENANCE ITEMS						
Sludge Removal from Settling Ponds	1	ls	$94,489	$94,489	1 to 50	$1,304,000
Filter Sand Layer Removal	1	ls	$2,439	$2,439	1 to 50	$34,000
Filter Sand Replacement	1	ls	$55,591	$55,591	6,12,18,...	$107,000
Spraying to Control Vegetation on Landfill Cover	1	ls	$46,890	$46,890	1 to 50	$647,000
Landfill Leachate Removal	2	ls	$27,917	$55,834	1 to 50	$771,000
Diversion Swale/Conveyance Ditch Maintenance	15,090	lf	$2.29	$34,556	1 to 50	$477,000
Conveyance Pipe Cleaning (pigging/jetting)	6,230	lf	$7.20	$44,856	3,6,9,...	$192,000
Subtotal - Special Maintenance Items						*$3,532,000*
EQUIPMENT/FACILITY REPLACEMENT						
New Sludge Landfill Cell	1	ls	$9,076,295	$9,076,295	50	$308,000
Old Sludge Landfill Cell Cover	1	ls	$7,563,871	$7,563,871	50	$257,000
Riprap Maintenance	1	ls	$154,907	$154,907	10,20,30,...	$155,000
Electrical Generators	1	ls	$111,019	$111,019	20,40	$36,000
Misc. Treatment Components	1	ls	$307,700	$307,700	15,30,45	$167,000
Lime Silo	1	ls	$319,533	$319,533	50	$11,000
Tank Vibrators	1	ls	$40,870	$40,870	20,40	$13,000
Mechanical Lime Addition	1	ls	$204,353	$204,353	20,40	$66,000
Controls, Motor Starters, Transformer, Heater, etc.	1	ls	$471,869	$471,869	10,20,30,...	$471,000
Fuel Tanks (15,000 gal steel AST)	1	ls	$24,150	$24,150	20,40	$8,000
Aeration Equipment	1	ls	$148,620	$148,620	50	$5,000
GWTP Sludge Removal Equipment (includes pipeline)	1	ls	$265,822	$265,822	20,40	$86,000
Water Conveyance Pipelines	1	ls	$863,433	$863,433	50	$29,000
Structures	1	ls	$170,051	$170,051	40	$11,000
Treatment Pond Linings and Media Filters	1	ls	$1,218,905	$1,218,905	50	$41,000
Monitoring Wells	1	ls	$139,631	$139,631	50	$5,000
Subtotal - Equipment/Facility Replacement						*$1,669,000*
SUBTOTAL O&M						*$19,847,000*
ENVIRONMENTAL MONITORING						
Year 1				$732,756	1	
Year 2				$563,233	2	
Year 3				$604,894	3	
Year 4				$445,798	4	
Year 5				$615,321	5	
Present Worth of Environmental Monitoring Costs in Years 1 to 5						$2,449,000
Years 6 to 15					6 to 15	$2,991,000
Years 16 to 30					16 to 30	$1,315,000
Years 31 to 50					31 to 50	$369,000
Subtotal - Environmental Monitoring						*$7,124,000*
AGENCY REVIEW & OVERSIGHT						
Baseline Annual Costs for Years 1 to 5				$157,000	1 to 5	
Additional Costs for 5-Year Annual Review				$89,000	5	
Present Worth of Agency Review & Oversight Costs in Years 1 to 5						$707,000
Years 6 to 15					6 to 15	$864,000
Years 16 to 30					16 to 30	$380,000
Years 31 to 50					31 to 50	$107,000
Subtotal - Agency Review & Oversight						*$2,058,000*
TOTAL PRESENT WORTH OF POST-CONSTRUCTION COSTS (2005 DOLLARS)						**$29,030,000**

Notes:

1. Discount Rate for Present Worth Calculation: 7%

APPENDIX B
ASSESSMENT OF LIME APPLICATION FOR *IN SITU* TREATMENT OF SOILS TO REDUCE BIOAVAILABILITY AND MOBILITY OF HAZARDOUS SUBSTANCES

APPENDIX B
ASSESSMENT OF LIME APPLICATION FOR *IN SITU* TREATMENT OF SOILS TO REDUCE BIOAVAILABILITY AND MOBILITY OF HAZARDOUS SUBSTANCES

OVERVIEW

This Appendix provides information related to the application of a lime amendment to reduce the bioavailability of metals in areas impacted by tailings and waste rock. A variety of technical documents were reviewed to assess feasibility of this approach for remediation of some impacted areas at the Holden Site, as an alternative to other active remedial approaches that might be considered. The relevant findings of this review are discussed below.

A considerable amount of information has been published on the use and application of lime and lime-derived products for use in environmental remediation. Most of this experience relates to treatment of acid mine drainage (AMD) and stabilization/solidification of liquids and slurries; but lime is also used to enhance revegetation of acidic soils and waste rock. While the primary goal for revegetation is typically to enhance plant viability, lime application has also been shown in some studies to reduce mobility and bioavailability of hazardous substances including metals that are constituents of concern at Holden. Available information (summarized below) suggests that this benefit may be achieved more often than is reported, since reduced bioavailability is not necessarily a remediation objective at some sites where lime is used to enhance revegetation. A related issue is that published reports do not always distinguish between the effects of lime and the effects of other soil amendments such as biosolids, since lime application is often part of a remedial approach that combines multiple components.

Lime application is a potential remediation action to reduce bioavailability of metals released into the terrestrial environment as a result of tailings and waste rock oxidation. This approach has potential application at the Holden Site where existing topography or land use limits the applicability of other remedial techniques. The efficacy of pH adjustment to reduce metals bioavailability is reported to be greatest when the lime is incorporated into the soil media by tilling into the upper six inches (or more) of the soil. Fewer studies have addressed surface application as would be required for areas where remediation needs to be compatible with maintenance of existing forest habitat or on existing steep slopes.

Results of the literature review presented herein indicate this approach is feasible and likely would mitigate the risk of metals to terrestrial receptors at the Holden Site. However, results of a prior test at the Holden Site showed that no consistent pattern was observed in foliar metal concentrations for Lupine, Penstemon, and Sitka Alder, as a result of lime application for tailings revegetation. Also, surficial application of lime is less effective than incorporating lime into the soil matrix.

The use of lime application as part of remediation at Holden would need to be based on treatability studies conducted during remedial design to determine the application method, rate, extent, and frequency of application that would be most beneficial. Test plots would likely be required to demonstrate that the proposed approach does not adversely impact existing or desirable plants and benthic macroinvertebrates by creating conditions that are too alkaline. Finally, site-specific tests are needed to assess whether increasing soil pH would have unacceptable side effects such as increased mobility of some constituents (e.g., arsenic) while reducing the mobility of other hazardous substances.

Summaries of Reported Experience

A field study conducted on a mine tailings deposit by Brown et al. (2009) examined the restoration of zinc, cadmium, and lead tailings with biosolids and lime using plants in a field setting. The study included lime in the form of agricultural lime (L), sugar beet lime (SBL), lime kiln dust (LKD), and biosolids amendments that were applied by hand and incorporated into the top 0 to 15 centimeters (cm) of soil using a hand-operated rototiller. Aboveground plant tissue samples were collected and analyzed for zinc and cadmium concentrations. Within the surface soil horizon, the LKD was the most effective at increasing pH in the soil from approximately 5.2 to averaged 7.72. The SBL and biosolids treatment produced the next highest surface layer pH at 6.92. At depths below the surface soil horizon, the study showed that increases in pH as a result of surface lime addition were less pronounced. The study found that "All treatments reduced both extractable cadmium and zinc compared to the control at 0 to 15 cm depth." The study concluded that the "application of biosolids in combination with different sources of alkalinity and LKD alone neutralized both surface and subsoil pH and consequently reduced extractable metal concentrations."

An earlier study by Brown et al. (2005) examined ecosystem function in alluvial tailings after biosolids and lime application. A mix of municipal biosolids and agricultural limestone were applied to the surface of portions of the tailings deposits using a rear-throw spreader and incorporated to a depth of 20 cm. Soil samples were collected from an uncontaminated site, a contaminated vegetation area, and four areas that received biosolids and lime applications. Earthworm tissue was analyzed for metal accumulation after a 28-day exposure to the soil. Results indicated that metal concentrations of cadmium, lead, and zinc in the earthworms in the treated soil were lower than the concentrations in the contaminated vegetation area, and thus the amendment reduced the bioavailability of contaminants from the tailings.

A study by Jones et al. (1997) examined arsenic transport in mine tailings following lime application. The study concluded that liming for soil remediation has the potential to mobilize arsenic. The initial pH of six mine soil samples was adjusted to 10.1 with potassium hydroxide to evaluate arsenic transport. The evaluated samples had pH values ranging from 3.5 in the reprocessed tailings to 8.0 in the smelter stack deposits. While the study showed that other metals are immobilized, it concluded that "remediation of acidic mine tailings or other arsenic-contaminated soils using lime amendments should be evaluated with respect to the potential effects on arsenic mobilization, especially at contaminated sites hydraulically connected to surface water or groundwater.

Krebs et al. (1998) examined the solubility and plant uptake of metals with and without liming of sludge-amended soils. The study used pea (*Pisum arvense* L.) to measure the concentrations of $NaNO_3$, extractability of copper, zinc, and cadmium in relation to soil pH and soil organic matter content. The study showed that "liming raised the soil pH by approximately one unit to 6.4 and 6.9 in pig manure- and sewage sludge-treated plots, respectively, and resulted in decreasing concentrations of copper, zinc, and cadmium in seeds and crop residues of field pea." The study suggested that plant uptake and solubility of metals can be higher in manure- and sludge-treated soils than in control plots, and also that liming effectively reduces the solubility and plant uptake of zinc and cadmium. While the study indicated that additional research is needed about the effects of lime on copper, the lime reduced risks that metals pose by entering the food chain.

Cox and Rains (1972) conducted a greenhouse study on the effect of lime on lead uptake by five plant species. They analyzed lead-contaminated soil samples from an urban farming area downwind of an existing smelter. The study concluded that "liming at 2.2 and 4.4 tons/hectare reduced lead concentrations in the tops of 10-week-old plants of all species. The lower plant lead concentrations with lime can be attributed to lower availability of soil lead per se, as there was no effect of lime on yield of plant tops."

A 1992 study by Marschner et al. evaluated lime effects on pine forest floor leachate chemistry and element fluxes. A combination of lime and potassium fertilizer was applied to a subplot and a control plot and evaluated for 30 months. This study revealed two significant conclusions. First, the surface application of lime neutralized acid inputs. Soil pH was raised from 3.8 in the control plots to greater than 7.0 in the first month of the study and remained elevated throughout the study period. Second, liming increased metal retention in the forest floor and the immobilization of potentially toxic substances improved the filter function of the ecosystem for anthropogenic inputs. However, the study also showed that while metal retention may increase, the risk of negative effects on roots or microorganisms also increases.

A study performed by Zimdahl and Foster (1976) looked at the influence of applied phosphorus, manure, and lime as calcium carbonate ($CaCO_3$) on uptake and absorption of lead in the soil in corn plant roots and foliage. Increases in the application of lime decreased lead translocation to corn shoots, thus decreasing the uptake of lead by corn. The findings of this study indicated that more lead is immobilized at a higher pH. The study concluded that "the primary effect of liming acidic soils may be on translocation of lead rather than on its uptake by crop plants."

Orndorff et al. (2008) investigated the use of lime-stabilized biosolids on the reclamation of acid sulfate soils with the goal of revegetating the site. The study indicated that incorporation of relatively high rates of lime-stabilized biosolids was successful in reducing dissolved metal loadings, but that additional research would be required to evaluate the long-term effects of this treatment.

A study conducted by Hossner and Doolittle (2003) evaluated limestone (calcium carbonate, $CaCO_3$) applied to overburden materials with different iron sulfide (FeS_2) contents. (Oxidation of FeS_2 is the primary mechanism by which metals are released from tailings and waste rock at Holden). Three samples of overburden strata were excavated from an active mine site and analyzed in a laboratory setting. The study found that "additions of limestone affected FeS_2 oxidation by controlling the pH of the system. Liming to greater than 50% of the acid-base account deficit did not significantly affect the oxidation rate. Dissolution of the applied limestone was found to be faster than the oxidation of FeS_2 at pH values greater than 4." Similar studies found that lime may dissolve in the system faster than FeS_2 will oxidize, which suggests that periodic reapplication is needed to maintain the beneficial effect of liming over time.

John and Van Laerhoven (1972) examined lead uptake by lettuce and oats as affected by lime, nitrogen, and various sources of lead. The laboratory study indicated that the "interaction of lime and lead treatments significantly affected the lead content of both lettuce and oat tops" and that "the addition of 1,000 ppm of lead (to soil) resulted in an almost four-fold increase in the lead content of lettuce grown in unlimed soil, whereas only small increases were found when the soil was limed." The study also suggested that "liming may restrict the translocation of lead from roots to above-ground portions."

A study by Conder et al. (2001) applied lime-stabilized municipal biosolids to soils contaminated by zinc. The study found that the lime-stabilized biosolids was the only amendment that successfully immobilized zinc in the soil, and concluded that lime-stabilized biosolids is an effective amendment for reducing metal bioavailability to earthworms. However, the study also found that the effectiveness of the amendment may only be temporary.

A field study conducted by Scherer et al. (1996) at the Holden Site evaluated the nutrient content and survival of native species on ameliorated mine tailings. The pH of the tailings ranged from 2.6 to 4.8 prior to treatment with gravel only; gravel mixed with fertilizer and lime; and gravel mixed with sludge. The study concluded that the gravel-sludge treatment showed the best opportunity for survival of the selected plant species.

The Forest Service (Scherer and Everett 1998) also conducted a field study to evaluate the reforestation of copper tailings at the Holden Mine. A compost and lime treatment was applied to conifer and alder planting holes on eight soil islands or test plots. The study indicated that the best survival and growth occurred in the compost only, and compost and lime treatment blocks for all tree species. The alder grew exceptionally well, and was identified as the most tolerant of the acidic tailings material, but achieved better growth in moderate pH conditions provided by the compost and lime treatment.

A field study conducted by Zabowski and Everett (undated) examined the results of four ameliorative treatments including gravel, gravel and sludge, and gravel, fertilizer and lime treatment on plots established on the tailings piles to evaluate extractable metals and plant uptake. Soil analysis suggests that none of the treatments were effective at raising the low pH of the tailings. However, the gravel, fertilizer and lime treatment maintained higher pH in the gravel overburden plots. The soil analysis also indicated that nickel and manganese was increased by the gravel, fertilizer and lime treatment, compared to the control plots. Plant analysis was also conducted for Lupine, Penstemon, and Sitka Alder. The results indicated that plant survival with the gravel, fertilizer and lime treatment was lower and highly variable among replicate plots. Plant survival appeared to be strongly correlated with pH of the gravel. The study also evaluated treatment effects on foliar metal concentrations. The results indicated that no consistent pattern was observed between species or metal and suggests that sludge or fertilizer with lime additions are not effective at reducing metal uptake in the species selected for this study.

Finally, the use of lime to reduce bioavailability of metals was discussed with researchers in West Virginia and Oregon. Jeff Skousen, West Virginia University Extension Professor, described research being conducted on dry lime applications in forested areas on ridge tops at a National Forest site in the northeast (Telephone communication between Jeff Skousen and Celina Abercrombie of Hart Crowser on October 30, 2009). Personal communication with Skousen indicated that the slope and area must be considered before lime is applied in order to determine suitable application rates. Site gradient may result in migration of the surface-applied lime downslope and a higher application rate may be necessary to maintain adequate and relatively consistent coverage of an area. In addition, the area to be limed will determine the appropriate amount of lime to be placed at a site.

In a telephone conversation between Matt Haynes of the Oregon Department of Agriculture and Celina Abercrombie of Hart Crowser on October 23, 2009, Mr. Haynes cautioned that in a forested setting lime application might have a negative impact on existing vegetation by altering the pH of the soil to a neutral or alkaline condition that is not suitable to existing vegetation.[1] However, Haines also noted his experience indicates that surface applications of lime without tilling or incorporation in the surface soils will generally not affect the surface soil layer below ¼ inch, and that improved results are seen with incorporating the lime application into the surface of the soil.

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APPENDIX C
PERFORMANCE OBJECTIVES FOR CAPPING HAZARDOUS SUBSTANCES

APPENDIX C
PERFORMANCE OBJECTIVES FOR CAPPING HAZARDOUS SUBSTANCES

INTRODUCTION

This Appendix presents performance requirements for caps (including soil covers or other physical barriers) that may be required at certain areas of the Site in order to reduce risk to human health and ecological receptors, and to comply with potentially applicable or relevant and appropriate requirements (ARARs). Capping is proposed in Alternatives 11M, 13M, and 14 for contaminated soils in the area referred to as the Maintenance Yard, and could potentially be considered for other areas of the Site.

The performance objectives discussed in this Appendix do not replace state requirements for caps on limited purpose landfills, although landfill caps may be similar to caps on other contaminated soils as discussed herein.[1]

DERIVATION OF CAP PERFORMANCE OBJECTIVES

As a component of a cleanup action, the performance objectives of caps are based on the overall requirement of the cleanup to be protective of human health and the environment.

Many of the remedy selection components under CERCLA and MTCA [i.e., the requirements presented in 40 CFR § 300.430(e)(9)(iii) and WAC 173-340-360(2)] can be used to assess the degree to which a proposed cap would satisfy the basic requirement of protecting human health and the environment.[2] In order to satisfy this basic requirement, a cap should satisfy performance objectives that are drawn from both CERCLA and MTCA, summarized below.

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[1] Limited purpose landfills are defined under WAC 173-350-100. Requirements for caps on limited purpose landfills presented in WAC 173-340-400(3)(e) are potentially applicable to the facility that will need to be constructed for long-term disposal of sludge from the groundwater treatment system, as well as potentially relevant and appropriate for the tailings and waste rock piles at the Site.

[2] The CERCLA and MTCA remedy selection criteria do not all pertain equally to establishment of performance criteria for caps although, of course, all the criteria are considered in selecting a cleanup action. For example, cap performance is expected to reduce the mobility of hazardous substances, but would not necessarily reduce the toxicity or volume of hazardous substances.

a) Comply with ARARs;
b) Provide long-term effectiveness and permanence;
c) Reduce mobility of hazardous substances;
d) Be effective over the short-term;
e) Be readily implementable;
f) Be able to be implemented at a reasonable cost;
g) Enable its effectiveness to be monitored; and
h) Be acceptable to the state and the public.

Performance objectives based on these criteria are discussed in more detail below.

Comply with ARARs

Portions of the MTCA—specifically, the regulations dealing with Terrestrial Ecological Evaluations; the state Solid Waste Handling Standards; and the performance standards for caps on limited purpose landfills—are potentially relevant and appropriate for establishing requirements for capping soil contaminated with hazardous substances.[3] [WAC 173-340-7490 through 173-340-7494; Chapter 173-350 WAC; and WAC 173-350-400(e)(i), respectively.]

The Land and Resource Management Plan for Wenatchee National Forest (LRMP, Forest Service 1990), as amended by the Pacific Northwest Forest Plan (NWFP 1994) and subsequent amendments of the NWFP (2001, 2004, and 2007) is also potentially relevant and appropriate for capping hazardous substances. The standards and guidelines developed under the NWFP include a section titled MM-3 which controls solid waste and mine waste facilities within Riparian Reserves, and the Aquatic Conservation Strategy (ACS).

These potential ARARs are discussed below.

Terrestrial Ecological Evaluations

WAC 173-340-7490 through 173-340-7494 define the procedures for conducting a Terrestrial Ecological Evaluation (TEE) under MTCA. WAC 173-340-7491 outlines several conditions under which the performance of a TEE is not required because the conditions limit exposure and are considered to be adequately protective of terrestrial organisms. The Agencies consider two of the conditions defined in WAC 173-340-7491(1) to be potentially relevant and

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[3] Other portions of the MTCA that are discussed in later sections of this Appendix are also potential ARARS.

appropriate for developing criteria for caps over hazardous substances. These conditions are:

a) All soil contaminated with hazardous substances is, or will be, located below the point of compliance;[4,5] or

b) All soil contaminated with hazardous substances is, or will be, covered by buildings, paved roads, pavement, or other physical barriers that will prevent plants or wildlife from being exposed to the soil contamination.

Since it is unlikely that soil caps even six feet in thickness would be acceptable under some circumstances, caps may incorporate physical barriers to wildlife burrows and root penetration, in order to achieve protectiveness. Composite caps that integrate physical barriers with a surficial soil cover to support native vegetation provide multiple benefits as discussed later.

Solid Waste Handling Standards

The Agencies also consider requirements in WAC 173-350-400 that address the long-term protectiveness, durability, and maintenance of landfill caps to be relevant and appropriate performance criteria for caps on hazardous substances that are not landfills. These performance requirements for landfill caps include the following:

a) Prevent exposure of waste materials;

b) Minimize infiltration;

c) Prevent erosion from wind and water;

d) Sustain native vegetation;[6]

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[4] The standard MTCA point of compliance for soils is 15 feet below the ground surface, but this may be reduced where specified requirements are met [WAC 173-340-740(6)(f)]. The conditional point of compliance for protection of terrestrial receptors is 6 feet below ground surface, but this may also be modified where specific criteria are satisfied [WAC 173-340-7490(4)(a)]. Notable among these criteria is the need to consider the depth to which animals likely to occur at the site are expected to burrow, and the depth to which plant roots are likely to extend (see Figure C-1).

[5] The other conditions listed in WAC 173-340-7491 that would exclude a site from the TEE requirement involve the availability of habitat and the abundance of receptors; however, these are not considered relevant to the development of performance criteria for caps.

e) Address anticipated settlement so as to maintain no less than a specified minimum slope after settlement (i.e., in order to promote runoff and prevent ponding and infiltration of precipitation);

f) Provide sufficient stability and mechanical strength and address potential freeze-thaw and desiccation (to assure long-term durability of the cap);

g) Provide for the management of run-on and runoff, preventing erosion or other damage to the closure cover;

h) Minimize the need for long-term maintenance;

i) Provide for collection and removal of methane and other gasses generated in the landfill; and

j) Meet the requirements of regulations, permits, and policies of air pollution control authorities.

Northwest Forest Plan

Particular aspects of the Pacific Northwest Forest Plan Section MM-3 (MM-3) that are potentially relevant and appropriate to closure of the tailings and waste rock piles at the Site include requirements for designing waste facilities using best conventional techniques to prevent the release of acid or toxic materials; and reclamation and monitoring of waste facilities to ensure chemical and physical stability.

The ACS includes requirements that are potentially relevant and appropriate for maintaining and restoring native species and habitat. This is consistent with other potential TBCs such as Forest Service Manual 2070 that promotes the use of native plant materials for the revegetation, rehabilitation and restoration of native ecosystems; and Executive Order 13112 that provides for restoration of native species and habitat conditions. Also, the Surface Mining Control and Reclamation Act of 1977 directs establishment of a “diverse, effective and permanent vegetative cover of the same seasonal variety native to the area...” where this is consistent with the approved post-mining land use.

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[6] Use of native vegetation instead of non-native or invasive species satisfy several other ARARs and “to be considered” (TBC) criteria, see Section 2.2 of the ASFS.

Consideration of the ARARs described above indicates that caps over hazardous substances should satisfy the following performance objectives:

- A cap (if constructed of soil) must either isolate the hazardous substance below the point of compliance for soils, or the cap must consist of a physical barrier (such as a pavement) that will prevent ecological receptors from being exposed to the hazardous substance.[7]

- The cap should be capable of supporting native vegetation species and restoring and maintaining native habitat, and not allow invasion of non-native species.

- Minimize or prevent infiltration to avoid generation of leachate that would need to be collected and treated, or that otherwise would degrade groundwater and/or surface water quality. A cap that does not completely prevent leaching of hazardous substances may be acceptable where other measures such as containment, collection, and treatment would satisfy the requirements of MM-3.

- Provide sufficient durability to protect the integrity of the cap from damage caused by erosion, instability, freeze-thaw, and desiccation, which could impair performance of the cap.

- Design the cap to minimize the need for maintenance to assure its performance over time.[8,9]

Long-Term Effectiveness and Permanence

Both CERCLA and MTCA require that a cleanup action provide long-term effectiveness and performance. Under CERCLA, this issue is covered under the first of the five primary balancing criteria, whereas MTCA addresses this by requiring that a cleanup action be permanent to the maximum extent practicable.

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[7] CERCLA and MTCA allow use of institutional controls to prevent human exposure to hazardous substances as an alternative to, or to complement physical barriers such as caps.

[8] This could include use of self-sustaining native vegetation to prevent erosion of soil caps.

[9] In contrast to the objectives noted, other limited purpose landfill requirements related to managing methane and other gases, and complying with air quality regulations, are not potential performance objectives for capping hazardous substances at the Site.

CERCLA considers the magnitude of risk remaining after implementation, and the adequacy and reliability of control measures in determining whether a remedy (or a component of a remedy) provides adequate long-term effectiveness and permanence. The factors that are used to assess this are presented in 40 CFR § 300(e)(9)(iii)(C).

Caps over hazardous substances would minimize the magnitude of residual risk remaining after implementation to the extent that the cap reduces the potential mobility of the hazardous substance by preventing physical dispersion or leaching of the hazardous substances. Caps would not be effective in reducing the hazardous substances' volume, toxicity, or propensity to bioaccumulate.

Caps are an example of engineered control measures for management of hazardous substances. CERCLA indicates that the adequacy and reliability of caps would depend on factors such as the potential need for replacement of the cap to provide long-term protection, and potential exposure pathways and risks posed should the cap need replacement [40 CFR § 300.430(e)(9)(iii)(C)(2)].

MTCA requires that cleanup actions use permanent solutions to the maximum extent practicable. A permanent cleanup action is defined as an action in which cleanup standards can be met without further action being required, other than disposal of treatment residue (WAC 173340-200). MTCA uses the Disproportionate Cost Analysis to determine if cleanup actions are permanent to the maximum extent practicable [WAC 173-340-360(3)(e)]. The Disproportionate Cost Analysis is used to rank the permanence of different alternatives (and by extension, a component of a cleanup alternative such as a cap), using the following factors:

a) Protectiveness;
b) Permanence;
c) Cost;
d) Long-term effectiveness;
e) Short-term risk;
f) Technical and administrative implementability; and
g) Public considerations.

The Disproportionate Cost Analysis would be used to determine if the incremental cost of one type of cap over that of a lower-cost alternative cap exceeds the incremental degree of benefits achieved by the first alternative over that of the other lower-cost alternative. In addition, the second and fourth factors listed above pertain to identifying performance objectives for caps over hazardous substances.

MTCA describes permanence as the degree to which a cleanup alternative permanently reduces the toxicity, mobility, or volume of the hazardous substance, and relevant to caps in particular, the reduction or elimination of hazardous substance releases. MTCA describes long-term effectiveness as including the reliability of the alternative during the period that hazardous substances remain on-site at concentrations that exceed cleanup levels, and the degree of certainty that the alternative will be successful.

Consideration of the CERCLA and MTCA provisions described above indicates that caps over hazardous substances used as part of a cleanup action should satisfy the following:

- Minimize the magnitude of residual risk remaining after implementation by reducing the potential mobility of the hazardous substance due to physical dispersion or leaching of the hazardous substances; and

- Use adequate design and construction so as to perform reliably and avoid cap replacement to provide protection for as long as hazardous substances exceed cleanup levels.

Reduce Mobility of Hazardous Substances

The objective of reducing the mobility of hazardous substances is part of the second primary balancing criteria under CERCLA [40 CFR § 300.430(e)(9)(iii)(D)], as well as a consideration in the MTCA requirement to use permanent solutions to the maximum extent practicable [WAC 173-340-360(3)(e)].

From the standpoint of cap performance objectives, reducing the mobility of hazardous substances includes the following:

- Minimize or prevent infiltration that would produce leaching of hazardous substances into the groundwater;

- Minimize or prevent the uptake of hazardous substances by plants; and

- Minimize or prevent physical dispersion of hazardous substances due to:

  - Human activities;
  - Erosion by wind or precipitation runoff;
  - Soil turnover (bioturbation) due to soil invertebrates; and
  - Burrowing animals.

Figure C-1 shows the depth of plant roots and wildlife burrows for representative conditions at the Site.

Effectiveness Over the Short-Term

Short-term effectiveness is evaluated under CERCLA based on consideration of: potential risks to the community and workers during implementation; potential environmental impacts; and the time until protection is achieved [40 CFR § 300.430(e)(9)(iii)(E)].

Short-term effectiveness is considered under MTCA as part of determining whether a cleanup action provides for a reasonable restoration time frame [WAC 173-340-360(4))]. The MTCA factors used to assess reasonableness of the restoration time frame for one alternative compared to another include:

a) Potential risks posed by the site;

b) Practicability of achieving a shorter restoration time frame;

c) Current and potential future use of the site;

d) Potential future use of the site;

e) Availability of alternative water supplies;

f) Likely effectiveness and reliability of institutional controls;

g) Ability to control and monitor migration of hazardous substances from the site;

h) Toxicity of the hazardous substances; and

i) Documentation of natural process that would reduce concentration of the hazardous substances.

From the standpoint of cap performance objectives, short-term effectiveness includes the following:

- The cap should be able to be constructed without exposing the community, remediation workers, or the environment to increased risk. This would include, for example, preventing generation of dust that would expose humans and environmental receptors to hazardous substances;

- The cap should be protective under current conditions and be able to accommodate anticipated future use of the site; and

- The effectiveness of the cap should be able to be monitored.

Implementability

Implementability under CERCLA is evaluated considering technical and administrative feasibility; and the availability of services and materials including necessary equipment, specialists, additional resources, and prospective technologies [40 CFR § 300.430(e)(9)(iii)(F)]. Under MTCA, implementability is evaluated considering whether an alternative is technically possible; availability of necessary off-site facilities, services, and materials; administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction and monitoring, integration with existing operations, and other current and potential remedial actions [WAC 173-340-360(3)(f)(vi].

Many of the implementability factors that are considered under CERCLA and MTCA were discussed in the preceding sections. Implementability of caps as a remedy component includes the following cap performance objectives that have not been previously discussed:

- The cap should be readily constructible with existing technology including available construction services, materials, equipment and other resources;

- The cap should be administratively acceptable to the agencies having jurisdiction; and

- Implementation of the cap should be consistent with available resources and other components of the remedy.

Cost

CERCLA requires that cost considerations include capital costs (including both direct and indirect costs), annual operation and maintenance (O&M) costs, and the net present value of capital and O&M costs [40 CFR § 300.430(e)(9)(iii)(G)]. CERCLA further requires that a selected remedy (including its components) that satisfies the threshold criteria should also be cost effective, which is determined based on consideration of whether its costs are proportional relative to its overall effectiveness [40 CFR § 300.430(f)(1)(ii)(D)].

The MTCA uses the Disproportionate Cost Analysis to determine whether the incremental costs are disproportionate to the incremental benefits of alternative remedy components [WAC 173-340-360(3)(e)].

Cost is a factor in establishing performance objectives of caps to the extent that cost becomes a factor in selecting a cap as a remedy component, e.g., where different types of caps could be used but would have different degrees of effectiveness.

Performance objectives for caps, therefore, include the following cost consideration:

- Caps over hazardous substances should not have costs (i.e., the NPV of capital and O&M costs) that disproportionately exceed the cost of other remedial components that meet the threshold requirements (including other types of caps), compared to the relative environmental benefit achieved.

Monitoring Effectiveness

CERCLA requires that the effectiveness of a remedy can be monitored as part of evaluating the technical feasibility factor of implementability [40 CFR §300.430(e)(9)(iii)(F)(1)], which is one of the primary balancing criteria. Under MTCA, compliance monitoring is one of the threshold criteria for selection of a remedy [WAC 173-340-360(2)(a)].

Performance objectives for caps therefore include the following:

- Performance of the cap in achieving other cleanup objectives (e.g., as described above) can be monitored over the life of the remedy.

Acceptability

As with all other components of a cleanup action under CERCLA, selection of a cap must consider the acceptance of the state and community [40 CFR § 300.430(e)(9)(iii)(H) and (I)]. Under MTCA, selection of a cleanup action must consider public concerns [WAC 173-340-360(2)(b)(iii)]. While acceptability is part of selecting a cleanup action, it does not specifically lead to performance requirements for caps.

SUMMARY OF CAP PERFORMANCE OBJECTIVES

Based on analyses presented in the previous sections, performance requirements for caps used as part of cleanup actions are summarized below.

1. A cap (if constructed of soil) must either isolate the hazardous substance below the point of compliance for soils, or the cap must consist of or include a physical barrier (such as a pavement) that will prevent ecological receptors from being exposed to the hazardous substance.

2. A cap should minimize or prevent infiltration to avoid generation of leachate that would need to be collected and treated, or that otherwise would degrade groundwater and/or surface water quality. A cap that does not completely prevent leaching of hazardous substances may be acceptable where other measures such as containment, collection, and treatment would satisfy the ARARs (e.g., MM-3).

3. A cap should have sufficient durability to protect integrity of the cap from damage due to erosion, instability, freeze-thaw and desiccation, which could impair performance of the cap.

4. A cap should minimize the magnitude of residual risk remaining after implementation by reducing the potential mobility of the hazardous substance due to physical dispersion or leaching of the hazardous substances.

5. A cap should be designed and constructed so as to perform reliably and avoid the potential need for maintenance or replacement to assure its performance over time. The cap should be readily constructible with existing technology including available construction services, materials, equipment and other resources.

6. A cap should be capable of supporting native vegetation and habitat, but minimize or prevent the uptake of hazardous substances by plants.

7. A cap should minimize or prevent physical dispersion of hazardous substances due to:

   a. Human activities;
   b. Erosion by wind or precipitation runoff;
   c. Soil turnover (bioturbation) due to soil invertebrates; and
   d. Burrowing animals.

8. A cap should be able to be constructed without exposing the community, remediation workers, or the environment to increased risk.

9. A cap should be protective under current conditions and be able to accommodate anticipated future use of the Site; and

10. The effectiveness of the cap should be able to be monitored.

11. The cap should be administratively acceptable to the agencies having jurisdiction.

12. Implementation of the cap should be consistent with available resources and other components of the remedy.

13. The cap should be readily constructible with existing technology including available construction services, materials, equipment and other resources.

14. Caps over hazardous substances should not have costs (i.e., the NPV of capital and O&M costs) that disproportionately exceed the cost of other remedial components that address the same pathway (including other types of caps), compared to the relative environmental benefit achieved.

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Maximum and Minimum Burrowing and Rooting Depths of Select Animal and Plant Species at Holden Mine

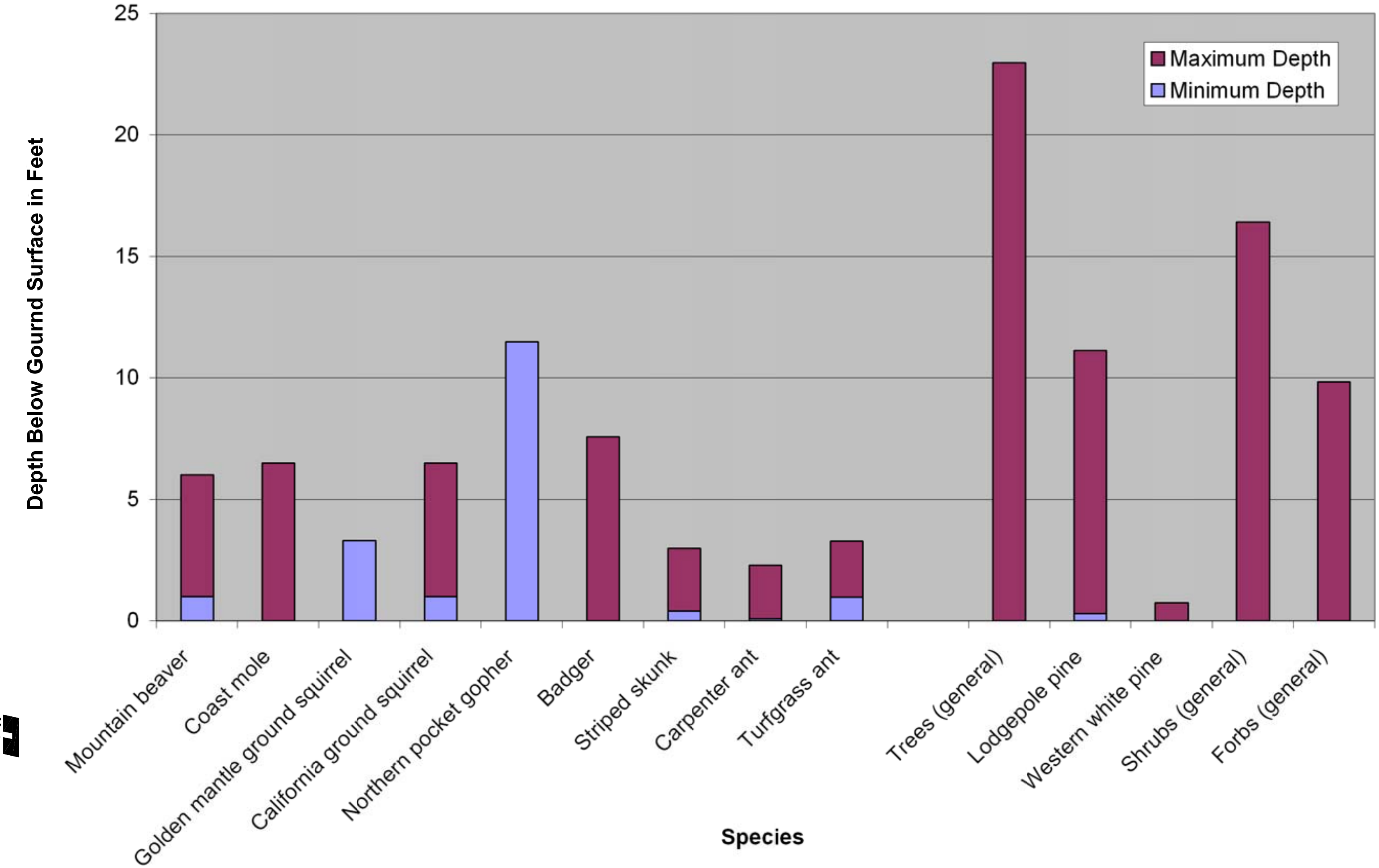

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Figure C-1

APPENDIX D
ALTERNATIVE GROUNDWATER CONTAINMENT AND COLLECTION SYSTEM EVALUATION

APPENDIX D
ALTERNATIVE GROUNDWATER CONTAINMENT AND COLLECTION SYSTEM EVALUATION

D-1 INTRODUCTION

This Appendix explains the Agencies' analysis of two possible configurations for the groundwater containment and collection system downgradient of Tailings Piles 2 and 3. The Agencies conducted this analysis to determine which components should be included in Alternative 14 that are presented in the ASFS.

Alternatives 11M and 13M both include groundwater containment and collection around the Lower West Area and Tailings Pile 1. Alternative 11M also includes a groundwater containment and collection system around Tailings Piles 2 and 3. Intalco proposed omitting such a containment and collection system for Alternative 13M, pending further observations of groundwater and surface water quality downgradient of Tailings Piles 2 and 3 (ERM and URS 2009, Section 3.2.12).

The Agencies evaluation of Alternative 13M found that it would not satisfy ARARs (see Section 6.2.2.2 of the ASFS) since this alternative does not include containment and collection of groundwater impacted by releases from Tailings Piles 2 and 3. The Agencies developed Alternative 14 to address deficiencies in Alternative 13M. As part of developing Alternative 14, the Agencies compared two different configurations for the groundwater containment and collection system downgradient of Tailings Piles 2 and 3. These included the configuration previously proposed in the SFS for Alternative 11 (and retained as part of Alterative 11M), and the configuration that Intalco presented as a contingency for Alternative 13M in meetings with the Agencies on May 6–8, 2009. This approach is referred to herein as Alternative 13M with Contingency, or Alternative 13M/C. Intalco presented the groundwater containment and collection system for Alternative 13M/C in Figure E4-2 (see Appendix E of ERM and URS 2009).

The Agencies compared the Tailings Piles 2 and 3 groundwater containment and collection system configurations of Alternatives 11M and 13M/C as part of developing Alternative 14, as discussed in this Appendix.

The Agencies conducted this analysis to identify the groundwater containment configuration that best meets the CERCLA and MTCA criteria for selection of a preferred alternative for cleanup of the site. The configuration of groundwater containment and collection systems affect how Alternative 14 compares to other alternatives with respect to the primary balancing criteria under CERCLA (long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; and cost) and the MTCA requirement to use permanent solutions to the maximum extent practicable.

As discussed in this Appendix, the groundwater containment system configuration affects the volume and quality of groundwater collected. Water volume and quality can affect treatment requirements, including the treatment system footprint and the amount of lime and electrical power (regardless of the source) needed to operate the treatment system over the life of the remedy. Water volume and quality also affect treatment system byproducts, including the volume of sludge generated (which dictates the required size of the sludge disposal landfill) and the mass of metals released to the environment in the treatment system effluent.[1]

The MTCA requires a comparative analysis, referred to as the Disproportionate Cost Analysis [WAC 173-340-360(3)(e)], to determine whether a cleanup action uses permanent solutions to the maximum extent practicable. The analysis presented in this Appendix was used to evaluate the best approach to containment and collection for treatment of impacted groundwater downgradient of Tailings Piles 2 and 3. Use of the Disproportionate Cost Analysis in this way satisfies MTCA requirements for development of the best alternative for cleanup of the Site. Alternative 14 includes the groundwater containment and collection system selected on the basis of this analysis. Alternative 14 is, overall, compared to Alternatives 11M and 13M using the CERCLA and MTCA criteria as discussed in Section 6 of the ASFS.

[1] As discussed in Appendices A and F of the SFS, treatment systems that rely on pH adjustment and precipitation are anticipated to produce hazardous substances concentrations in the treatment system effluent that are the same for each system that relies on this technology. Alternatives 11M, 13M, and 13M/C all rely on the same treatment system technology, thus they would produce effluent with the same water quality. Because the effluent concentration is the same, the system that produces the largest effluent volume would release the largest mass of hazardous substances to the environment, since the mass released is equal to the product of concentration times flow. Although the concentration is the same, release of a larger mass of hazardous substances would result in greater potential environmental harm, especially if concentrations exceed protective levels, and over time. Although more severe impacts occur when concentrations exceed ARARs based on protection of aquatic life, adverse impacts are likely when concentrations are close to, but do not actually exceed ARARS, as discussed in USFWS (2002). Adverse effects will depend on seasonal variability in pH and hardness within Railroad Creek (USFWS 2004 and USFWS 2005).

D-2 BACKGROUND

As described by Intalco for Alternative 13M, groundwater would be collected in the contained area around the Lower West Area and Tailings Pile 1, and in the former Railroad Creek channel along the northwest side of Tailings Pile 2. Intalco's Alternative 13M contingency approach (i.e., Alternative 13M/C) relies on a fully penetrating groundwater barrier wall and collection system extending along the east side of Tailings Pile 3 and across the former Railroad Creek channel to terminate north of about the middle of Tailings Pile 3 (see Figure D-1).

In contrast to the approach proposed by Intalco, Figure D-2 shows the groundwater barrier wall and collection system configuration around Tailings Piles 2 and 3 that were proposed for Alternative 11M. This groundwater barrier wall would also fully penetrate the alluvial aquifer and tie into the underlying glacial till or bedrock on the east, north and west sides of the combined Tailings Piles 2 and 3 footprint, as described in the SFS for Alternative 11.

The Agencies used Intalco's groundwater model (the model described in Appendix E of ERM and URS 2009) to evaluate the effectiveness of the groundwater barrier wall and collection system proposed for Alternative 13M/C. This analysis shows that Alternative 13M/C would collect a considerable volume of clean groundwater.

- Some of the clean water that would be collected would flow from northwest of Tailings Pile 2 and into the former Railroad Creek channel collection ditch adjacent to Tailings Pile 2.

- Clean groundwater would also flow under the new and old creek channels and be collected in the ditch along the containment barrier downgradient of Tailings Pile 3.

Collection of water from various locations is indicated by the particle tracking flow lines shown on Figures D-1 and D-2.[2]

An increase in the total volume of groundwater collected due to collection of additional clean water results in dilution (lower concentration of hazardous substances) of the water that is treated. Collection of clean water into the

[2] The figures only depicts flow in one stratigraphic layer of the groundwater model, but is useful for illustrative purposes since flow in other layers is generally similar.

treatment system is an undesired addition to the desired collection of groundwater impacted by releases from Tailings Piles 2 and 3.

The total estimated groundwater flow that would be collected and conveyed through the treatment system under Alternative 13M/C [870 million gallons per year (MGY)] greatly exceeds the volume previously estimated in the SFS for Alternative 11 (600 MGY).

Since the method described in the SFS to estimate the volume of groundwater collected for treatment is quite different from the current groundwater model developed by Intalco (Appendix E of ERM and URS 2009), the Agencies also used Intalco's current model to estimate the volume of groundwater that would be collected with Alternative 11M to provide a comparison with Alternative 13M/C using a consistent method of calculation and related assumptions. Results are shown below.

Alternative	Annual Estimated Volume of Groundwater Collected for Treatment (million gallons per year)
Alternative 11M (Agencies' estimate using Intalco's model, 2009)	620
Alternative 13M/C	870

The configuration of the groundwater barrier and collection system significantly affects both the volume and quality of water collected for treatment and, therefore, the potential suitability of one alternative compared to another. The Agencies performed additional analysis to determine the optimal groundwater containment and collection system configuration for Alternative 14.

The remainder of this appendix compares the different groundwater containment and collection configurations and treatment approaches proposed for Alternative 11 (and retained in Alternative 11M) and Alternative 13M/C to determine which approach is permanent to the maximum extent practicable and, therefore, should be included in Alternative 14. This evaluation is undertaken through the Disproportionate Cost Analysis, as presented in WAC 173-340-360(3)(e). These evaluation criteria are individually discussed later in this appendix.

D-3 COMPARISON OF THE GROUNDWATER TREATMENT SYSTEM REQUIREMENTS RELATED TO DIFFERENCES IN THE GROUNDWATER CONTAINMENT AND COLLECTION SYSTEM

Differences between the Alternatives 13M/C and 11M treatment system components listed below result from the more extensive Alternative 11M groundwater containment system and the resulting decrease in volume of water collected and treated. The Agencies estimated the size of the treatment system east of Tailings Pile 3, the annual amounts of lime and fuel that would be used in treating the groundwater, and the volume of byproduct sludge using the methods and assumptions discussed in Appendix F of the SFS and Appendix A of the ASFS.

	Alternative 13M/C	Alternative 11M
Length of Groundwater Barrier Downgradient of Tailings Piles 2 and 3 (feet)	1600	4200
Volume of Water Collected, Treated and Discharged (MGY)	870	620
Approximate Treatment System Footprint (Acres)	10 acres	10 acres
Lime Required for Treatment (TPY)	2,200	2,300
Potential Volume of Diesel Fuel Required for Treatment[3] (Gallons per Year)	8,700	8,800
Volume of Byproduct Sludge, at 4 percent solids (MGY)	10.1	10.6
Sludge Disposal Landfill Volume[4] (cubic yards)	1,000,000	1,060,000

Although there would be a larger volume of water collected and treated annually under Alternative 13M/C compared to Alternative 11M, the summary above indicates that the treatment system footprint, and fuel and lime consumption requirements are very similar. This is because the concentration of hazardous substances is lower in the treatment system influent for Alternative 13M/C than Alternative 11M; and the mass load of hazardous substances is the

[3] The volume of fuel would be reduced significantly if hydroelectric generating capacity or another alternative to diesel-powered generators is developed as part of the remedy.

[4] The sludge landfill volume shown is the nominal capacity estimated for a 50-year capacity. The landfill capacity would exceed the volume required for 50 years, to the extent that sludge dewatering increases the solids content above 4 percent before disposal of the sludge in the landfill.

same despite the more dilute nature of the Alternative 13M/C influent. The volume of sludge produced is also similar, although somewhat greater for Alternative 11M since Alternative 11M would remove a larger mass of hazardous substances from the environment compared to Alternative 13M/C, as discussed below.

The anticipated concentration of hazardous substances is the same in the effluent that would be discharged from the treatment systems for both Alternatives 13M/C and 11M. This is because the same pH adjustment and precipitation treatment method is used for all of the alternatives discussed in the ASFS. Since Alternative 13M/C involves treating a larger volume of water and the effluent concentrations are the same, a larger mass of hazardous substances would be discharged under Alternative 13M/C compared to Alternative 11M. The difference is summarized below.

	Alternative 13M/C	Alternative 11M
Annual Volume of Treated Water Discharged (MGY)	870	620
Mass of Hazardous Substances Discharged to Railroad Creek in Treated Effluent (Pounds per Year)[5]		
• Aluminum	2,000	1,300
• Cadmium	7	4
• Copper	200	130
• Iron	3,900	2,700
• Zinc	650	450

D-4 REGULATORY ANALYSIS FOR COMPARISON OF ALTERNATIVES 13M/C AND 11M

It appears that both Alternatives 13M/C and 11M should satisfy the threshold requirements for selection of a permanent remedy under both MTCA and CERCLA. The discussion in Section D-4.1 compares Alternatives 13M/C and 11M using the MTCA Disproportionate Cost Analysis to assess which alternative is permanent to the maximum extent practicable. This is followed by a discussion in Section D-4.2 that compares these alternatives with respect to the CERCLA primary balancing criteria.

[5] Note that lead is not included in the calculation because Intalco has not consistently analyzed the concentration of lead in groundwater at the Site.

D-4.1 MTCA Analysis

Cleanup actions must meet the minimum requirements of WAC 173-340-360(2) for cleanup actions. These consist of the threshold requirements and the "other requirements" which include the use of permanent solutions to the maximum extent practicable (WAC 173-340-360(2)(b)(i)). The MTCA gives preference to permanent solutions.

Permanent solution means "...a cleanup action in which cleanup standards of WAC 173-340-700 through 173-340-760 can be met without further action being required at the site being cleaned up or any other site involved with the cleanup action, other than the approved disposal of any residue from the treatment of hazardous substances." For example, detoxification of soil is more permanent than capping because no additional action is required once the hazardous constituents in the soil are removed or destroyed. When contaminated soil is left in place with a cap, ongoing maintenance of the cap is required to ensure its integrity. Therefore, the less permanent alternative (the cap) may be selected only if: a) it provides sufficient environmental protection (i.e., meets the threshold requirements within a reasonable restoration timeframe); and b) the cost is disproportionate to the benefit provided by other more permanent alternative(s).

The comparative analysis required by the MTCA is presented in WAC 173-340-360(3)(e) (Disproportionate Cost Analysis). Each of the criteria used in the Disproportionate Cost Analysis to determine whether a cleanup action is permanent, to the maximum extent practicable, are discussed below.

Protectiveness [WAC 173-340-360(3)(f)(i)]

This criterion evaluates the degree of protectiveness of each alternative. This includes: a) the degree of risk reduction; b) restoration time frame; c) risks resulting from implementation of the alternative; and d) overall improvement in environmental quality.

Alternative 11M would be more protective than Alternative 13M/C because it would reduce the risk to aquatic life to a greater degree. The Alternative 11M treatment facility effluent would discharge a lower mass of all hazardous substances into Railroad Creek compared to Alternative 13M/C. This would result in a lower concentration of hazardous substances in Railroad Creek.

As noted in Appendix F of the SFS (particularly in Attachment D to Appendix F), there is some chance that the treated effluent associated with any of the Alternatives will not immediately satisfy ARARs for all constituents. In this event, the treatment system will need to be modified to achieve the desired level of performance. During the time needed to clean up the Site, the increased mass of hazardous substances discharged during any period when the effluent is not meeting ARARs would pose a greater risk to aquatic life for the Alternative 13M/C discharge compared to the discharge under Alternative 11M.

Even if the treated effluent generally meets ARARS, it may not satisfy discharge criteria all the time, e.g., during periods of low flow in the creek, during seasonal variations in hardness and pH, and during extreme weather conditions.[6] The protectiveness of the ARARs depends, in part, on actual pH, hardness, and other conditions that vary naturally in Railroad Creek, [see the discussion in USFWS (2004), USFWS (2005) and USFWS (2007)]. Although more severe impacts occur when concentrations exceed ARARs based on protection of aquatic life, adverse impacts are likely when concentrations are close to, but do not actually exceed ARARS, as discussed in USFWS (2002). Because the concentration of hazardous substances in the treated effluent would be similar for both alternatives, the effect of discharging a greater volume of effluent would result in higher concentrations in the creek for Alternative 13M/C compared to Alternative 11M. Information needed to accomplish a mixing zone analysis will need to be collected as part of remedial design. The greater mass of metals released over any period when the effluent does not meet ARARs would result in greater environmental harm.

Permanence [WAC 173-340-360(3)(f)(ii)]

The degree to which an alternative permanently reduces the toxicity, mobility, or volume of hazardous substances is evaluated in this criterion. This evaluation includes the degree of irreversibility of a treatment process, and the quality and quantity of residue generated by the treatment process.

There would not be any difference in the toxicity of hazardous substances for Alternatives 13M/C and 11M. Both alternatives rely on the same treatment process and would have the same degree of irreversibility and quality of the residue, e.g., the long-term chemical stability and the nature of the sludge. Alternative 11M is anticipated to produce a slightly greater volume of sludge

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[6] Treatment system performance may be reduced during or immediately following extremely high precipitation, when increased flows could result in short circuiting the ponds where precipitation of the metal hydroxide sludge would normally occur. Also, incomplete mixing and aeration may occur during very cold weather. In either case, the treated effluent may exceed ARARs at the point of discharge for some period of time.

than Alternative 13M/C, since the concentration of the influent is greater and, as a result, a larger mass of metals is removed by treatment under Alternative 11M than under Alternative 13M/C.

Alternative 11M would achieve a greater reduction in the volume and mobility of hazardous substances compared to Alternative 13M/C, since it would reduce the amount of hazardous substances re-released to the environment in the treatment system effluent. There would not be any difference in the toxicity of hazardous substances for Alternatives 13M/C and 11M.

Based on the analyses described above, Alternative 11M is more permanent than Alternative 13M/C.

Cost [WAC 173-340-360(3)(f)(iii)]

The cost of implementing an alternative includes the capital costs, the operation and maintenance (O&M) costs throughout the life of the project expressed in net present value (NPV), and agency oversight costs. The methods and assumptions used in the Agencies' cost estimates are discussed in Appendix A of the ASFS and Appendix B of the SFS.

The capital and operating costs of Alternatives 13M/C and 11M for the groundwater containment, collection, and treatment system components would differ as shown below.

Capital Costs for Groundwater Containment and Collection System Components that Differ Between Alternatives 13M/C and 11M[7]	**Alternative 13M/C**	**Alternative 11M**
Groundwater Barrier and Collection System	$7,540,000	$10,700,000
Groundwater Treatment Facilities	$3,230,000	$2,980,000
Sludge Landfill (50-year capacity)	$5,390,000	$5,550,000
Total Capital Cost	$16,200,000	$19,200,000

[7] The capital costs shown do not include Contractor mark-ups (overhead and profit, Division 1 costs) or non-construction capital costs, see Appendix A.

Net Present Value for O&M of Groundwater Collection and Treatment	Alternative 13M/C	Alternative 11M
Direct Costs for Fuel and Lime	$11,400,000	$12,200,000
Maintenance[8]	$3,420,000	$3,470,000
Equipment/Facility Replacement[9]	$1,650,000	$1,480,000
Total NPV of O&M Costs	$16,500,000	$17,200,000

Total costs for groundwater collection and treatment components of Alternative 13M/C, including both capital and NPV of long-term costs is $32.7 million, compared to the total for Alternative 11M of $36.4 million. The difference is due to the cost to construct a more extensive groundwater containment and collection system, and increased treatment and disposal costs associated with handling a somewhat larger volume of sludge for Alternative 11M, which are partially offset by lower maintenance costs related to handling a smaller volume of water for Alternative 11M.

Long-Term Effectiveness [WAC 173-340-360(3)(f)(iv)]

The long-term effectiveness criterion evaluates the reliability of the alternative during the period that hazardous substances remain on-site at concentrations that exceed cleanup levels. The evaluation includes the degree of certainty the alternative will be successful, residual long-term risk posed by the site, and the effectiveness of controls to manage treatment residues and wastes remaining on site. The MTCA suggests using the following as a guide in this evaluation, in descending order of priority:

1. Reuse/recycling;
2. Destruction/detoxification;
3. Immobilization/solidification;
4. On- or off-site disposal in an engineered structure;
5. On-site isolation/containment with engineering controls; and
6. Institutional controls with monitoring.

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[8] Maintenance items include sludge removal, filter sand replacement, landfill leachate removal, landfill cover vegetation control, and maintenance of the collection and conveyance pipes and ditches.

[9] Equipment/facility maintenance includes replacing and closing a sludge landfill cell after 50 years and replacing mechanical equipment and other treatment facility components that wear out, as discussed in Appendix A of the ASFS and Appendix B of the SFS. These costs were developed for purposes of comparing the alternatives using consistent assumptions. The actual schedule and costs for facilities and equipment replacement would depend on decisions made during remedial design and over the life of the remedy.

Alternatives 13M/C and 11M do not differ with respect to the above items numbered 1, 2, and 6. Regarding items numbered 3, 4, and 5, Alternative 11M would immobilize, dispose of, and contain a larger mass of hazardous substances in an on-site engineered landfill, compared to Alternative 13M/C, since Alternative 13M/C results in a greater mass of hazardous substances that would be re-released to Railroad Creek. Alternative 11M, therefore, has greater long-term effectiveness than Alternative 13M/C.

Short-Term Risks [WAC 173-340-360(3)(f)(v)]

This criterion evaluates the short-term risks to human health and the environment associated with implementation of the cleanup action, including the effectiveness of measures to reduce risks during construction (e.g., best management practices).

Alternative 11M involves constructing a greater length of groundwater barrier wall adjacent to Tailings Piles 2 and 3, compared to Alternative 13M/C. Although both alternatives involve relocation of Railroad Creek away from the barrier wall alignment, Alternative 11M includes constructing a barrier wall adjacent to Copper Creek and Alternative 13M/C does not. As a result, there is a somewhat greater risk of a release of cement, bentonite, or sediment during construction of Alternative 11M compared to Alternative 13M/C.

Alternative 11M also involves handling about 5 percent more lime for treating groundwater compared to Alternative 13M/C. If electrical power is supplied by diesel-fueled generators, Alternative 11M would require about 1 percent more fuel for treatment system operation. As a result, there is a slightly greater risk to human health and the environment associated with long-term operation of the groundwater treatment facilities for Alternative 11M compared to Alternative 13M/C.

The same mitigative measures (spill prevention, control, and countermeasure plans and worker training, as well as engineered controls) are available for both Alternatives 13M/C and 11M. Such mitigative measures reduce but do not completely eliminate the risks described above.

Technical And Administrative Implementability [WAC 173-340-360(3)(f)(vi)]

The implementability of a project includes consideration of the following factors:

1. Technical feasibility;

2. Availability of off-site facilities (if alternative includes use of off-site treatment or disposal);
3. Availability of services and materials needed to implement the cleanup action;
4. Administrative and regulatory requirements;
5. Scheduling, size, and complexity of the action;
6. Monitoring requirements; and
7. Integration into existing operations or future potential remedial actions.

Alternative 11M requires construction of a longer subsurface barrier wall than would alternative 13M/C, and there is greater potential for encountering subsurface conditions that could make barrier wall construction more difficult. The depth of the barrier walls differs also, as summarized below.

- Alternatives 11M and 13M/C would have comparable maximum and average barrier wall depth requirements around Tailings Pile 1 and the Lower West Area, except that Intalco estimated the average depth of the Alternative 13M/C barrier wall would be 70 feet compared to 76 feet for Alternative 11M. This difference results from relocating Railroad Creek, which enables moving the barrier wall adjacent to Tailings Pile 1 slightly north where the depth to glacial till or bedrock is slightly less than at the location proposed for Alternative 11M.

- Alternatives 11M and 13M/C would also have comparable barrier wall depths along the east and north sides of Tailings Pile 3, with maximum depths of 130 feet for Alternative 11M compared to 135 feet for Alternative 13M/C. However, the average barrier wall depth would be less in this area for Alternative 13M/C, since the barrier wall depth would decrease to 10 feet or less where the barrier wall extends into bedrock north of Railroad Creek near the middle of Tailings Pile 3; whereas, the Alternative 11M barrier wall would extend to the west along the existing Railroad Creek channel.

The difference in the barrier wall configurations and depths is illustrated in Figures C-13-1 through C-13-8 in appendix C of ERM and URS (2009). The average depth of the Alternative 11M barrier wall that extends along the north side of Tailings Piles 2 and 3 and wraps around the west side of Tailings Pile 2 is only 60 feet, according to Intalco's estimate. As a result, although the length of the Alternative 11M groundwater barrier wall exceeds that of Alternative 13M/C, the depths are comparable and do not present any significant construction challenges.

Alternatives 13M/C and 11M equally satisfy the criteria above numbered 1, 2, 3, 4, 6, and 7. Alternatives 11M and 13M/C differ with respect to criterion 5 since the longer (alternative 11M) barrier wall would require a longer period to construct and barrier wall construction would be somewhat more complex. Alternative 13M/C would have a slightly larger and more complex treatment system since it handles a larger volume of water compared to Alternative 11M. However, Alternative 11M would have slightly larger and more complex sludge handling and disposal requirements compared to Alternative 13M/C.

Alternatives 13M/C and 11M appear to have comparable administrative feasibility, and the technical feasibility is similar except for the greater uncertainty associated with constructing the longer barrier wall for Alterative 11M.

Public Considerations [WAC 173-340-360(3)(f)(vi)]

The evaluation of alternatives needs to consider public concerns and the degree to which the alternative addresses the public's concerns. This includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization having an interest in the Site.

The Agencies will evaluate public concerns in response to public comments on the Proposed Plan before issuing a Record of Decision (ROD). There is no difference in the Agencies' ability to address potential comments for either Alternative 13M/C or 11M.

Summary of the MTCA Disproportionate Cost Analysis

Based on the preceding discussion, Alternatives 13M/C and 11M can be compared as follows:

- Alternative 11M is more protective than Alternative 13M/C;
- Alternative 11M is more permanent than Alternative 13M/C;
- Alternative 13M/C has lower cost than Alternative 11M;
- Alternative 11M has greater effectiveness over the long term than Alternative 13M/C;
- Alternative 11M has slightly greater short-term risks than Alternative 13M/C;
- Alternative 13M/C and Alternative 11M have essentially the same technical and administrative feasibility; and

- The Agencies have the same ability to address public concerns for both Alternative 13M/C and Alternative 11M.

The estimated cost of the groundwater containment, collection, and treatment components for Alternative 11M is about 12 percent more than for Alternative 13M/C, yet Alternative 11M provides the following benefits:

1. Alternative 11M would collect and treat a smaller volume of clean water compared to Alternative 13M/C;

2. Alternative 11M would release a smaller mass of hazardous substances into Railroad Creek via the treatment system effluent, compared to Alternative 13M/C. Thus Alternative 11M would achieve a greater reduction in the volume and mobility of hazardous substances compared to Alternative 13M/C; and

3. Alternative 11M would have less risk to aquatic receptors during periods of seasonal low flow and variation in pH, hardness and other parameters compared to Alternative 13M/C, as well as any time the effluent does not meet ARARs due to problems with the treatment system.

Considering all of the evaluation criteria used in WAC 173-340-360(3)(f) as described above, the groundwater containment and collection system components of Alternative 11M do not have incremental costs compared to Alternative 13M/C that are disproportionate to the incremental benefits of Alternative 11M compared to Alternative 13M/C. Therefore, Alternative 11M uses permanent solutions to the maximum extent practicable for the groundwater containment and collection components and Alternative 13M/C does not.

D-4.2 CERCLA Analysis

The groundwater containment and collection system components of Alternatives 13M/C and 11M can be compared using the primary balancing criteria under CERCLA in the same way as described above. The primary balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; and cost; are discussed below.

Long-Term Effectiveness and Permanence

Alternative 11M has greater long-term effectiveness and permanence than Alternative 13M/C because Alternative 11M would immobilize a larger mass of hazardous substances in an on-site engineered landfill, compared to Alternative 13M/C.

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 11M would achieve a greater reduction in the volume and mobility of hazardous substances compared to Alternative 13M/C, since it would reduce the amount of hazardous substances that are re-released to the environment in the treatment system effluent.

Short-Term Effectiveness

Alternative 11M would achieve greater short-term effectiveness than Alternative 13M/C since it would immediately decrease the mass of hazardous substances released into Railroad Creek via discharge from the treatment facilities. This is particularly significant since the treated effluent may not immediately achieve ARARs without treatment system modifications. Such modifications could require monitoring and adjustment of treatment system operations over a period of months or years.

Cost

Alternative 13M/C has a lower estimated total cost than Alternative 11M for groundwater collection and treatment components, including both capital and the NPV of long-term costs. The estimated difference is $3.7 million, or about 12 percent of the cost of the components that distinguish Alternative 13M/C from Alternative 11M. Nonetheless, the groundwater containment and collection system components of Alternative 11M provide significant benefits not provided by Alternative 13M/C that are summarized below.

- Alternative 11M would prevent contamination of otherwise clean groundwater by collecting a smaller volume of clean water and combining it with impacted groundwater compared to Alternative 13M/C.

- Alternative 11M would release a smaller mass of hazardous substances into Railroad Creek via the treatment system effluent, compared to Alternative 13M/C. Thus, Alternative 11M would achieve a greater reduction in the volume and mobility of hazardous substances compared to Alternative 13M/C.

- Alternative 11M would have less risk to aquatic receptors during periods of seasonal low flow and variation in pH, hardness and other parameters compared to Alternative 13M/C, as well as any time the effluent does not meet ARARs due to problems with the treatment system.

Summary of the Evaluation of the CERCLA Balancing Criteria

In summary, the groundwater containment and collection components of Alternative 11M better satisfy the balancing criteria under CERCLA compared to Alternative 13M/C, as described above.

D-4.3 Summary of the Regulatory Analysis for Comparison of the Groundwater Containment and Collection System Components for Alternatives 13M/C and 11M

As discussed in this appendix, the groundwater containment and collection system components of Alternative 11M better satisfy both the MTCA Disproportionate Cost Analysis and the CERCLA primary balancing criteria compared to Alternative 13M/C. As a result of these evaluations, the Agencies selected the groundwater containment and collection components that are used in Alternative 11M as the basis for developing these components in Alternative 14.

The ASFS provides an overall comparison of Alternative 14 to Alternatives 11M and 13M.

D-5 REFERENCES

ERM and URS, 2009. Draft Alternative 13M Evaluation Report, Holden Mine Site, Chelan County, Washington. August 14, 2009.

USFWS, 2002. Comparison of Measured Railroad Creek Chemistry with Published Aquatic Toxicity Values. US Fish and Wildlife Service, Upper Columbia Fish and Wildlife Office. November 27, 2002.

USFWS, 2004. Comparison of Published Toxicity Values at Water Hardness Concentrations Similar to Railroad Creek. US Fish and Wildlife Service. June 16, 2004.

USFWS, 2005. Aluminum and Iron Toxicity Related to Water Quality Parameters Similar to Railroad Creek. US Fish and Wildlife Service. January 3, 2005.

USFWS, 2007. Response to Intalco's June 17, 2005, Comments on Potential for Impacts to Aquatic Life in Railroad Creek from Copper, Cadmium, Zinc, Aluminum and Iron. August 27, 2007.

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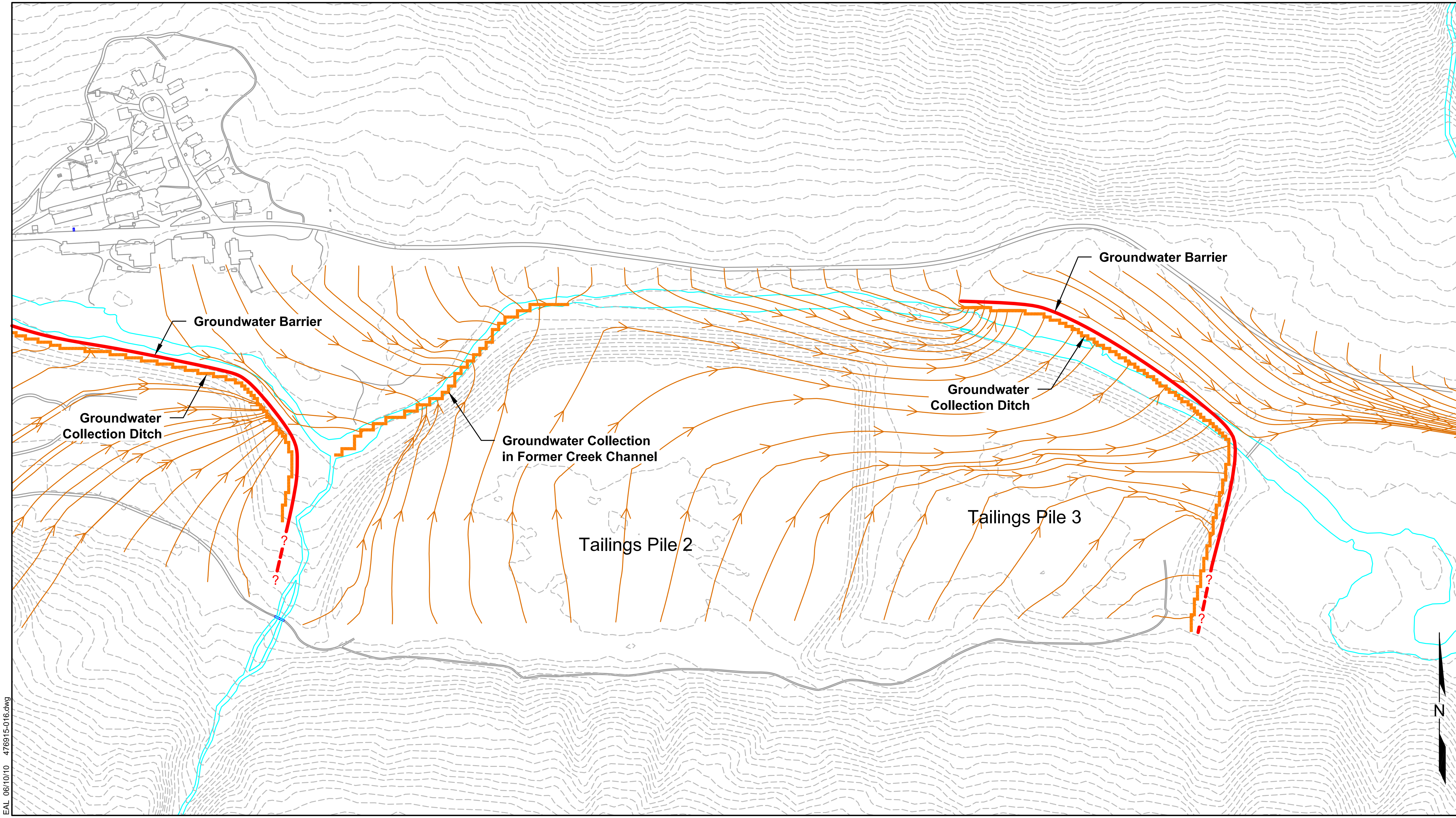
Alternative 13M/C Conceptual Layout for Groundwater Barrier and Collection Systems



EAL 06/10/10 476915-016.dwg

Groundwater Flow as Indicated by Particle-Tracking in Model

Notes:
1. Creek channel relocation not shown, for clarity.
2. Particle tracking varies by layer in the groundwater model. Shallow groundwater shown for illustrative purposes.
3. Southerly extent of groundwater barrier and collection systems to be determined during remedial design.

0 300 600

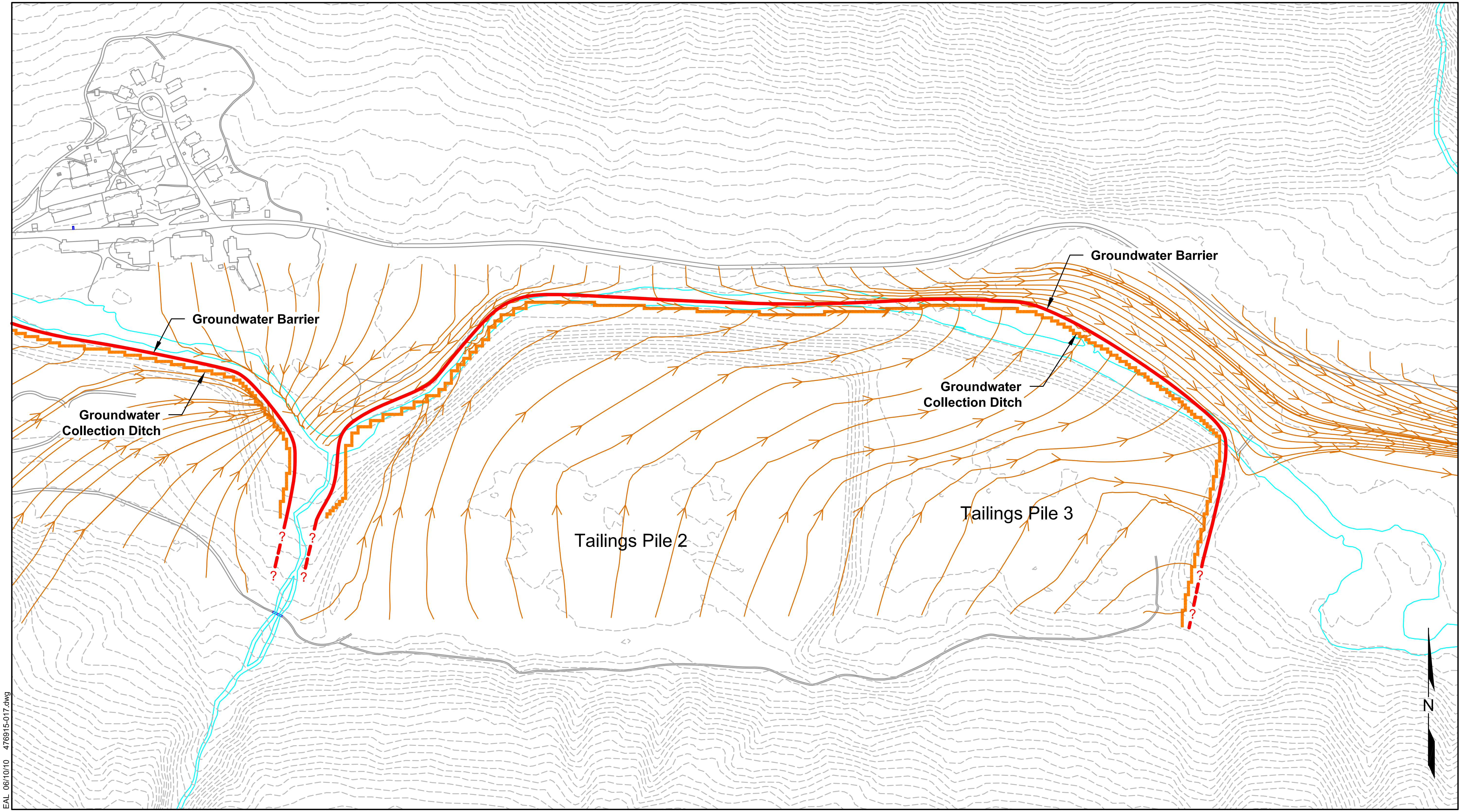
Scale in Feet

HARTCROWSER

4769-15 *6/10*

Figure D-1

Alternative 11M Conceptual Layout for Groundwater Barrier and Collection Systems



Groundwater Flow as Indicated by Particle-Tracking in Model

Notes:
1. Creek channel relocation not shown, for clarity.
2. Particle tracking varies by layer in the groundwater model. Shallow groundwater shown for illustrative purposes.
3. Southerly extent of groundwater barrier and collection systems to be determined during remedial design.

0 300 600
Scale in Feet

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4769-15 *6/10*

Figure D-2

APPENDIX E
DERIVATION OF TERRESTRIAL ECOLOGICAL RISK-BASED SOIL CLEANUP LEVELS (ECOLOGY, 2010B)

Memorandum

Date: 2/3/2010

TO: Norm Day, Holden Mine Project Manager
US Forest Service

FROM: Valerie Bound, Section Manager –Toxics Cleanup Program
Central Regional Office, Yakima

In consultation with key Toxics Cleanup Program staff

David Sternberg, Ecotoxicologist
Policy and Technical Support Unit

Laura Klasner, Project Engineer
Central Regional Office, Yakima

SUBJECT: Review of new Toxicity Reference Values (TRVs) for Copper, Thallium, Aluminum, Lead, Mercury, Molybdenum, and Zinc for the Holden Mine Site, as proposed by ERM in 2 submittals

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This memo reflects Ecology's official comments on the documents referenced below. We appreciate the opportunity to review and comment.

- September 2009. Draft Proposed Alternative Toxicity Reference Values for Copper, Thallium, and Aluminum in Support of the Holden Mine Site Terrestrial Ecological Evaluations. ERM. (including toxicity studies referenced)
- November 2009. Draft Proposed Alternative Toxicity Reference Values for Lead, Mercury, Molybdenum, and Zinc in Support of the Holden Mine Site Terrestrial Ecological Evaluations. ERM. (including toxicity studies referenced)

Toxicity Reference Values Used to Calculate Cleanup Levels

Ecology has accepted the majority of the proposed alternative TRVs submitted by ERM for Intalco. However, there are a few notable exceptions (Table E-1). ERM proposed alternative plant TRVs for aluminum (*Al*), copper (*Cu*), mercury (*Hg*), molybdenum (*Mo*), lead (*Pb*), thallium (*Tl*), and zinc (*Zn*). Alternative TRVs for *Cu* and *Pb* were also proposed for invertebrates inhabiting the site. In addition, ERM proposed alternative small mammalian wildlife TRVs for *Al, Cu, and Tl*. Ecology concurs with the use of the alternative plant TRVs for *Cu, Hg, Mo, Pb* and *Tl*. However, there was not enough information presented in the Draft Proposed Alternative TRV document (November, 2009) to justify the use of the alternative plant TRV for *Zn*. Also, Ecology has determined an alternative TRV (70 mg/kg DW) for plants is more appropriate than ERM proposed alternative for *Al*. Similarly, Ecology has determined that ERM's alternative invertebrate TRVs for *Cu* and *Pb* should not be accepted, given that peer-reviewed literature suggesting a TRV of 40 mg/kg/ DW *Cu* is more appropriate for the protection of earthworms (Ma, 2005). Also, an alternative invertebrate TRV of 88 mg/kg DW *Pb* must be used in the calculation of the EISCs for the site based on additional literature (Inouye et al., 2006). A determination was made that the proposed mammalian TRV for *Cu* did not represent the lowest observed adverse effect level (LOAEL) required by MTCA. MTCA TRVs were used to calculate EISCs for the shrew, vole, and robin.

Based on TRVs accepted and approved by Ecology, soil cleanup levels (CULs) have been developed for the protection of terrestrial organisms at the Holden Mine Site. Please see Tables E-1 and E-2 for accepted and approved terrestrial TRVs and CULs. Final CULs will be determined using these terrestrial CULs, human health CULs, and site-specific background information.

Ecologically Protective Cleanup Levels

Cleanup levels presented in Table E-2 of this memo were calculated/selected using procedures consistent with the site-specific Terrestrial Ecological Evaluation (TEE) methods specified in WAC 173-340-7493. The following ecologically protective cleanup levels are based on conditions which currently exist at the Holden Mine site. The cleanup levels have not been changed to reflect natural background concentrations of metals at the site and are not necessarily protective of human health. The selected cleanup levels are protective of the range of potential ecological receptors identified by the resource agencies associated with Holden Mine. Specifically, cleanup levels were chosen that are protective of voles, shrews, hares, robins, deer, and grouse as well as soil invertebrates and plant species. A single cleanup level is provided for each of the nine areas of interest (AOIs) comprising the Holden Mine site. The lowest value determined to be protective of each of species/group was selected as the cleanup level for the area. Where site-specific values were available and evaluated at the site, site-specific cleanup levels were calculated using Ecology's Wildlife Exposure Model for predators (*Equation 1*) and herbivores (*Equation 2*). Cleanup levels that are protective of plants and soil invertebrates found on the site were determined using a combination of values provided in MTCA [Table 749-3, Ecological Indicator Soil Concentrations (EISCs)] and EPA Ecological Soil Screening Level (ECO-SSL) documents. Where site-specific information was available, soil cleanup levels were calculated for invertebrates and plants using the equation provided below (*Equation 3*).

MTCA Wildlife EISC formulas:

Equation 1

$$EISC_{ay} = TRV_{ay}/[(FIR_a \times P_a \times BAF_y)+(SIR_a \times RGAF_y)]$$

Equation 2

$EISC_{ay} = TRV_{ay}/[(FIR_a \times P_a \times K_{Plant})+(SIR_a \times RGAF_y)]$

Plant & Invertebrate EISC formula using tissue-based TRVs

Equation 3
$EISC_{plant\ or\ Invert.} = TRV_{tissue}/BAF_y$

$EISC_{ay}$ = ecological indicator soil concentrations for receptor a & chemical y (mg/kg)

TRV_{ay} = toxicity reference value for receptor a & chemical y (mg/kg/d)

FIR_a = food ingestion rate for receptor a (kg DW/kg BW/d)

P_a = proportion of contaminated food in diet for receptor a (unitless)

BAF_y = bioaccumulation factor for chemical y
different BAF (e.g., K_{plant}) are available for different tissue types (unitless)

SIR_a = soil ingestion rate for receptor a (kg DW/kg BW/d)

$RGAF_y$ = gut absorption factor for chemical y in soil (unitless); assumed to be 1

Procedure for Selection of Ecologically Protective Cleanup Levels

In developing the soil CULs, Ecology relied on the following:

- November 2007. Model Toxics Control Act (MTCA) Statute and Regulation (Chapters 173-340-7490 through 173-340-7494). Ecology Publication No. 94-06.
- EPA's website on Ecological Screening Levels, http://www.epa.gov/ecotox/ecossl/, including the referenced chemical-specific publications

The following hierarchy of criteria was used for selecting cleanup levels within each ecological category (plant, soil invertebrate, or wildlife):

a. Site-Specific EISC: If a site-specific EISC was calculated based on field sampling, this value was considered the most reliable value and selected as a cleanup level.
b. EPA ECO-SSL: Ecology will likely incorporate these values into a future rule, given that they represent a wider body of more recent data than MTCA EISCs. If no site-specific EISC was calculated, then EPA ECO-SSLs (for plants and soil invertebrates only) were the preferred default cleanup level. Because EPA uses

a different wildlife exposure model than MTCA, EPA ECO-SSL values were not used as default wildlife cleanup level.

c. MTCA EISCs: MTCA EISCs were used only in cases where site-specific EISCs or EPA ECO-SSLs were not available.

Once the data was narrowed down to three cleanup levels [one cleanup level protective of each of the three ecological categories (plants, soil invertebrates, and wildlife)], the lowest of the three values was selected as the final risk-based cleanup level protective of terrestrial ecological receptors. Footnotes on Table E-2 summarize the origin of the cleanup levels.

Table E-1. Approved TRVs

Constituents of Concern (mg/kg)	Proposed plant tissue-based TRVs (mg/kg tissue)(a)	Approved plant tissue-based TRVs (mg/kg tissue)	Proposed soil invertebrate tissue-based TRVs (mg/kg tissue)(a)	Approved soil invertebrate tissue-based TRVs (mg/kg tissue)	Proposed small mammal dose-based TRVs (mg/kg body wt/d)(a)	Approved small mammal dose-based TRVs (mg/kg body wt/d)
Aluminum	125	70			100	100
Arsenic						
Barium						
Cadmium						
Chromium						
Copper	16	16	61	40	136	used MTCA values instead
Lead	35	35	120	88		
Mercury	0.29	0.29			--	
Molybdenum	2.33	2.33			--	
Selenium						
Silver						
Thallium	11	11			0.074	0.074
Zinc	176	used MTCA values instead				

(a) TRVs from the following two reports: September 2009. Draft Proposed Alternative Toxicity Reference Values for Copper, Thallium, and Aluminum in Support of the Holden Mine Site Terrestrial Ecological Evaluations. ERM. And November 2009. Draft Proposed Alternative Toxicity Reference Values for Lead, Mercury, Molybdenum, and Zinc in Support of the Holden Mine Site Terrestrial Ecological Evaluations. ERM. See Table E-3 for further detail.

Table E-2. Approved Ecologically Protective Levels for the Holden Mine Site (not considering background or human health pathways)

Metal	Tailings Piles	Honeymoon Heights	East & West Waste Rock Piles	Wind-blown Tailings Area	Downslope Honeymoon Heights	Holden Village	Ballfield	Lower West Area - West	Lower West Area - East
Aluminum	**4369**	**69**	**69**	**4666**	**4822**	**4571**	**4600**	**4767**	**4694**
Arsenic	**(18)**[a]	**(18)**[a]	**(18)**[a]	**(18)**[a]	**(18)**[a]	**(18)**[a]	**(18)**[a]	**(18)**[a]	**(18)**[a]
Barium	**(330)**[b]	**102**	**102**	**232**	**106**	**131**	**227**	**49**	**122**
Cadmium	**5.5**	**14**	**14**	**9**	**13.5**	**16**	**8**	**5**	**12**
Chromium	**29**	**29**	**29**	**(42)**[c]	**29**	**29**	**29**	**29**	**29**
Copper	**85**	**46**	**46**	**85**	**288**	**112**	**46**	**24**	**39**
Lead	**161**	**118**	**118**	**139**	**201**	**124**	**201**	**201**	**121**
Mercury	**(0.1)**[d]	**(0.1)**[d]	**(0.1)**[d]	**(0.1)**[d]	**(0.1)**[d]	**(0.1)**[d]	**(0.1)**[d]	**(0.1)**[d]	**(0.1)**[d]
Molybdenum	**18.6**	**2.3**	**2.3**	**6.0**	**5.5**	**0.7**	**0.3**	**0.8**	**1.2**
Selenium	**(0.5)**[a]	**0.31**	**0.31**	**(0.5)**[a]	**(0.5)**[a]	**(0.5)**[a]	**0.44**	**(0.5)**[a]	**(0.5)**[a]
Silver	**18.5**	**3.9**	**3.9**	**11.9**	**3.9**	**3.9**	**16.5**	**3.9**	**8.5**
Thallium	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Zinc	**(120)**[b]	**(120)**[b]	**(120)**[b]	**(120)**[b]	**(120)**[b]	**(120)**[b]	**(120)**[b]	**(120)**[b]	**(120)**[b]

Footnotes: **( )** Parentheses indicate the cleanup level is based on a regulatory value. All other values are based on site specific information.

a Acceptable use of EPA ECO-SSL plant value.
b Acceptable use of EPA ECO-SSL invertebrate value.
c MTCA plant EISC.
d MTCA invertebrate EISC.
e MTCA wildlife EISC.
***** Soil invertebrate values are not available. Therefore, it is unknown whether the final EISC values are protective of soil invertebrates.

Table E-3. Origin of Selected Levels in Table 1

Constituent	Origin of Selected Cleanup Levels in Table 1
Aluminum	Used site-specific BAFs based on robin, grouse, and shrew consuming invertebrates except HH and E&W WRP (only conifer tissue available) which used default MTCA BAFs for grass, shrub, and invert.
Arsenic	Based on a substitution of MTCA plant EISC with EPA ECO SSL values for plants.
Barium	Based on voles consuming shrubs, except Honeymoon Heights and East & West Waste Rock Piles (only conifer tissue available) which used default MTCA BAFs for grass, conifer, and invertebrates. Cleanup levels for the Tailings Pile are based on a substitution of EPA ECO-SSL values for invertebrates.
Cadmium	Based on shrews inhabiting each of the areas with the exception of Downslope Honeymoon Heights where the cleanup level is based on grouse. MTCA plant EISC values were not used because higher EPA ECO-SSL values for plants are available.
Chromium	Based on grouse consuming vegetation and used default MTCA BAFs, except for the Windblown Tailings area where the MTCA plant and soil invertebrates value was used.
Copper	Based on the most conservative site-specific EISC values for plants or invertebrates.
Lead	Based on site–specific ISCs generated for grouse in all areas except for Honeymoon Heights and the East & West Waste Rock Piles where the site-specific values for robins were used.
Mercury	Based on the MTCA invertebrate EISC.
Molybdenum	Cleanup levels based on site-specific ISC for plants.
Selenium	MTCA plant EISC except at Honeymoon Heights, East & West Waste Rock Piles, and Wilderness Boundary/Ballfield where shrew consuming invertebrates (BAFs were MTCA default for Honeymoon Heights and East & West Waste Rock Piles and site-specific for Wilderness Boundary/Ballfield).
Silver	Based on robins inhabiting each of the areas with the exception the Tailings Pile area where the cleanup level is based on voles. MTCA plant EISC values were not used because higher EPA ECO-SSL values for plants are available.
Thallium	Based mainly on shrews consuming invertebrates (using MTCA default BAF) except for Tailings Pile area where the cleanup level is based on voles.
Zinc	Based on the acceptable use of EPA ECO-SSL values for invertebrates.

Table E-4. MTCA EISCs and EPA ECO-SSLs

	MTCA Default EISCs (a)			EPA ECO-SSLs (b)	
Constituents of Concern (mg/kg)	Plants (mg/kg soil)	Soil biota (mg/kg soil)	Wildlife (mg/kg soil)	Plants (mg/kg soil)	Soil invertebrates (mg/kg soil)
Aluminum	50	--	--	pH dependent	pH dependent
Arsenic	10	60	132	18	---
Barium	500	--	102	---	330
Cadmium	4	20	14	32	140
Chromium	42	42	67	---	---
Copper	100	50	217	70	80
Lead	50	500	118	120	1,700
Mercury	0.3	0.1	5.5	---	---
Molybdenum	2	--	7	---	---
Selenium	1	70	0.3	0.52	4.1
Silver	2	--	--	560	---
Thallium	1	--	--	---	---
Zinc	86	200	360	160	120

(a) MTCA Default EISCs come from Table 7493, WAC 173-340-900.

(b) EPA ECO-SSLs are found at http://www.epa.gov/ecotox/ecossl/

Table E-5 - Final Cleanup Levels

Using a Comparison of Terrestrial and Human Health Risk-BasedConcentrations and Background

Holden Mine Site, Chelan County, WA

	Final CULs for each Area of Interest (AOI)									Background		Human Health Criteria		
Metal	Tailings Piles	Honeymoon Heights	E&W Waste Rock Piles	Wind-blown Tailings Area	Downslope Honeymoon Heights	Holden Village	Wilderness Boundary/Ballfield	Lower West Area - West	Lower West Area - East	Mixed Conifer Background Area	Riparian Background Area	Human Health MTCA Method A Soil Cleanup Levels	Human Health MTCA Method B Soil Cleanup Levels for Soil Ingestion	Human Health MTCA Method B Soil Cleanup Levels for Soil Ingestion and Dermal Contact
Aluminum *	(18200)g	(18200)g	(18200)g	(18200)g	(17600)h	(18200)g	(18200)g	(17600)h	(17600)h	18,200	17,600	--	--	--
Arsenic	(4.8)gi	(4.8)gi	(4.8)gi	(4.8)gi	(16)hi	(4.8)gi	(4.8)gi	(16)hi	(16)hi	4.80	16.0	20.0	0.670	0.620
Barium	(330)b	(164)g	(164)g	232	(133)h	(164)g	227	49	(133)h	164	133	--	5,600	5,000
Cadmium	5.5	14	14	9	14	16	8	5	12	3.30	1.80	2.00 (f)	80.0	74.0
Chromium	29	29	29	(42)c	(38)h	29	29	(38)h	(38)h	24.0	38.0	2,000 (f)	120,000	110,000
Copper	85	46	46	85	288	112	46	(110)h	(110)h	45.0	110	--	2,960	2,700
Lead	161	118	118	139	201	124	201	201	121	14.0	25.0	250	--	--
Mercury	(0.93)g	(0.93)g	(0.93)g	(0.93)g	(0.43)h	(0.93)g	(0.93)g	(0.43)h	(0.43)h	0.930	0.430	2.00 (f)	24.0	18.0
Molybdenum *	18.6	(8.8)g	(8.8)g	(8.8)g	5.5	(8.8)g	(8.8)g	(2.9)h	(2.9)h	8.80	2.90	--	400	360
Selenium	(12)g	(12)g	(12)g	(12)g	(1.4)h	(12)g	(12)g	(1.4)h	(1.4)h	12.0	1.40	--	400	360
Silver *	18.5	3.9	3.9	11.9	3.9	3.9	16.5	3.9	8.5	0.650	0.600	--	400	360
Thallium *	(0.36)g	(0.36)g	(0.36)g	(0.36)g	(0.13)h	(0.36)g	(0.36)g	(0.13)h	(0.13)h	0.360	0.130	--	5.60	5.00
Zinc	(136)g	(136)g	(136)g	(136)g	(177)h	(136)g	(136)g	(177)h	(177)h	136	177	--	24,000	22,000

Footnotes:

a Acceptable use of EPA ECO-SSL plant value.

b Acceptable use of EPA ECO-SSL Invert value.

c MTCA plant EISC.

d MTCA invert EISC.

e MTCA wildlife EISC.

f Value is based on protection of groundwater (WAC 173-340-900, Table 740-1). These values are provided for reference.

g Mixed conifer background concentration used if greater than terrestrial risk-based concentration.

h Riparian background concentration used if greater than terrestrial risk-based concentration.

i Human health criteria comparison results in lowering cleanup level to human health criteria or background, whichever is higher.

***** Soil invertebrate values are not available. Therefore, it is unknown whether the final EISC values are protective of soil invertebrates.

Table E-6 - Derivation of Ecology Approved Risk-Based Levels for Protection of Terrestrial Organisms (see following tables)

PROCEDURE:

1. The following hierarcy of criteria was used for selecting ecological risk-based levels:

a. site-specific EISC

b. EPA ECO-SSL

c. MTCA EISC

2. Within the plant category, select the appropriate EISC for plants using the above hierarchy (selected value shaded).

3. Repeat for a soil invertebrates EISC (selected value shaded).

4. Repeat for a wildlife EISC. However, use site-specific EISCs and MTCA EISCs only. Do not use EPA's wildlife ECO-SSLs because they use a different wildlife exposure model tha in MTCA (selected value shaded).

5. Now that you have narrowed the data down to three EISCs [one EISC protective of each of the three critter categories (plants, soil invertebrates, and wildlife)], choose the lowest of the three values as your final risk-based level protective of terrestrial organisms.

NOTES:

* Al, Mo, Ag, Tl do not have soil invertebrate values. Therefore,it is uncertain whether the final EISC value is protective of soil invertebrates .

TAILINGS PILES

		MTCA EISC	EPA ECO-SSL	Site Specific EISC
Al	plants	50	na	4901
*	inverts	na	na	na
	wildlife	na	na	4369
As	plants	10	18	na
	inverts	60	na	na
	wildlife	132	na	131.83
Ba	plants	500	na	na
	inverts	na	330	na
	wildlife	102	na	457
Cd	plants	4	32	na
	inverts	20	140	na
	wildlife	14	na	5.52
Cr	plants	42	na	na
	inverts	42	na	na
	wildlife	67	na	29.05
Cu	plants	100	70	112.8
	inverts	50	80	85
	wildlife	217	na	207.68
Pb	plants	50	120	1205.6
	inverts	500	1700	1101.5
	wildlife	118	na	160.89
Hg	plants	0.3	na	3.4
	inverts	0.1	na	na
	wildlife	5.5	na	5.5
Mo	plants	2	na	18.6
	inverts	na	na	na
	wildlife	7	na	49.73
Se	plants	1	0.52	na
	inverts	70	4.1	na
	wildlife	0.3	na	4.43
Ag	plants	2	560	na
	inverts	na	na	na
	wildlife	na	na	18.45
Tl	plants	1	na	10.9
	inverts	na	na	na
	wildlife	na	na	0.02
Zn	plants	86	160	na
	inverts	200	120	na
	wildlife	360	na	403.14

HONEYMOON HEIGHTS

		MTCA EISC	EPA ECO-SSL	Site Specific EISC
Al	plants	50	na	69.3
*	inverts	na	na	na
	wildlife	na	na	96.2
As	plants	10	18	na
	inverts	60	na	na
	wildlife	132	na	131.83
Ba	plants	500	na	na
	inverts	na	330	na
	wildlife	102	na	102.13
Cd	plants	4	32	na
	inverts	20	140	na
	wildlife	14	na	14.43
Cr	plants	42	na	na
	inverts	42	na	na
	wildlife	67	na	29.05
Cu	plants	100	70	552.3
	inverts	50	80	45.5
	wildlife	217	na	217.28
Pb	plants	50	120	446.8
	inverts	500	1700	127.5
	wildlife	118	na	118
Hg	plants	0.3	na	3.4
	inverts	0.1	na	na
	wildlife	5.5	na	5.5
Mo	plants	2	na	2.3
	inverts	na	na	na
	wildlife	7	na	7.24
Se	plants	1	0.52	na
	inverts	70	4.1	na
	wildlife	0.3	na	0.31
Ag	plants	2	560	na
	inverts	na	na	na
	wildlife	na	na	3.91
Tl	plants	1	na	10.9
	inverts	na	na	na
	wildlife	na	na	0.01
Zn	plants	86	160	na
	inverts	200	120	na
	wildlife	360	na	359.03

E&W WASTE ROCK PILES

		MTCA EISC	EPA ECO-SSL	Site Specific EISC
Al	plants	50	na	69.3
*	inverts	na	na	na
	wildlife	na	na	96.2
As	plants	10	18	NA
	inverts	60	na	NA
	wildlife	132	na	131.83
Ba	plants	500	na	na
	inverts	na	330	na
	wildlife	102	na	102.13
Cd	plants	4	32	na
	inverts	20	140	na
	wildlife	14	na	14.43
Cr	plants	42	na	na
	inverts	42	na	na
	wildlife	67	na	29.05
Cu	plants	100	70	800
	inverts	50	80	45.5
	wildlife	217	na	217.28
Pb	plants	50	120	7446.8
	inverts	500	1700	127.5
	wildlife	118	na	118
Hg	plants	0.3	na	3.4
	inverts	0.1	na	na
	wildlife	5.5	na	5.5
Mo	plants	2	na	2.3
	inverts	na	na	na
	wildlife	7	na	7.24
Se	plants	1	0.52	na
	inverts	70	4.1	na
	wildlife	0.3	na	0.31
Ag	plants	2	560	na
	inverts	na	na	na
	wildlife	na	na	3.91
Tl	plants	1	na	10.9
	inverts	na	na	na
	wildlife	na	na	0.01
Zn	plants	86	160	na
	inverts	200	120	na
	wildlife	360	na	359.03

WIND-BLOWN TAILINGS AREA

		MTCA EISC	EPA ECO-SSL	Site Specific EISC
Al	plants	50	na	5860.5
*	inverts	na	na	na
	wildlife	na	na	4666
As	plants	10	18	na
	inverts	60	na	na
	wildlife	132	na	131.83
Ba	plants	500	na	na
	inverts	na	330	na
	wildlife	102	na	231.78
Cd	plants	4	32	na
	inverts	20	140	na
	wildlife	14	na	8.81
Cr	plants	42	na	na
	inverts	42	na	na
	wildlife	67	na	177.61
Cu	plants	100	70	84.5
	inverts	50	80	114.1
	wildlife	217	na	172.81
Pb	plants	50	120	729.1
	inverts	500	1700	1600
	wildlife	118	na	138.25
Hg	plants	0.3	na	3.4
	inverts	0.1	na	na
	wildlife	5.5	na	5.5
Mo	plants	2	na	6
	inverts	na	na	na
	wildlife	7	na	18.2
Se	plants	1	0.52	na
	inverts	70	4.1	na
	wildlife	0.3	na	1.74
Ag	plants	2	560	na
	inverts	na	na	na
	wildlife	na	na	11.87
Tl	plants	1	na	10.9
	inverts	na	na	na
	wildlife	na	na	0.01
Zn	plants	86	160	na
	inverts	200	120	na
	wildlife	360	na	376.87

DOWNSLOPE HONEYMOON HEIGHTS

		MTCA EISC	EPA ECO-SSL	Site Specific EISC
Al	plants	50	na	5760.6
*	inverts	na	na	na
	wildlife	na	na	4822
As	plants	10	18	na
	inverts	60	na	na
	wildlife	132	na	131.83
Ba	plants	500	na	na
	inverts	na	330	na
	wildlife	102	na	105.91
Cd	plants	4	32	na
	inverts	20	140	na
	wildlife	14	na	13.49
Cr	plants	42	na	na
	inverts	42	na	na
	wildlife	67	na	29.05
Cu	plants	100	70	289.16
	inverts	50	80	288.4
	wildlife	217	na	329.16
Pb	plants	50	120	7446.8
	inverts	500	1700	3513.2
	wildlife	118	na	201
Hg	plants	0.3	na	3.4
	inverts	0.1	na	na
	wildlife	5.5	na	5.5
Mo	plants	2	na	5.5
	inverts	na	na	na
	wildlife	7	na	16.58
Se	plants	1	0.52	na
	inverts	70	4.1	na
	wildlife	0.3	na	3.01
Ag	plants	2	560	na
	inverts	na	na	na
	wildlife	na	na	3.91
Tl	plants	1	na	10.9
	inverts	na	na	na
	wildlife	na	na	0.01
Zn	plants	86	160	na
	inverts	200	120	na
	wildlife	360	na	777.67

HOLDEN VILLAGE

		MTCA EISC	EPA ECO-SSL	Site Specific EISC
Al	plants	50	na	7749
*	inverts	na	na	na
	wildlife	na	na	4571
As	plants	10	18	na
	inverts	60	na	na
	wildlife	132	na	131.83
Ba	plants	500	na	na
	inverts	na	330	na
	wildlife	102	na	131.28
Cd	plants	4	32	na
	inverts	20	140	na
	wildlife	14	na	16.38
Cr	plants	42	na	na
	inverts	42	na	na
	wildlife	67	na	29.05
Cu	plants	100	70	112.1
	inverts	50	80	159.5
	wildlife	217	na	206.99
Pb	plants	50	120	540.8
	inverts	500	1700	1106.8
	wildlife	118	na	124.49
Hg	plants	0.3	na	3.4
	inverts	0.1	na	na
	wildlife	5.5	na	5.5
Mo	plants	2	na	0.7
	inverts	na	na	na
	wildlife	7	na	2.27
Se	plants	1	0.52	na
	inverts	70	4.1	na
	wildlife	0.3	na	3.25
Ag	plants	2	560	na
	inverts	na	na	na
	wildlife	na	na	3.91
Tl	plants	1	na	10.9
	inverts	na	na	na
	wildlife	na	na	0.01
Zn	plants	86	160	na
	inverts	200	120	na
	wildlife	360	na	446.61

BALLFIELD AREA

		MTCA EISC	EPA ECO-SSL	Site Specific EISC
Al	plants	50	na	9135
*	inverts	na	na	na
	wildlife	na	na	4600
As	plants	10	18	na
	inverts	60	na	na
	wildlife	132	na	131.83
Ba	plants	500	na	na
	inverts	na	330	na
	wildlife	102	na	226.8
Cd	plants	4	32	na
	inverts	20	140	na
	wildlife	14	na	7.84
Cr	plants	42	na	na
	inverts	42	na	na
	wildlife	67	na	29.05
Cu	plants	100	70	94
	inverts	50	80	45.3
	wildlife	217	na	185.32
Pb	plants	50	120	7446.8
	inverts	500	1700	2112
	wildlife	118	na	200.96
Hg	plants	0.3	na	3.4
	inverts	0.1	na	na
	wildlife	5.5	na	5.5
Mo	plants	2	na	0.3
	inverts	na	na	na
	wildlife	7	na	0.98
Se	plants	1	0.52	na
	inverts	70	4.1	na
	wildlife	0.3	na	0.44
Ag	plants	2	560	na
	inverts	na	na	na
	wildlife	na	na	16.45
Tl	plants	1	na	10.9
	inverts	na	na	na
	wildlife	na	na	0.01
Zn	plants	86	160	na
	inverts	200	120	na
	wildlife	360	na	481.75

LOWER WEST AREA-WEST

		MTCA EISC	EPA ECO-SSL	Site Specific EISC
Al	plants	50	na	8217.3
*	inverts	na	na	na
	wildlife	na	na	4767
As	plants	10	18	na
	inverts	60	na	na
	wildlife	132	na	176.35
Ba	plants	500	na	na
	inverts	na	330	na
	wildlife	102	na	49.31
Cd	plants	4	32	na
	inverts	20	140	na
	wildlife	14	na	5.06
Cr	plants	42	na	na
	inverts	42	na	na
	wildlife	67	na	29.05
Cu	plants	100	70	76.8
	inverts	50	80	23.6
	wildlife	217	na	114
Pb	plants	50	120	7446.8
	inverts	500	1700	2640
	wildlife	118	na	200.96
Hg	plants	0.3	na	3.4
	inverts	0.1	na	na
	wildlife	5.5	na	5.5
Mo	plants	2	na	0.8
	inverts	na	na	na
	wildlife	7	na	2.64
Se	plants	1	0.52	na
	inverts	70	4.1	na
	wildlife	0.3	na	1.28
Ag	plants	2	560	na
	inverts	na	na	na
	wildlife	na	na	3.91
Tl	plants	1	na	10.9
	inverts	na	na	na
	wildlife	na	na	0.01
Zn	plants	86	160	na
	inverts	200	120	na
	wildlife	360	na	237.33

LOWER WEST AREA-EAST

		MTCA EISC	EPA ECO-SSL	Site Specific EISC
Al	plants	50	na	6034.2
*	inverts	na	na	na
	wildlife	na	na	4694
As	plants	10	18	na
	inverts	60	na	na
	wildlife	132	na	74.61
Ba	plants	500	na	na
	inverts	na	330	na
	wildlife	102	na	121.62
Cd	plants	4	32	na
	inverts	20	140	na
	wildlife	14	na	11.59
Cr	plants	42	na	na
	inverts	42	na	na
	wildlife	67	na	29.05
Cu	plants	100	70	38.5
	inverts	50	80	132.8
	wildlife	217	na	95.89
Pb	plants	50	120	509
	inverts	500	1700	2485
	wildlife	118	na	121.38
Hg	plants	0.3	na	3.4
	inverts	0.1	na	na
	wildlife	5.5	na	5.5
Mo	plants	2	na	1.2
	inverts	na	na	na
	wildlife	7	na	3.74
Se	plants	1	0.52	na
	inverts	70	4.1	na
	wildlife	0.3	na	1.65
Ag	plants	2	560	na
	inverts	na	na	na
	wildlife	na	na	8.53
Tl	plants	1	na	10.9
	inverts	na	na	na
	wildlife	na	na	0.01
Zn	plants	86	160	na
	inverts	200	120	na
	wildlife	360	na	374.87

LAGOON, MAINTENANCE YARD, & SRA

		MTCA EISC	EPA ECO-SSL	Site Specific EISC
Al	plants	50	na	na
*	inverts	na	na	na
	wildlife	na	na	na
As	plants	10	18	na
	inverts	60	na	na
	wildlife	132	na	na
Ba	plants	500	na	na
	inverts	na	330	na
	wildlife	102	na	na
Cd	plants	4	32	na
	inverts	20	140	na
	wildlife	14	na	na
Cr	plants	42	na	na
	inverts	42	na	na
	wildlife	67	na	na
Cu	plants	100	70	na
	inverts	50	80	na
	wildlife	217	na	na
Pb	plants	50	120	na
	inverts	500	1700	na
	wildlife	118	na	na
Hg	plants	0.3	na	na
	inverts	0.1	na	na
	wildlife	5.5	na	na
Mo	plants	2	na	na
	inverts	na	na	na
	wildlife	7	na	na
Se	plants	1	0.52	na
	inverts	70	4.1	na
	wildlife	0.3	na	na
Ag	plants	2	560	na
	inverts	na	na	na
	wildlife	na	na	na
Tl	plants	1	na	na
	inverts	na	na	na
	wildlife	na	na	na
Zn	plants	86	160	na
	inverts	200	120	na
	wildlife	360	na	na
TPH-G	plants	na	na	na
	inverts	100	na	na
	wildlife	5000	na	na
TPH-D &	plants	na	na	na
TPH-HO	inverts	200	na	na
	wildlife	6000	na	na

APPENDIX F
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA

APPENDIX F
POTENTIAL ARARS AND TBCS FOR THE HOLDEN MINE SITE

OVERVIEW

This Appendix combines the list of potential Applicable or Relevant and Appropriate Requirements (ARARs) and "to-be-considered" (TBCs) criteria provided in the Supplemental Feasibility Study (SFS, Forest Service 2007) and in the main text of the Addendum to the Supplemental Feasibility Study (ASFS, Forest Service 2010), to provide a complete list of all currently identified potential ARARs and TBCs for the Holden Mine Site (Site) in a single document. Numerical values associated with potential chemical-specific ARARs and TBCs are provided in the SFS and ASFS.

1.0 Potential Applicable or Relevant and Appropriate Requirements (ARARs)

This Appendix provides a preliminary identification of potential ARARs and TBCs for the Site. The following sections define potential ARARs and TBCs and discuss them in terms of environmental medium and type of criteria (chemical-specific, action-specific, and location-specific).

1.1 Definitions

1.1.1 Potential ARARs

ARARs are defined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 CFR Part 300]. "Applicable" requirements are those cleanup standards and other environmental protection requirements promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. While not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site, "relevant and appropriate" requirements address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the site. ARARs are potential or preliminary until finalized in a Record of Decision (ROD).

ARARs fall into three broad categories, based on the manner in which they are applied: chemical-, action-, and location-specific. Cleanup levels are based on the most stringent potential ARAR, where more than one potential ARAR exists. In general, only the substantive requirements of an ARAR need to be implemented at the Site.

- Chemical-specific ARARs include requirements that regulate the release to, or presence in, the environment of materials with certain chemical or physical characteristics, or containing specified chemical compounds. The requirements are usually either health- or risk-based numerical values or methodologies that establish the acceptable amount or concentration of a chemical that may remain in or be discharged to the environment.

- Action-specific ARARs set performance, design, or similar controls or restrictions on particular kinds of activities related to the management of hazardous substances, pollutants, or contaminants. The ARARs are activated by the particular remedial action selected for implementation, and indicate how, or to what level, the alternative must achieve the requirements.

- Location-specific ARARs are restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. They relate to the geographic or physical position of the site. Remedial actions may be restricted or precluded depending on the location or characteristics of the site and the requirements that apply to it. Location-specific ARARs may apply to actions in natural or man-made features. Examples of natural site features include wetlands and floodplains. An example of a man-made feature is an archaeological site.

1.1.2 ARAR Waiver

The NCP provides for the waiver of ARARs under certain circumstances [40 CFR § 300.430(f)(1)(ii)(C)]. For example, an ARAR may be waived if "compliance with the requirement [ARAR] is technically impracticable from an engineering perspective" [40 CFR § 300.430(f)(1)(ii)(C)(3)].

1.1.3 TBCs

TBCs are non-promulgated criteria, advisories, guidance, and proposed standards issued by federal, state, or tribal governments that, although not legally enforceable, may be helpful in establishing protective cleanup levels and developing, evaluating, or implementing remedy alternatives. If no ARARs address a particular chemical or situation, or if existing ARARs do not provide adequate information, TBCs are available for use in developing remedial alternatives.

1.2 State Regulations

Under CERCLA, State of Washington cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated by the State of Washington are potential ARARs. Determination of whether these State of Washington standards, requirements, criteria, and limitations become ARARs is conducted using the eligibility criteria set forth in Section 121 of CERCLA (i.e., the requirements are promulgated, legally enforceable, generally applicable, more stringent than federal requirements, and identified in a timely manner). The state is working closely with the federal agencies on the identification of potential ARARs, under CERCLA guidelines.

The state is also exercising its independent cleanup authority for this Site under the Model Toxics Control Act (MTCA), which is applicable to the Site according to state law [RCW 70.105D]. MTCA sets forth various ways to determine the numeric values for ARARs (i.e., cleanup levels) for surface water, groundwater, and soil. This includes using tables with cleanup standards for individual contaminants [Washington Administrative Code (WAC) 173-340-704] and methods for addressing multiple contaminants and pathways [WAC 173-340-705, -706, and -708].

1.3 Site-Specific Potential ARARs

Potential ARARs for the Site are discussed in this subsection under the following categories:

- Potential Chemical-Specific ARARs
    - Surface Water Quality
    - Groundwater Quality
    - Soil Quality

- Potential Action-Specific ARARs

- Potential Location-Specific ARARs

A discussion of TBCs follows the discussion of potential ARARs.

1.3.1 Potential Chemical-Specific ARARs

1.3.1.1 Surface Water Quality

The State of Washington regulations [WAC 173-201A-200 and -600] require that the surface water bodies at the Site, Railroad Creek and Copper Creek, be protected for their designated beneficial uses.

Potential chemical-specific ARARs for surface water are discussed below.

A. **National Recommended Water Quality Criteria [Federal Water Pollution Control Act (Clean Water Act) 33 USC § 1251 et seq., Section 304(a)].** The National Recommended Water Quality Criteria (NWQC) is guidance established by the Environmental Protection Agency (EPA, 2006) for evaluating toxic effects on human health and aquatic organisms. The 2006 NWQC and the 2007 copper criterion[1] are potentially relevant and appropriate at the Site under CERCLA [Section 121(d)(2)]. The 1999 NWQC is potentially applicable to the Site [WAC 173-340-730(3)(b)(i)(B)] as these were the NWQC version available when the MTCA regulations were last updated. Even if not potentially applicable, the 1999 criteria are potentially relevant and appropriate for protection of aquatic life under MTCA [WAC 173-340-710(4)]. The 2006 NWQC and subsequent NWQC (such as the 2007 copper criterion) are potentially relevant and appropriate for protection of aquatic life under MTCA [WAC 173-340-710(4)].

B. **National Toxics Rule [40 CFR Part 131].** The National Toxics Rule (NTR) established numeric water quality standards for protection of human health and aquatic organism for states that failed to fully comply with Section 303(c)(2)(C) of the Clean Water Act (CWA). The State of Washington is required to comply with certain standards in the NTR [40 CFR § 131.36(d)(14)], and MTCA identifies the NTR as a potential ARAR [WAC 173-340-730(3)(b)(i)(C)]. The NTR standards mandated for Washington are potentially applicable for the Site.

C. **Maximum Contaminant Levels [40 CFR Part 141].** Under the Safe Drinking Water Act [SDWA; 42 USC § 300 et seq.], EPA establishes health goals based on risk and sets legal limits—maximum contaminant levels (MCLs)—to help ensure consistent quality of the water supply. Since surface water at

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[1] The Aquatic Life Ambient Freshwater Quality Criteria–Copper 2007 Revision (EPA 2007), (the "2007 copper criterion") was published in the Federal Register on February 22, 2007. The 2007 copper criterion provides a basis to determine acute and chronic concentrations for protection of aquatic organisms based on the Biotic Ligand Model. The model determines concentrations that are protective based on an analysis of ambient conditions for a number of parameters. To date, relatively few data have been collected at the Site to provide a basis for predicting acute and chronic copper concentrations for Railroad Creek under this criterion. The Agencies anticipate the cleanup level established at the time of the ROD would be based on the background concentration for dissolved copper in accordance with WAC 173-340-730(5)(c), and that this could be modified in accordance with ARARs based on additional data collection following implementation of the remedy.

the Site is potable under MTCA [Chapter 173-340 WAC], the federal MCLs are potentially relevant and appropriate.

D. **National Maximum Contaminant Level Goals [40 CFR Part 141].** Under the SDWA [42 USC § 300 et seq.], EPA has established health-based MCL goals (MCLGs) for public water systems. Non-zero MCLGs are potentially relevant and appropriate for surface water at the Site.

E. **Washington State Drinking Water Standards [RCW 70.119A; Chapter 246-290 WAC].** Washington State has established health-based MCLs to protect consumers using public water supplies. MTCA identifies state MCLs as being potentially relevant and appropriate to potential surface water sources of drinking water at the Site.

F. **Washington State Water Quality Standards for Surface Water [RCW 90.48; Chapter 173-201A WAC].** Washington State has established aquatic life criteria for hazardous substances in fresh water. These provisions and standards in Chapter 173-201A WAC are potentially applicable for the Site, including the antidegradation policy [Section 300] and the narrative criteria [Section 260].

G. **Washington State Model Toxics Control Act [RCW 70.105D; Chapter 173-340 WAC].** The Model Toxics Control Act (MTCA), including WAC 173-340-730, is a potential ARAR under CERCLA, and is applicable to the surface water at the Site under state law. In general, MTCA states that surface water cleanup standards are to be based on estimates of the highest beneficial use and their reasonable maximum exposure expected to occur under current and potential future site uses.

1.3.1.2 Groundwater Quality

CERCLA and the NCP provide that groundwater should be returned to its beneficial use within a reasonable time frame wherever practicable. When restoration of groundwater is not practicable, it is necessary to prevent further migration of the plume and prevent exposure to the contaminated groundwater [40 CFR § 300.430(a)(1)(iii)(F)]. Since groundwater recharges to surface water at the Site, the more stringent of the groundwater and surface water designated beneficial uses apply to the Site.

Potential chemical-specific ARARs for groundwater are discussed below.

A. **Maximum Contaminant Level Goals [40 CFR Part 141].** Under the SDWA [42 USC § 300 et seq.], EPA establishes health goals based on risk and sets legal limits—MCLs—to help ensure consistent quality of the water supply. Since groundwater at the Site is potable under MTCA [Chapter 173-340 WAC], the federal MCLs are potentially relevant and appropriate.

B. **National Maximum Contaminant Level Goals [40 CFR Part 141].** Under the SDWA [42 USC § 300 et seq.], EPA has established health-based MCLGs for public water systems. Non-zero MCLGs are potentially relevant and appropriate for groundwater at the Site.

C. **Washington State Drinking Water Standards [RCW 119A; Chapter 246-290 WAC].** Washington State has established health-based MCLs to protect consumers using public water supplies. MTCA identifies state MCLs as being applicable to potential groundwater sources of drinking water at the Site.

D. **Washington State Model Toxics Control Act [RCW 70.105D; Chapter 173-340 WAC].** MTCA, including WAC 173-340-720, is a potential ARAR under CERCLA, and is applicable to groundwater at the Site under state law. In general, MTCA states that groundwater cleanup standards are to be based on estimates of the highest beneficial use and the reasonable maximum exposure expected to occur under current and potential future site uses. Groundwater cleanup standards are generally set under MTCA for both protection of drinking water and for the protection of surface water uses, including, where appropriate, the protection of aquatic life and human consumption of fish.

1.3.1.3 Soil Quality

Potential chemical-specific ARARs for soil are discussed below.

A. **Washington State Model Toxics Control Act [RCW 70.105D; WAC 173-340].** MTCA, including WAC 173-340-740 (unrestricted land use soil cleanup standards), -745 (industrial cleanup standards), -747 (soil concentrations for groundwater protection), and -7490 through –7494 (terrestrial ecological evaluation), is a potential ARAR under CERCLA and is applicable to soils across the Site under state law.

1.3.1.4 Sediment Quality

At this time neither the state nor federal governments have promulgated standards for sediment quality that would be referred to as potential chemical-specific ARARs.

Chemical-specific TBCs for sediment are presented in the Interim Final Sediment Evaluation Framework for the Pacific Northwest (U.S. Army Corps of Engineers et al. 2006) and other scientific studies. The state's Sediment Management Standards are potentially relevant and appropriate to the Site since as long as there is potential for additional metals release to surface water, including (but not limited to) WAC 173-204-120, which prohibits activities that would degrade existing beneficial uses; WAC 173-204-400, which specifies procedures for managing sources of sediment contamination (including AKART[2]); and WAC 173-204-590, which addresses the establishment and monitoring of sediment recovery zones where cleanups leave sediments that exceed potentially applicable sediment quality standards.

1.3.2 Potential Action-Specific ARARs

Potential action-specific ARARs for the Site are discussed below.

A. **Washington Model Toxics Control Act [RCW 70.105D; Chapter 173-340 WAC].** MTCA establishes administrative processes and standards to identify, investigate, and clean up facilities where hazardous substances are located. MTCA is a potential ARAR under CERCLA, and is applicable to the Site under state law. MTCA, including WAC 173-340-760, is potentially applicable to sediment at the Site.

B. **Washington State Sediment Management Standards [Chapter 173-204 WAC].** The intended purposes of the sediment management standards are potentially relevant and appropriate to clean up of sediments at the Site.

C. **Regulation and Licensing of Well Contractors and Operators [RCW 18.104; Chapter 173-162 WAC].** These regulations establish procedures for the examination, licensing, and regulation of well contractors and operators. "Well" means water wells, resources protection wells, instrumentation wells, dewatering wells, and geotechnical soil borings. These requirements are potentially applicable to contractors who install and/or decommission wells and borings at the Site.

D. **Minimum Standards for Construction and Maintenance of Water Wells [RCW 18.104; Chapter 173-160 WAC].** Washington State has developed minimum standards for constructing water and monitoring wells, and for the

[2] AKART is an acronym for "all known, available and reasonable methods of prevention, control and treatment" [WAC 173-204-400]. The State of Washington uses this concept to define requirements for managing point and non-point discharges in the water quality regulations [WAC 173-201A-020].

decommissioning of wells. These standards are potentially applicable to wells constructed at the Site for water withdrawal or monitoring, and for decommissioning of Site wells.

E. **Resource Conservation and Recovery Act [42 USC § 6901], Subtitle C - Hazardous Waste Management [40 CFR Parts 260 to 279].** Federal hazardous waste regulations specify hazardous waste identification, management, and disposal requirements. These regulations are potentially applicable for generation and management of hazardous waste at the Site. Where Washington has an authorized state hazardous waste program under RCW 70.105 and Chapter 173-303 WAC, it applies in lieu of the federal program.

F. **Resource Conservation and Recovery Act [42 USC § 6901] (RCRA), Subtitle D - Managing Municipal and Solid Waste [40 CFR Parts 257 and 258].** Subtitle D of RCRA establishes a framework for controlling the management of non-hazardous solid waste. These regulations also establish guidelines and criteria from which states develop solid waste regulations. Subtitle D is potentially applicable to solid waste generation and management at the Site.

G. **Washington State Hazardous Waste Management Act and Dangerous Waste Regulations [RCW 70.105; Chapter 173-303 WAC].** Washington State Dangerous Waste regulations govern the handling and disposition of dangerous waste, including identification, accumulation, storage, transport, treatment, and disposal. Washington State has not adopted an exemption for certain mining wastes (such as the Bevill Amendment) from regulation under RCRA Subtitle C.[3] The Dangerous Waste regulations are potentially applicable to generating, handling, and managing Dangerous Waste at the Site, and would be potentially relevant and appropriate even if Dangerous Wastes are not managed during remediation. In particular, the point of compliance regulations for releases from regulated units such as landfills are potentially relevant and appropriate [WAC 173-303-645(6)].

H. **Washington State Solid Waste Handling Standards [RCW 70.95; Chapter 173-350 WAC].** Washington State Solid Waste Handling Standards apply to facilities and activities that manage solid waste. The regulations set

[3] Washington did adopt a limited exemption from the Dangerous Waste regulations for mining overburden returned to the Site. However, overburden is defined as a material used for reclaiming a surface mine and is not a discarded material within the scope of RCRA (45 FR 33000; May 19, 1980, and 67 FR 63060; October 10, 2002).

minimum functional performance standards for proper handling and disposal of solid waste; describe responsibilities of various entities; and stipulate requirements for solid waste handling facility location, design, construction, operation, and closure. Particular to the Site, tailings and waste rock pile operations ceased prior to enactment of the Solid Waste Management Act, Chapter 70.95 RCW, and before the effective date of Chapter 173-350 WAC, and the tailings and waste rock piles are not currently being operated as limited purpose landfills. However, all substantive requirements for closure and post-closure of limited purpose landfills [WAC 173-350-400] are potential ARARs [WAC 173-340-710(7)(c)]. The tailings and waste rock piles at the Site are landfills that contain solid waste and are releasing hazardous substances above both state and federal cleanup standards.[4]

This regulation is also potentially applicable or relevant and appropriate for management of excavated soil, soil-like material, and debris that will be generated during the Site cleanup. The regulation is potentially applicable to the proposed limited purpose landfill at the Site that will be used for disposal of sludge produced during long-term groundwater treatment operations.

I. **Hydraulic Code [RCW 77.55; Chapter 220-110 WAC].** The Hydraulic Code requires that any construction activity that uses, diverts, obstructs, or changes the bed or flow of state waters must be done under the terms of a Hydraulics Project Approval permit issued by Washington State Department of Fish and Wildlife (WSDFW). Depending on the selected remedial action, substantive provisions of the Hydraulic Code are potentially applicable at the Site.

J. **Federal Water Pollution Control Act--Water Quality Certification [Clean Water Act; 33 USC § 1341, Section 401].** Section 401 of the CWA provides that applicants for a license or permit to conduct any activity, including, but not limited to, the construction or operation of facilities, which may result in discharges into the navigable waters, shall obtain certification from the state that discharges will comply with applicable water quality standards. While no formal certification will be required for the Site, substantive requirements will be potentially applicable to remedial actions that require substantive compliance with federal permit equivalency (e.g., National Pollution Discharge Elimination System (NPDES), Section 404).

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[4] Portions of the MM-3 Standard (Forest Service 1990 and subsequent amendments) also include potentially relevant and appropriate requirements for management of mining wastes at the Site. These requirements are described more fully below in Section 1.3.3 as location-specific ARARs.

(Under Chapter 173-225 WAC: Federal Water Pollution Control Act - Establishment of Implementation Procedures of Application for Certification, the State of Washington designated the Washington State Department of Ecology (Ecology) as the state's water pollution control agency for purposes of processing applications for certification required under Section 401.)

K. **Federal Water Pollution Control Act--National Pollution Discharge Elimination System [Clean Water Act; 33 USC § 1342, Section 402].** The NPDES regulations establish requirements for point source discharges and stormwater runoff. In particular for the Site, these regulations are potentially applicable for any point source discharge of contaminated water (e.g., discharge following treatment of groundwater and portal drainage), stormwater runoff at the Site, and where the construction Site involves 1 acre or more.

L. **Federal Water Pollution Control Act--Discharge of Dredge and Fill Materials [Clean Water Act; 33 USC § 1344, Section 404].** Section 404 of the CWA establishes a program to regulate the discharge of dredged and fill materials into the waters of the United States, including wetlands. The substantive provisions of this requirement are potentially applicable to remedial actions involving dredging, filling, diversion, and/or construction in streams or wetlands at the Site.

M. **Water Quality Standards for Surface Waters of the State of Washington–Mixing Zones [RCW 90.48; WAC 173-201A-400].** In Washington State, mixing zones and the associated effluent limits are established in discharge permits, general permits, or orders. Mixing zones do not apply to discharges directly from the groundwater to surface water per WAC 173-340-730(6)(b). Prior to a mixing zone for a point source discharge being authorized, the discharger must fully apply AKART. This regulation is potentially applicable where the Site remedial action involves compliance with the substantive requirements of a discharge permit (i.e., NPDES).

N. **Water Quality Standards for Surface Waters of the State of Washington–Short-Term Modifications [RCW 90.48; WAC 173-201A-410].** State water quality criteria can be modified for a specific water body on a short-term basis (e.g., actual periods of non-attainment are generally limited to hours or days rather than weeks or months) when necessary to accommodate essential activities, respond to emergencies, or to otherwise protect the public interest, even though such activities may result in a temporary reduction of water quality conditions. Where the selected remedy for the Site involves activities near or in streams and wetlands that could impact water quality and cause exceedance of water quality criteria, substantive provisions of this regulation are potentially applicable.

O. **Submission of Plans and Reports for Construction of Wastewater Treatment Facilities in Washington State [RCW 90.48; Chapter 173-240 WAC].** Under this law, regulations were established requiring submission of wastewater treatment system design plans, specifications, and reports to Ecology for review and approval. The regulations also include provisions for Ecology review and approval of proposed methods for operation and maintenance, and for construction modifications. Substantive aspects of these requirements are potentially applicable to the Site under MTCA, since the remedial action involves construction of a wastewater treatment system.

P. **Aquatic Lands Management - Washington State [RCW 79.90; Chapter 332-30 WAC].** The Aquatic Lands Management law develops criteria for managing state-owned aquatic lands. Aquatic lands are to be managed to promote uses and protect resources as specified in the regulations. While not directly applicable to the Site, the criteria in the Aquatic Lands Management are potentially relevant and appropriate to remedial actions involving Railroad and/or Copper Creeks under MTCA.

Q. **Water Code and Regulation of Public Ground Waters of Washington State - Surface Water and Groundwater Withdrawal [RCW 90—90.03 and 90.44].** These laws specify the criteria and procedures for appropriating surface water and groundwater for beneficial use. Any use of surface water and groundwater (except for certain uses of less than 5,000 gallons per day of groundwater) requires a water right permit or certificate. Substantive compliance with these laws is potentially applicable to the Site under MTCA, since remedial actions involve withdrawal and/or diversion of surface water or groundwater that would otherwise require a state water rights permit or certificate.

R. **Maximum Environmental Noise Levels - Washington State [RCW 70.107; Chapter 173-60 WAC].** The Maximum Environmental Noise Levels regulations of Washington State establish maximum noise levels permissible in identified environments, and provide use standards relating to the reception of noise within these environments. These regulations are potentially applicable depending on the remedial activities selected for the Site.

S. **Clean Air Act [42 USC § 7401 et. seq.; 40 CFR Part 50].** The federal Clean Air Act creates a national framework designed to protect ambient air quality by limiting air emissions. These regulations are potentially applicable to construction activities at the Site.

T. **Washington Clean Air Act and Implementing Regulations [WAC 173-400-040(8)].** This regulation is potentially relevant and appropriate to remedial actions at the Site. It requires the owner or operator of a source of fugitive dust to take reasonable precautions to prevent fugitive dust from becoming airborne and to maintain and operate the source to minimize emissions.

U. **General Regulations for Air Pollution Sources - Washington State [RCW 70.94; Chapter 173-400 WAC].** These regulations provide for the systematic control of air pollution from air contaminant sources and for the proper development of the state's natural resources. The purpose of the regulations is to establish technically feasible and reasonably attainable standards, and to establish rules generally applicable to the control and/or prevention of the emission of air contaminants. Depending on the remedial action selected, these regulations are potentially applicable to the Site (e.g., generation of fugitive dust during remediation of soil and tailings, or emissions from equipment).

V. **National Emissions Standards for Hazardous Air Pollutants (NESHAP) - Asbestos, 40 CFR Part 61, Subpart M.** Demolition or removal of any asbestos-containing materials in the former Mill Building must comply with NESHAP requirements.

W. **Dam Safety Chapter 173-175 WAC.** This regulation provides for the comprehensive regulation and supervision of dams in order to reasonably secure safety to life and property and is potentially relevant and appropriate to the tailings piles (i.e., former tailings impoundments) at the Site.

Although not a potential ARAR under CERCLA, proposed remedial activities at the Site will need to be considered in accordance with substantive requirements of the Washington State Environmental Policy Act [SEPA: RCW 43.21C; Chapter 197-11 WAC] based on MTCA ARARs. One of the primary purposes of SEPA legislation is to ensure that state governmental agencies consider the environmental impacts of an action prior to making a decision. SEPA regulations establish a uniform method for identifying possible environmental impacts, considering mitigating measures, and reaching a decision on a proposed action.

1.3.3 Potential Location-Specific ARARs

Potential location-specific potential ARARs are discussed below.

A. **National Forest Management Act [16 USC §§ 1600 – 1614] (NFMA) and Land and Resource Management Plan for Wenatchee National Forest (LRMP, Forest Service 1990), as amended by Pacific Northwest Forest Plan (NWFP, 1994) and subsequent amendments of the NWFP (2001, 2004, and 2007).** NFMA, which is the primary statute governing the administration of National Forests, requires management based on multiple-use, sustained-yield principles. The USDA Forest Service promulgated the LRMP, as required by NFMA. Portions of the LRMP (and the NWFP amendments to the LRMP) are potentially applicable or relevant and appropriate for assessing Site remedial alternatives. The LRMP and NWFP include standards and guidelines that are potentially relevant and appropriate to actions at the Site, including activities within, or that affect Riparian Management Areas along Railroad and Copper Creeks, or are otherwise necessary to meet Aquatic Conservation Strategy (ACS) objectives. These standards and guidelines include RF-2 through RF-7, which control the design, construction, and use of temporary and permanent roads and other modifications within Riparian Reserves; and MM-3, which controls solid waste and mine waste facilities within Riparian Reserves. Particular aspects of MM-3 that are potentially relevant and appropriate to closure of the tailings and waste rock piles at the Site include requirements for: a) analysis based on best conventional methods; b) designing waste facilities using best conventional techniques to ensure mass stability and prevent the release of acid or toxic materials; and c) reclamation and monitoring waste facilities to ensure chemical and physical stability, and to meet ACS objectives.

B. **National Historic Preservation Act [16 USC § 470].** The National Historic Preservation Act (NHPA) requires federal agencies to take into account the effect of any federally assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places (NRHP) or as a National Historic Landmark. Depending on the remedial actions selected for the Site and, in particular, determination of the need for demolition of the abandoned mill building, NHPA requirements are potentially applicable and will need to be addressed during remedial design.

C. **Historic Site, Buildings, Objects, and Antiquities Act [16 USC §§ 461 - 467].** The Historic Site, Buildings, Objects, and Antiquities Act requires preservation of historic sites, buildings, and objects of national significance. This Act is potentially applicable where components of the Site listed or eligible for listing on the Historic Site, Buildings, Objects and Antiquities Federal Register will be impacted by remedial actions.

D. **Archaeological and Historic Preservation Act [16 USC § 469].** The Archaeological and Historic Preservation Act (AHPA) provides for the preservation of archaeological and historic data that might be destroyed through alteration of terrain due to a federal construction project or a federally licensed program or activity. This Act is potentially applicable to the Site where remedial activities would cause loss or adverse impacts to significant scientific, prehistoric, historic, or archaeological data.

E. **Archaeological Resources Protection Act [16 USC § 470].** The Archaeological Resources Protection Act prescribes the steps that must be taken by investigators to preserve archaeological resources. This Act is potentially applicable to the Site where remedial activities would cause loss or adverse impacts to significant scientific, prehistoric, historic, or archaeological data.

F. **Native American Graves Protection and Reparation Act [25 USC § 3001 et seq].** The Native American Graves Protection and Reparation Act protects the remains, funerary objects, and cultural artifacts of Native Americans. The requirements of this Act must be followed when graves are discovered or ground-disturbing activities encounter Native American burial sites. This Act is potentially applicable to the Site where remedial actions involve disturbance/alteration of the ground and/or site terrain.

G. **Fish and Wildlife Coordination Act [16 USC §§ 661-667].** The Fish and Wildlife Coordination Act provides that when the waters or channel of a body of water are modified by a federal entity, the department or agency must first consult with the U.S. Fish and Wildlife Service (USFWS) and with the head of the agency exercising administration over the wildlife resources of the state (WSDFW), with a view to the conservation of wildlife resources. The requirements of this Act are potentially applicable to the Site where the implementation of remedial activities involve impacts to water or stream channels.

H. **Fish and Wildlife Conservation Act [16 USC §§ 2901 - 2911].** The purpose of the Fish and Wildlife Conservation Act is to promote conservation of non-game fish and wildlife through assistance to states and use of federal authority. The requirements of this Act are potentially applicable to Site remedial activities, including action in Railroad Creek and Copper Creek involving stream diversion, dredging, and/or channel altering activities.

I. **Endangered Species Act [16 U.S.C. §§ 1531 - 1544].** The Endangered Species Act (ESA) protects species of fish, wildlife, and plants that are listed as threatened or endangered with extinction. It also protects designated critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, including consultation with resource agencies. The requirements of the ESA are potentially applicable to the Site since listed threatened or endangered species habitat areas will, or could, be impacted by remedial action. The Agencies anticipate Section 7 consultation will be completed concurrent with the ROD.

The Railroad Creek valley has historically provided habitat to spotted owls, lynx, grizzly bears, gray wolves, and other potentially threatened or endangered species. These species may occur within or adjacent to the Site as recovery of the species and/or the habitat progress. Consistent with ESA Section 7, if any federally designated threatened or endangered species are identified in the vicinity of remediation work, and the action may affect such species and/or their habitat, the Agencies will consult with USFWS to ensure that remedial actions are conducted in a manner to avoid adverse habitat modification and jeopardy to the continued existence of such species.

J. **Wilderness Act [16 USC §§ 1131 - 1136].** The Wilderness Act established the National Wilderness Preservation System, which is to be comprised of federal land designated by Congress as wilderness areas, and administered to leave the land unimpaired for future use as a wilderness. The requirements within the Act are potentially applicable for assessing Site remedial alternatives.

K. **Washington State Shoreline Management Act [RCW 90.58].** The purpose of the Shoreline Management Act is to prevent inherent harm in the uncoordinated and piecemeal development of the state's shorelines. It applies to all marine waters; streams with a mean annual flow greater than 20 cfs; water areas larger than 20 acres; plus shorelands 200 feet landward from the edge of the aforementioned waters; and associated wetlands, river deltas, and floodplains. Local governments adopt shoreline master programs based on state guidelines but tailored to specific needs. The requirements of Chelan County's Shoreline Management Plan are potentially applicable on lands deeded to non-federal entities (e.g., the claims owned by Holden Village Inc.) when remedial activities take place in and/or within 200 feet of the 100-year floodplain of creeks and water bodies. On federal lands owned in fee where remedial action will take place within 200 feet of the 100-year floodplain, substantive actions at the Site will need to be consistent with the County Plan, in accordance with potential ARARs.

L. **Executive Order 11990 - Protection of Wetlands.** Executive Order 11990 requires that potential impacts to wetlands be considered, and as practical, destruction, loss, or degradation of wetlands be avoided. EPA promulgated regulations to implement this Executive Order under 40 CFR Part 6. The requirements of this Order are potentially applicable to remedial activities that take place within Railroad and Copper Creeks and Site wetlands.

M. **Executive Order 11988 - Protection of Floodplains.** Executive Order 11988 requires evaluation of the potential effects of actions that take place in a floodplain to avoid, to the extent possible, adverse impacts. EPA promulgated regulations to implement this Executive Order under 40 CFR Part 6. The requirements of this Order are potentially applicable to remedial activities that take place within the 100-year floodplain of Railroad and Copper Creeks.

N. **The American Indian Religious Freedom Act [AIRFA; 42 USC § 1996].** This Act mandates federal agencies to protect the right of Indian Tribes to exercise their traditional religions. It is applicable to land-disturbing activities implemented during remedial action if places and physical paraphernalia needed for religious practice are affected. This Act is potentially applicable to the Site if traditional cultural properties, archaeological resources, or historic sites important to the practice of American Indian religions are present.

O. **Migratory Bird Treaty Act (MBTA), 16 USC § 703 et seq.** The MBTA makes it unlawful to "hunt, take, capture, kill" or take various other actions adversely affecting a broad range of migratory birds, including tundra swans, hawks, falcons, songbirds, without prior approval by the USFWS. (See 50 CFR 10.13 for the list of birds protected under the MBTA.) Under the MBTA, permits may be issued for take (e.g., for research) or killing of migratory birds (e.g., hunting licenses). The mortality of migratory birds due to ingestion of contaminated sediment is not a permitted take under the MBTA. The MBTA and its implementing regulations are potentially relevant and appropriate for protecting migratory bird species identified. The selected response action will be carried out in a manner that avoids the taking or killing of protected migratory bird species, including individual birds or their nests or eggs.

P. **Roadless Area Conservation Rule 2001 [66 Fed. Reg. 3244, January 12, 2001].** This rule limits road construction, reconstruction, and timber harvest in inventoried roadless areas because they have the greatest likelihood of altering and fragmenting landscapes, resulting in immediate, long-term loss of roadless area values and characteristics. This rule is potentially applicable to permanent roads and temporary construction roads in the vicinity of the Site.

The following listed potential location-specific ARARs that are described above, are also potential action-specific ARARs:

- Fish and Wildlife Coordination Act [16 USC §§ 661-667];
- Fish and Wildlife Conservation Act [16 USC §§ 2901 - 2911];
- Executive Order 11988 - Protection of Floodplains;
- Executive Order 11990 - Protection of Wetlands; and
- Washington State Shoreline Management Act [RCW 90.58].

1.3.4 Potential To-Be-Considered Criteria

TBCs for the Site are discussed below.

A. **Natural Background Soil Metals Concentrations in Washington State (Department of Ecology, Publication 94-115, October 1994).** This Ecology document contains information on the natural background concentrations of metals in surficial soil throughout Washington State. The MTCA [WAC 173-340-200] defines natural background as "...concentration of hazardous substances consistently present in the environment which has not been influenced by localized human activities." Natural background values are provided on a statewide basis, and for four areas: Puget Sound, Clark County, Yakima Basin, and Spokane Basin. Since the Site is within the Yakima Basin, the natural background metals concentrations for the Yakima Basin are TBCs.

B. **Superfund Remedial Design and Remedial Action Guidance [EPA OSWER Directive 9355.0-4A, June 1986].** This guidance is a TBC for the remedial design and remedial action components of the Site remediation. The document provides guidance on such things as design initiation, reviews, compliance with permitting requirements, and community relations.

C. **Permit Writer's Manual (Department of Ecology, Publication 92-109, Rev. July 2002).** The Permit Writer's Manual is a technical guidance and policy manual for permit writers who develop wastewater discharge permits in Washington State. For the Site, the manual is a TBC for the remedial selection process. This consideration will include, but not be limited to, evaluation of discharge limits, AKART, and mixing zones.

D. **Numeric Values for Freshwater Sediment Quality.** As noted in Section 1.3.1.4, neither the federal government nor Washington State has current promulgated freshwater sediment standards. However, this is an area that is the subject of active scientific evaluations by EPA and Ecology, as well as other agencies (U.S. Army Corps of Engineers et al. 2006). The results of the ongoing interagency cooperative assessment provide information that is helpful in establishing protective cleanup levels.

E. **Executive Order 11593 - Protection and Enhancement of the Cultural Environment.** Executive Order 11593 directs federal agencies to nominate historic properties to the NRHP and to treat properties eligible for the NRHP as though they were listed. The requirement is potentially applicable to land-disturbing activities implemented during remedial action if archaeological resources or sites are present or encountered. The requirements of this Order are potentially "to be considered" for the Site if archaeological resources or historic sites are encountered.

F. **Executive Order 13007 - Indian Sacred Sites.** Executive Order 13007 requires federal agencies to avoid physical damage to Indian sacred sites and to avoid interfering with access to such sites. The requirement is potentially applicable to land-disturbing activities implemented during remedial action if archaeological resources or sites are present or encountered. The requirements of this Order are potentially "to be considered" for the Site if Indian archaeological resources or historic sites are present.

G. **Executive Order 13112 - Invasive Species.** Executive Order 13112 requires federal agencies prevent the introduction of invasive species and not authorize, fund, or carry out action believed to be likely to cause or promote the introduction or spread of invasive species, unless the benefits of such actions clearly outweigh the potential harm caused by invasive species and actions are taken to minimize harm. This Order is potentially "to be considered" for persons and equipment used during implementation of remedial actions to ensure invasive species are not introduced to the Site.

H. **Executive Order 13186 - Responsibilities of Federal Agencies to Protect Migratory Birds.** Executive Order 13186 requires federal agencies avoid or minimize adverse impacts to migratory bird resources, restore and enhance migratory bird habitat, and prevent or abate pollution or detrimental alteration of the environment for the benefit of migratory birds to the extents practicable. This Order is potentially "to be considered" for the remedial actions at the Site.

I. **Dam Safety Guidelines Part 4- Dam Design and Construction (Department of Ecology, Publication 92-55d, July 1993).** Guidelines developed by the Washington Department of Ecology Dam Safety Office (DSO) as required under WAC 173-175-050 are a potential TBC based on DSO jurisdictional interpretations regarding the tailings piles at the Site.

J. **Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration, OSWER Directive 9283.** This Directive provides a compilation of some key existing EPA groundwater policies to assist EPA Regions in making groundwater restoration decisions pursuant to CERCLA and the NCP. It addresses the following:
   - Whether CERCLA remedial action is warranted
   - Appropriate role of institutional controls
   - Groundwater classification and beneficial use policy
   - Remedial action cleanup levels
   - Groundwater point of compliance

K. The Agencies have identified EPA guidance on native plants and invasive species as potential TBCs.[5] This guidance includes:
   - **Revegetating Landfills and Waste Containment Areas Fact Sheet, EPA 542-F-06-001**, (http://www.epa.gov/tio/download/remed/revegetating_fact_sheet.pdf);
   - **Frequently Asked Questions About Ecological Revitalization of Superfund Sites, EPA 542-F-06-002**, (http://www.cluin.org/download/remed/542f06002.pdf); and
   - **Ecological Revitalization and Attractive Nuisance Issues EPA 542-F-06-003**, (http://www.epa.gov/tio/download/remed/542f06003.pdf).

L. **Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, and Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance, October 5, 2009.** Executive Order 13423 sets goals in the areas of energy efficiency, acquisition, renewable energy, toxics reductions, recycling, renewable energy, sustainable buildings, electronics stewardship, fleets, and water conservation. In addition the order requires more widespread use of Environmental Management Systems as the framework in which to manage and continually improve these sustainable practices.

[5] Note that the Forest Plan (Forest Service 1990, and subsequent amendments) also addresses requirements for use of native vegetation and control of invasive species.

Executive Order 13514 expands on the energy reduction and environmental performance requirements for Federal agencies identified in Executive Order 13423 and requires federal agencies to make reductions in greenhouse gas emissions a priority for federal agencies. Executive Order 13514 states that the federal government must lead by example in increasing energy efficiency, reducing greenhouse gas emissions, etc. In addition, the following green remediation policy statements may be TBCs:

- **Superfund Green Remediation Strategy, Office of Superfund Remediation and Technology Innovation, August 2009.** Sets out the plans of the Superfund Remedial Program to reduce greenhouse gas emissions and other negative environmental impacts that might occur during remediation of a hazardous waste site.

- **Incorporating Sustainable Practices into Remediation of Contaminated Sites, April, 2008, EPA 542-R-08-002.** Outlines the principles of green remediation and describes opportunities to reduce the footprint of cleanup activities throughout the life of a project.

- **EPA's Principles for Greener Cleanups, August 27, 2009.** Sets forth the goal to evaluate cleanup actions comprehensively to ensure protection of human health and the environment and to reduce the environmental footprint of cleanup activities, to the maximum extent possible.

- **EPA Region 10's Clean and Green Policy, August 13, 2009.** EPA Region 10's Clean and Green Policy applies to all Superfund cleanups, including those performed by Potentially Responsible Parties. The Policy encourages cleanup practices that, among other things, employ 100 percent use of renewable energy, and energy conservation and efficiency approaches including EnergyStar equipment; and use of cleaner fuels and diesel emissions controls.

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EPA 2007. Aquatic Life Ambient Freshwater Quality Criteria – Copper. EPA-822-R-07-001. February 2007.

Forest Service 1990. Land and Resource Management Plan for Wenatchee National Forest as Amended by Pacific Northwest Forest Plan (NWFP, 1994) and subsequent amendments of the NWFP (2001, 2004, and 2007).

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