DRAFT ALTERNATIVE 13M EVALUATION REPORT HOLDEN MINE SITE CHELAN COUNTY, WASHINGTON

14 August 2009

ERM-West, Inc.
915 118th Avenue SE, Suite 130
Bellevue, Washington 98005

URS Corporation
1501 4th Avenue, Suite 1400
Seattle, Washington 98101

TABLE OF CONTENTS

LIST OF FIGURES (immediately following text)

LIST OF TABLES (immediately following Figures)

LIST OF APPENDICES

LIST OF ACRONYMS/ABBREVIATIONS

AKART	all known, available, and reasonable methods of treatment
AOC	Administrative Order on Consent
AOI	areas of interest
ARAR	applicable or relevant and appropriate requirements
asl	above sea level
BAT	best available technology
bgs	below ground surface
BLM	biotic ligand model
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWA	Clean Water Act
CPOC	conditional point of compliance
CSM	conceptual site model
cy	cubic yards
DFFS	Draft Final Feasibility Study
DRI	Draft Remedial Investigation
DSO	Dam Safety Office
Ecology	Washington State Department of Ecology
EISC	Ecological Indicator Soil Concentration
ERA	ecological risk assessment
ERM	ERM-West, Inc.
fps	feet per second
gpm	gallons per minute
HHRA	human health risk assessment
HQ	hazard quotient
TBC	items to be considered
lf	linear feet
LRMP	Land and Resource Management Plan
LWA	Lower West Area
MCL	maximum contaminant level
MCLG	MCL Goals
MDE	Maximum Design Earthquake
MTCA	Model Toxics Control Act
MUSYA	Multiple Use - Sustained Yield Act
NFMA	National Forest Management Act
NPDES	National Pollutant Discharge Elimination System
NRDA	Natural Resource Damage Assessment

LIST OF ACRONYMS/ABBREVIATIONS

NRWQC	National Recommended Water Quality Criteria
NTR	National Toxics Rule
NWFP	Pacific Northwest Forest Plan
O&M	Operation and Maintenance
PCOC	potential constituents of concern
POC	Point of compliance
PQL	practical quantitation limit
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD/RA	remedial design/remedial action
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	remediation level
ROD	Record of Decision
sf	square feet
SFS	Supplemental Feasibility Study
SMS	Sediment Management Standards
SRA	Surface Water Retention Area
SWQC	surface water quality criteria
TEE	Terrestrial Ecological Evaluation
URS	URS Corporation
USCOLD	United States Committee on Large Dams
USDA Forest Service	United States Department of Agriculture Forest Service
USEPA	United States Environmental Protection Agency
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Health

ALTERNATIVE 13M SUMMARY

This report describes and evaluates the remediation components assembled under Remedial Action Alternative 13M for the Holden Mine site located in Chelan County, Washington to support the Agencies' development of a Draft Proposed Plan. Alternative 13M is based on Alternative 13, which was presented by Intalco to the Agencies in October 2007, and the results of additional site investigation and technical evaluation tasks completed by Intalco in 2008 and early 2009. Many of the remediation components included under Alternative 13M are common to Alternative 11, which was presented by the Agencies (e.g., United States Department of Agriculture Forest Service Region 6, United States Environmental Protection Agency Region 10, and Washington State Department of Ecology) in the Final Draft Proposed Plan, dated 18 September 2007. The remediation components that are unique to Alternative 13M are based on an improved understanding of site conditions as a result of the additional work completed by Intalco in 2008 and 2009, and were developed to provide comparable protectiveness to those included under Alternative 11.

This report combines the results of the additional technical evaluations performed by Intalco in 2008 and 2009 with previous site characterization data into a concise site characterization summary (Section 1), proposes updated remedial action objectives (RAOs) and cleanup requirements, (Section 2), presents a comprehensive description of Alternative 13M (Section 3), and evaluates Alternatives 11 and 13M using evaluation criteria provided under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Section 4) and the Washington State Model Toxics Control Act (MTCA) (Section 5).

Based on the available information and results of the evaluations presented in this report, Alternative 13M is the preferred remedial alternative for the Site. The principal components of Alternative 13M include the following:

- Control the main portal drainage flow using hydraulic barriers installed within the 1500-level of the mine (if feasible) and reduce air flow through the mine and control human access by placing restrictions in other open underground mine openings.
- Contain, collect, and treat the main portal drainage and seeps and groundwater having metals concentrations that exceed potential

surface water criteria and would otherwise enter Railroad Creek adjacent to the former mine facility.

- Closure of the tailings piles and east and west waste rock piles to improve stability, reduce surface water runon, improve surface water runoff, and support native vegetation in accordance with the Washington State Standards for Solid Waste Handling.

- Remove soils and mine-related materials from the lagoon area, surface water retention area, and former mill building, and cover the maintenance yard with a concrete slab or impermeable liner to reduce exposures to human and terrestrial ecological receptors and future releases of hazardous substances to groundwater.

- Realign Railroad Creek to the north adjacent to the tailings piles to provide improved long-term channel stability, enhanced aquatic and riparian habitat, and to hydraulically isolate the creek from shallow groundwater in the eastern portion of the Site. The creek realignment would also allow the construction of groundwater collections systems adjacent to tailings piles 1 and 2 without massive excavation and removal of tailings adjacent to the creek.

- Modify the Copper Creek channel to provide long-term erosion control, channel stabilization, and conveyance of water and sediment to the realigned Railroad Creek channel.

- Implement monitored natural recovery for portions of the Site (e.g., ballfield/wilderness boundary, area of windblown tailings, and Honeymoon Heights) where a low potential risk remains to terrestrial ecological receptors (primarily plants and invertebrates), but where active remediation would cause long-term or permanent impairment of the native habitat.

- Limit potential future exposure to groundwater or source materials that could impact human health or the environment and prevent activities that may interfere with the effectiveness of the remedy components through institutional controls, such as proprietary controls on private property or land use restrictions.

- Monitor surface water, groundwater, biota, sediment, and site operations to assess compliance and the protectiveness and effectiveness of the Alternative 13M remedy components.

The remedy components listed above for Alternative 13M would address all sources of mine-related hazardous substances at the Site and would satisfy the proposed RAOs.

The first RAO is to meet the surface water applicable or relevant and appropriate requirements (ARARs) or alternative risk-based concentrations that are protective of human health and aquatic life in Railroad Creek and Copper Creek within a reasonable restoration time frame. Alternative 13M satisfies this RAO by containing, collecting and treating the main portal drainage and seeps and groundwater having metals concentrations that exceed potential surface water criteria and that would otherwise enter Railroad Creek adjacent to site features, and hydraulically isolating the realigned creek channel from groundwater. Surface water quality restoration would begin immediately following implementation of Alternative 13M. Diffuse groundwater and seeps entering Railroad Creek upgradient (west) of the realigned creek channel would be contained and collected using a barrier wall and collection trench constructed immediately adjacent to the creek, surface water quality would be restored as soon as possible and a reasonable restoration time frame would be provided.

The second RAO is to meet ARARs or alternative risk-based concentrations that are protective of human health and aquatic life at conditional points of compliance (CPOCs) in surface water where groundwater enters Railroad and Copper Creeks within a reasonable restoration time frame. Alternative 13M satisfies this RAO by collecting and treating groundwater having metals concentrations that exceed potential surface water ARARs prior to discharge to Railroad Creek adjacent to the former mine facility. Alternative 13M is also expected to meet potential surface water ARARs at a CPOC(s) where groundwater discharges to Railroad Creek downgradient (east) of the former mining facility. This would be accomplished through a combination of: (1) water collection and treatment and source control actions that would reduce potential constituent of concern (PCOC) loadings to east area groundwater, and (2) natural attenuation processes that would both reduce PCOC loadings to groundwater over time and reduce PCOC concentrations in the downgradient groundwater with distance from the tailings piles.

The third RAO is to meet Washington State sediment quality requirements that are protective of human health and the environment within a reasonable restoration time frame. Alternative 13M meets this RAO under current conditions, based on the results of bioassay testing conducted on sediment samples from Railroad Creek and Lake Chelan at the Lucerne bar. The Railroad Creek realignment would bypass the portions of the existing channel where ferricrete is observed on the channel bottom and would provide new, clean substrate for aquatic organisms immediately after remedy implementation. The water collection and treatment and source control actions under Alternative 13M would also reduce metals loading to Railroad Creek surface water and sediment and further improve sediment quality downstream of the site over time.

The fourth RAO is to attain surface soil quality that is protective of human health and terrestrial ecological receptors. Results of the baseline human health risk assessment (HHRA) and the supplemental human health risk evaluations presented in Appendix F show that PCOC concentrations in site soils, waste rock, and tailings are protective of human health under current and anticipated future land uses and construction activities. Alternative 13M would provide additional protection of human health by removing or covering surface soils having concentrations above potential human-health (direct contact) criteria in the lagoon area and maintenance yard. Institutional controls, including land use restrictions, would also be implemented, as needed, to protect human health in areas where soil concentrations above potential risk-based criteria are managed in place and to mitigate potential exposure pathways to deeper soils.

Alternative 13M would address potential risks to terrestrial ecological receptors by removing soils in the lagoon area and former surface water retention area, and by removing the exposure pathways to soil and other mining-related materials in the maintenance yard and mill building. The available data indicate that the Alternative 13M soil cover on the tailings and east and west waste rock piles would be protective of wildlife, soil invertebrates, and shallow-rooted plants. While a low potential risk to deeper-rooted plants would remain on the piles, data and recent observations of the tailings piles show that deeper rooted plants are re-establishing, and a plant community representative of the surrounding habitats is expected to develop over time as a result of natural recovery. The incidental removal and/or covering of soils in portions of the lower west area and area of windblown tailings during implementation of other remedy components would also reduce the exposure of terrestrial ecological receptors in these areas. Alternative 13M would implement monitored natural recovery for the remaining portions of the Site (e.g., in the ballfield/wilderness boundary area, lower west area, area of windblown tailings, and Honeymoon Heights) where a low potential risk would remain to terrestrial ecological receptors (primarily plants and soil invertebrates), but where active remediation would result in long-term or permanent impairment of the native habitat.

The fifth RAO is to stabilize the tailings and waste rock pile side slopes, as needed, to satisfy ARARs, prevent future releases of tailings or waste rock into surface water, and protect human health. Alternative 13M would satisfy this RAO by regrading and stabilizing the tailings pile and east and west waste rock pile side slopes to provide adequate static and seismic factors of safety. The realignment of Railroad Creek to the north would provide greater distance between the tailings pile slopes and the creek and further reduce the potential for tailings transport to the creek in the event of sloughing or a slope failure.

The sixth RAO is to prevent access to underground mine workings and reduce the potential for human exposure to hazardous substances remaining on site following remedy implementation, including through use of groundwater as a drinking water source. Alternative 13M would meet this RAO by installing access restrictions in open mine portals and implementing institutional controls, such as proprietary controls on private property or land use restrictions, to limit potential future exposure to groundwater or source materials that could impact human health and prevent activities that may interfere with the effectiveness of the remedy components.

The seventh RAO is to perform appropriate natural resource damage assessment (NRDA) activities as agreed by the Parties to evaluate the potential for coordinated remediation and natural resource restoration activities. This RAO includes the evaluation and coordination of natural resource restoration activities with remedial action implementation to the extent feasible. Intalco and the natural resource Trustees are performing appropriate NRDA. The extent to which the selected remedial action alternative achieves natural resource restoration would be evaluated and considered to support a final NRD settlement for the Site.

The eighth RAO is to implement the remedial action in a manner that protects human health and the environment, including the Holden Village residential community during and after construction. The implementation of appropriate health and safety measures and close coordination with the Holden Village during construction of Alternative 13M would reduce safety risks to workers, Holden Village residents, and visitors. Similarly, potential environmental impacts during construction would be mitigated to the extent possible through careful construction practices, good housekeeping, and advanced preparation of a spill management other contingency plans.

Based on the information currently available, Alternative 13M is expected to satisfy the threshold requirements under CERCLA and MTCA, and is proposed as the preferred alternative because it would provide the best performance with respect to the balancing and modifying criteria under CERCLA, and the other requirements for selecting a cleanup action under MTCA. Alternative 13M is expected to provide greater long-term effectiveness and permanence, fewer short-term risks to human health and the environment during remedy implementation, greater technical implementability, at a lower total cost than other alternatives that satisfy the threshold criteria.

The magnitude of residual risks to human health and the environment would be low under Alternative 13M, and the actions included under Alternative 13M would provide a comparatively high degree of long-term reliability. Alternative 13M would use open trenches to convey water by gravity to the water treatment systems to the extent possible, thereby reducing the amount of system maintenance and monitoring and the risk of system failure associated with the reliance on energy-intensive pumps and closed piping. Similarly, the Alternative 13M soil cover would require minimal post-closure maintenance and could be repaired relatively quickly with locally-available, conventional equipment in the event of damage.

Alternatives 13M would pose few short-term risks to the local community, workers, and environment during the active construction seasons, and many of these risks can be managed or mitigated during remedy implementation. The short term risks posed by Alternative 13M are manageable because implementation of Alternative 13M includes handling a manageable volume of contaminated materials, a logistically feasible schedule of heavy construction activities, borrow soil and rock quarry requirements that are commensurate with local supply, and a relatively short construction duration. It is estimated that approximately 390,000 cubic yards (cy) of tailings would require relocation under Alternative 13M, which is approximately 60 percent less than other alternatives that satisfy the threshold criteria. Furthermore, the current toe of the tailings pile side slopes would remain in place, and the overbank deposits would not be exposed during slope regrading; thereby preserving the overall stability of the tailings piles during construction. Construction of Alternative 13M is expected to be completed within two full construction seasons, with final seeding and planting occurring in year three. This alternative reduces implementation time and the impacts on the local community and environment by a year or more relative to other alternatives that satisfy the threshold criteria.

Alternative 13M is the most implementable of the alternatives that satisfy the threshold criteria because it relies heavily on conventional technologies and construction methods, which allows for use of a locally available work force, and it has comparatively few constructability challenges and safety risks. The regrading and/or relocation actions proposed for the tailings piles and the east and west waste rock piles, construction of the cover for the tailings and waste rock piles, construction of the water conveyance and treatment systems, and most of the Railroad Creek realignment work would be completed using conventional technologies and construction methods and a locally available work force. Specialized equipment and contractors would be required for rock blasting, retaining wall construction, habitat construction within Railroad Creek, barrier wall construction and the installation of hydrostatic bulkheads. However, these activities are common and conventional at mining sites in North America, and the equipment and contractors needed to perform this work are readily available in North America. Alternative 13M has been designed to reduce the constructability challenges and safety risks associated with these specialized work activities to the extent practicable; however, they can be further mitigated by proper planning and the selection of experienced contractors and appropriate equipment.

The total cost is anticipated to be at least 40 percent lower than Alternative 11, the other alternative evaluated that satisfies the threshold criteria. The lower total cost for Alternative 13M is expected because it uses:

- A barrier wall only in areas where groundwater would discharge to Railroad Creek, having metals concentrations that exceed potential surface water ARARs;
- Source control actions combined with natural attenuation to address groundwater having metals concentrations that are expected to meet potential surface water ARARs at a CPOC(s) where the groundwater discharges to Railroad Creek downgradient (east) of the Site;
- Realignment of Railroad Creek to reduce the required regrading and buttressing of the tailings piles;
- An efficient plan for regrading and relocating the east and west waste rock piles that includes placement of rock on former mill building foundations;
- A protective soil cover for the tailings and east and west waste rock piles which avoids costly synthetic liners that potentially require a significant maintenance effort and which must be maintained free of treed vegetation native to the local area;
- Source material from the new creek and other on-site excavations to reduce the amount of import soil and rock material needed to complete the construction;

- Low-energy and low-maintenance water collection and treatment systems; and
- Monitored natural recovery rather than active remediation in areas, such as the Honeymoon Heights waste rock piles, where the long-term risks to the environment are low, but the construction safety risk and/or the risk of long-term or permanent impairment of the native habitat caused by active remediation is high.

1.0 INTRODUCTION

This report describes and evaluates the remediation components assembled under Remedial Action Alternative 13M for the Holden Mine site located in Chelan County, Washington ("Site"). Alternative 13M is based on Alternative 13, which was presented by Intalco to the Agencies in October 2007 (David E. Jackson & Associates, et al, 2007), and the results of additional site investigation and technical evaluation tasks completed in 2008 and early 2009. The additional work was performed by Intalco at the request of the United States Department of Agriculture (USDA) Forest Service Region 6 (Forest Service), United States Environmental Protection Agency Region 10 (USEPA), and Washington State Department of Ecology (Ecology), collectively referred to as the Agencies, to supplement the project record concerning remediation components to be considered for the Proposed Plan.

Many of the remediation components included under Alternative 13M are common to Alternative 11, which was presented by the Agencies in the Final Draft Proposed Plan, dated 18 September 2007 (USDA Forest Service, 2007a), and supporting Supplemental Feasibility Study (SFS) (USDA Forest Service, 2007b). The remediation components that are unique to Alternative 13M are based on an improved understanding of site conditions, as a result of the additional work completed by Intalco in 2008 and 2009, and were developed to provide comparable protectiveness to those included under Alternative 11, but with a lower cost and impact on the local community. A description of Alternative 13M is provided herein, along with an evaluation of Alternatives 11 and 13M using evaluation criteria provided under the CERCLA and MTCA. This report is intended to support the Agencies' development of a Draft Proposed Plan, scheduled for release in the fall of 2009.

The following subsections provide an overview of the project background, site history, site setting, principal site features, hydrogeologic conceptual site model (CSM), nature and extent of contamination, site risks, geotechnical analysis of existing tailings and waste rock pile conditions, and the current and anticipated future land use.

1.1 PROJECT BACKGROUND

The Holden Mine was operated between 1938 and 1957 by Howe Sound Company. The Site included an underground mine and mill facility that processed ore for off-site smelting. Since closure of the mine in 1957, the Agencies have identified potential environmental concerns at the Site. An Administrative Order on Consent (AOC) was executed on 11 April 1998 between Alumet (a predecessor to Intalco) and the Agencies to evaluate environmental conditions at the Site and identify remedial action alternatives to address environmental concerns through a remedial investigation/feasibility study (RI/FS) process conducted in conformance with both CERCLA and MTCA. Between 1996 and 1998, an RI was completed by Alumet to describe site features and characterize the nature and extent of potential contamination of site media from historic mining activities. The revised Draft Remedial Investigation Report (DRI) was submitted on 28 July 1999 (Dames and Moore, 1999), and was accepted as final by the Agencies, with associated comment resolution documents, on 8 February 2002.

Following acceptance of the RI, an FS was prepared to identify RAOs, identify and screen potential technologies to address site concerns, and to assemble and evaluate candidate site-wide alternatives for their ability to meet RAOs. A Draft Final Feasibility Study Report (DFFS) was submitted to the Agencies on 19 February 2004 (URS Corporation [URS], 2004). The DFFS evaluated eight site-wide remedial alternatives, including several subalternatives that were developed and agreed upon by Intalco and the Agencies. The analyses and evaluations documented in the DFFS supported Intalco's selection of Alternative 3b as the preferred remedy for the Site.

Subsequent to the DFFS, numerous technical meetings were held between Intalco and Agency representatives, and data collection activities at the Site continued. In September 2005, the Agencies presented a new preferred remedial alternative for the Site to the USEPA National Remedy Review Board, referred to as the 2005 Agencies Preferred Remedy (now known as Alternative 10). In November 2005, Intalco provided the Agencies with a description and evaluation of a new remedial alternative (Alternative 9) as a settlement offer. Both Alternatives 9 and 10 included additional remedial actions in the eastern portion of the Site than were included under Alternative 3b to address concerns related to groundwater associated with the three tailings piles.

In September 2007, the Agencies provided comments on the DFFS and released the SFS and Final Draft Proposed Plan, which presented a new remedial alternative (Alternative 11) as the proposed remedy for the Site. Intalco responded to the Final Draft Proposed Plan with an October 2007 memorandum describing Alternative 13, which was developed to provide equal protection of human health and the environment as Alternative 11, but with improved technical feasibility and less cost compared to Alternative 11.

In an 11 March 2008 letter from the USDA Office of the General Counsel to Mr. Theodore Garrett, Intalco's outside counsel, the Agencies requested additional site data and analyses to support the consideration of alternative remediation components in the Proposed Plan (Appendix A). As requested in the 11 March 2008 letter, Intalco completed additional field investigation and data analysis tasks to further evaluate the following:

- The feasibility of realigning Railroad Creek in the reach adjacent to the three tailings piles;
- The hydrogeologic CSM and groundwater collection actions adjacent to the tailings piles;
- The geotechnical stability of the tailings piles and east and west waste rock piles under current conditions, and potential actions to stabilize the slopes and comply with regulatory criteria;
- Metals concentrations in site soil, and potential risks to terrestrial ecological receptors in several areas of interest (AOIs); and
- The anticipated performance of the low-energy water treatment systems proposed under Alternatives 13 and 13M for metals removal from collected site waters.

The results of the additional work completed in 2008 and early 2009 have greatly improved the understanding of Site conditions. However, some of the new information opened up new questions and resulted in the need for additional field tasks and more detailed analyses. Although Intalco has moved expediently to collect the additional field data and conduct additional analyses beyond the original scope of work, these activities are ongoing. Information obtained from the additional work to be completed in 2009 will be pertinent to the remedy component evaluation and final remedy selection. Intalco will continue to work closely with the Agencies during completion of the additional work and will share the new data as they become available.

1.2 SITE HISTORY

The Site is an inactive copper mine located in the Wenatchee National Forest in north-central Washington State (Figure 1-1). The underground mine was developed and operated by the Howe Sound Company from 1938 to 1957 for the primary production of copper, zinc, silver, and gold. Approximately 60 miles of underground mine workings were developed during the period of mine operation.

Economic minerals were removed from the ore in an on-site mill. The resulting ore concentrate was then shipped off site for smelting. The on-site processing of ore generated approximately 10 millions tons of tailings, of which approximately 1.5 million tons were backfilled into the mine during operations. The remainder of the tailings was hydraulically placed on site in three piles covering approximately 70 acres. Two waste rock piles were also generated adjacent to the mill building and consist of an estimated 250,000 to 300,000 cy of rock that did not contain sufficient concentrations of economic minerals to process in the mill.

The mine ceased operations in 1957 due to economic conditions. The mine properties and structures were subsequently deeded to the Lutheran Bible Institute in 1960, which then transferred the properties to Holden Village, Inc. Holden Village, Inc. has operated an interdenominational church retreat at the Site since 1961 under a Conditional Use Permit issued by the USDA Forest Service.

1.3 SITE SETTING

The Site is situated in a remote area on the eastern slopes of the Cascade Mountain Range, within the Lake Chelan Watershed. The Site is located within the Wenatchee National Forest, and the Glacier Peak Wilderness generally bounds the Site to the west, north, and south.

The underground mine was developed on the south side of Railroad Creek, approximately 11 miles upstream from the creek's outlet at Lake Chelan (Figure 1-1). Physical access to the Site is provided by a gravel road from Lucerne, which is located on the southwestern shore of Lake Chelan. Access to Lucerne is provided by commercial boats from the community of Chelan and Field's Point Landing, and by float planes. There is no road access or power transmission to the Site from the community of Chelan. The Holden Village currently generates all power required for facility operations on-site with a hydroelectric power plant fed by diverted flow from Copper Creek and the use of small diesel-powered backup generators.

The Railroad Creek watershed is elongated and steep, and oriented west to east. The generally u-shaped valley is characterized by steep-sided slopes carved by the most recent glaciation. The glacial valley was carved into bedrock, and the valley bottom and lower sidewalls are covered with soil of glacial origin and alluvial deposits reworked by Railroad Creek. Elevations within the Railroad Creek watershed range from approximately 1,100 feet above sea level (asl) at Lucerne on Lake Chelan to more than 9,500 feet asl at Bonanza Peak several miles west and north of Holden Village.

The climate at the Site is characterized by relatively warm to hot, dry summers and mild to severe winters. Average monthly temperatures vary from highs in the mid 70s to lower 80s (in degrees Fahrenheit) in July and August, to low temperatures well below freezing in January. Average temperatures are generally below freezing between the months of November and March. Average precipitation at Holden Village from 1962 to 1997 was approximately 38 inches annually, with the highest monthly amounts occurring predominantly as snowfall between November and January, and the lowest between May and August. Snowmelt at the Site typically occurs during the months of May and June, although areas of snow may persist into July as a function of aspect, vegetative shading, and the amount and timing of winter snowfall.

1.4 DESCRIPTION OF PRINCIPAL SITE FEATURES

The principal site features are shown on Figure 1-2. The Site is generally divided into a west area and east area. The west area comprises the underground mine and mine support area, Honeymoon Heights, and the east and west waste rock piles. The east area includes tailings piles 1, 2, and 3. Most of the former mine facilities and tailings are between 3,200 and 3,400 feet asl, which is up to approximately 200 feet above Railroad Creek and Holden Village. The Honeymoon Heights portals and associated waste rock piles are situated above the former mining facilities, and range in elevation up to approximately 4,600 feet asl.

Principal site features include the following:

- *Railroad Creek* – Flowing across the Site from west to east, Railroad Creek is a glacier-fed tributary to Lake Chelan. Flow within Railroad Creek varies by season and by year. Baseflow (or "low-flow" condition) generally occurs from late summer to mid-spring. During the spring snowmelt period ("high-flow" condition), flow in Railroad Creek increases sharply and then decreases to low-flow conditions, with the magnitude and timing of the high-flow condition depending on weather conditions within the Railroad Creek watershed. Measured discharge in Railroad Creek during high-flow conditions have ranged between about 300 cubic feet per second (cfs) and 1,100 cfs. Discharge measurements of Railroad Creek during low-flow conditions have typically been about 50 cfs.

- *Copper Creek* – Copper Creek is a tributary which flows into Railroad Creek from the south between tailings piles 1 and 2. A portion of the flow from Copper Creek is diverted above the Site and conveyed by pipe to the Holden Village hydroelectric power plant. Measured discharges in Copper Creek adjacent to the Site have ranged from about 5 cfs to 100 cfs.

- *1500-level main portal* – The 1500-level main underground mine portal is located immediately above the west waste rock pile, near the southern edge of the former mill building. Following mine closure, the underground mine workings eventually flooded resulting in the discharge of water from the 1500-level main portal.

- *Tailings piles 1, 2, and 3* - Three tailings piles cover approximately 70 acres to the south of Railroad Creek. The tailings piles consist of approximately 8,500,000 cy of finely ground rock (silt and sand) remaining after the mineralized ore was crushed and the majority of the economic minerals were removed in the milling process. The tailings piles were constructed by Howe Sound Company under a permit with the USDA Forest Service. At the top edge of the slopes near Railroad Creek, tailings piles 1, 2, and 3 are approximately 50 feet, 120 feet and 70 feet high, respectively.

- *Area of windblown tailings* - The area of windblown tailings includes an approximately 77-acre area east and north of tailings pile 3 where wind has transported and dispersed the fine-grained tailings from the tailings piles. This area includes approximately 31 acres north of the gravel road to Lucerne and 46 acres south of the road. Gravel covers placed on the tailings piles by the USDA Forest Service between 1989 and 1991 significantly reduced the wind transport of tailings.

- *Honeymoon Heights mine portals* - The Honeymoon Heights area is situated south to southwest and upslope from the mill building, and includes six mine portals and associated underground tunnels that were developed before 1938 at the 300-, 550-, 700-, 800-, 1000-, and 1100-levels of the mine.

- *Honeymoon Heights waste rock piles* - A total of five waste rock piles were placed near the 300-, 550-, 700-, 800-, and 1100-portals in Honeymoon Heights. The Honeymoon Heights waste rock piles cover a total of approximately 5 acres and contain an estimated volume of approximately 42,600 cy of waste rock.
- *Areas downslope of the Honeymoon Heights waste rock piles* - The areas located directly downslope of the five Honeymoon Heights waste rock piles (at the 300-, 550-, 700-, 800-, and 1100-level portals) were identified by the Agencies and Intalco as a single AOI during the Terrestrial Ecological Evaluations (TEE) field program. This AOI encompasses a total of approximately 3 acres. The largest of these areas is an avalanche chute bordering and downslope of the 800- and 1100-level waste rock piles that covers approximately 0.9 acres.
- *East and west waste rock piles* - The east and west waste rock piles are located on the east and west sides of the former mill building. The piles consist of a total estimated 250,000 to 300,000 cy of rock removed from the underground mine that did not contain sufficient concentrations of economic minerals for processing in the mill. The maximum heights of the east and west waste rock piles are approximately 143 feet and 165 feet, respectively, with surface areas of approximately 4.2 and 3.9 acres, respectively.
- *Lower west area (LWA)* - The LWA consists of the relatively flat area south of Railroad Creek and west of tailings pile 1, and is downgradient of the underground mine, maintenance yard, former mill building, and the west waste rock pile. The LWA covers approximately 15 acres and includes the lagoon feature, and the Holden Village's hydroelectric plant and wood processing yard.
- *Lagoon* - The lagoon was constructed in the LWA during mining operations to collect surface water from the mill building and maintenance yard areas, and covers approximately 1 acre. Surface water runoff that collects within the lagoon features infiltrates into groundwater over the course of the spring and summer months.
- *Maintenance yard* - The maintenance yard was constructed to serve the mine operation and continues to be used by Holden Village for vehicle maintenance. The area is less than 1 acre in size and includes several buildings used by the Holden Village for vehicle maintenance, storage, and potable water treatment, and a gravel-covered yard with access road.
- *Former mill building* - During mine operations, economic minerals were removed from ore through crushing and processing at the on-site mill. The mill building was constructed on a relatively steep slope situated

between the east and west waste rock piles and covers an area of about 1.1 acres. A majority of the former mill building footprint is covered by concrete foundations.

- *Former Surface Water Retention Area (SRA)* - The former SRA is located near the western site boundary and is downgradient of the 1500-level ventilator portal. The bermed area, covering approximately 0.14 acres, was apparently used for water retention and solids removal during mining operations.
- *Holden Village* - The Holden Village is located on the north side of Railroad Creek and includes approximately 25 buildings that were built in the late 1930s, gravel roads, and landscaped areas. The Holden Village is currently operated as an interdenominational retreat with approximately 50 to 60 year-round residents and 5,000 to 6,000 visitors each year.
- *Ballfield/wilderness boundary area* - The baseball field (ballfield) covers approximately one-half acre and is located north of Railroad Creek approximately one-half mile west of Holden Village. The ballfield appears to have been constructed utilizing soil removed from a cut slope immediately north of the field, and is currently overgrown with grasses. The Glacier Peak Wilderness boundary is located immediately west of the ballfield and the AOI referred to as the "wilderness boundary area" extends to the west several hundred feet.

1.5 HYDROGEOLOGIC CONCEPTUAL SITE MODEL OVERVIEW

The hydrogeologic CSM was initially developed during the RI and has been refined based on the findings of subsequent investigations and evaluations. An additional field program was completed in 2008, and between 2008 and 2009 a groundwater flow model was developed for the Site to evaluate existing conditions, refine the CSM, and simulate remedial alternative components. The CSM presented herein incorporates findings from the 2008 field program and the subsequent groundwater flow model; however, hydrogeologic data collection is ongoing and may be used to further refine the CSM as more data become available.

The following sub-sections provide an overview of the hydrogeologic CSM, including hydrostratigraphic units and groundwater occurrence, recharge, flow, and interaction with Railroad Creek. Additional detail related to the hydrogeologic CSM and groundwater flow model are provided in the Draft Hydrogeology Technical Memorandum (Appendix E, URS, 2009d).

1.5.1 *Hydrostratigraphic Units*

As described previously in Section 1.3, the Site is located in a generally u-shaped valley carved into bedrock during the most recent glaciation. The valley bottom and lower sidewalls are covered with soil of glacial origin (glacial till, outwash, and drift), alluvial deposits (alluvium and overbank deposits), and debris flow (colluvium) deposits. Mine tailings and waste rock were placed on top of native materials in the valley. The following hydrostratigraphic units were identified at the Site:

- Bedrock;
- Glacial till;
- Glacial outwash;
- Glacial drift;
- Alluvium;
- Colluvium/debris flow deposits;
- Overbank deposits; and
- Tailings and waste rock.

The approximate extents of the mapped surface expressions of these materials are shown in Figure 1-3, which provides a generalized geologic map of the Site. The hydraulic conductivity values calculated from slug test and pumping tests completed at site wells indicate that the hydraulic conductivities for site geologic materials span several orders of magnitude (see Table 1-1).

The thickness of alluvial deposits in the valley ranges from about 20 feet in the LWA to greater than 130 feet east of tailings pile 3, as illustrated in the alluvial thickness contours shown on Figure 1-4. Representative cross sections showing the general stratigraphy in the west area and east area are provided on Figure 1-5 (cross section A-A′, west area) and Figure 1-6 (cross section B-B′, east area). The alluvial thickness contours and cross sections indicate that the alluvial thickness ranges between approximately 20 and 80 feet beneath the LWA, tailings pile 1, tailings pile 2, and tailings pile 3, and increases east of tailings pile 3 to greater than 130 feet.

1.5.2 *Groundwater Occurrence and Recharge*

Groundwater is recharged by infiltration of precipitation and surface water, and recharge rates vary based on the permeability of the surface material. Areas with higher permeability (e.g., alluvial deposits) receive greater groundwater recharge than glacial till and bedrock. High groundwater recharge zones exist along the mountain front, where snowmelt and runoff from mountain ridges infiltrate into unconsolidated deposits. Mountain front recharge is greatest in avalanche/debris chutes, where runoff and snowmelt are channeled into highly permeable fans of colluvium/debris flow deposits above Holden Village and tailings pile 3 (shown on Figure 1-3).

Groundwater occurs across the Site and has been encountered in all hydrostratigraphic units, although the primary water-bearing materials are alluvium, colluvium, and glacial deposits. Depth to groundwater is generally shallowest near Railroad Creek and deepens with distance away from the creek. With the exception of some areas beneath the tailings piles, site groundwater occurs under unconfined conditions within native materials. Due to the thickness of the saturated deposits, up to three different depth intervals (i.e., shallow, intermediate, and deep) within the alluvial aquifer are monitored using well pairs or clusters.

Groundwater within the tailings piles occurs in isolated perched zones and in a laterally continuous zone at the base of the piles. Groundwater levels in the tailings piles decrease over the summer and fall, and by fall the central and southern portions of the tailings piles may become dry.

1.5.3 Groundwater Flow and Interaction with Railroad Creek

Groundwater flow in the shallow groundwater zone beneath the Site is generally towards Railroad Creek and down valley (east) (Figure 1-7). Within the deep zone, groundwater flow is consistently down valley across the site. Groundwater flow within the intermediate zone has not been contoured due to the limited number of wells completed within this zone; however, groundwater flow within the intermediate zone is expected to be predominantly down valley.

Groundwater flow varies seasonally and forms two distinct flow patterns, which are generally described as “high-flow” and “low-flow” conditions. High-flow conditions are generally observed in mid spring to early summer depending on weather conditions, whereas low-flow conditions extend from late summer to early spring. The transition from low-flow to high-flow conditions happens during the spring snowmelt period, when the stage of Railroad Creek and groundwater levels near Railroad Creek rise several feet and water levels near the north and south valley slopes increase by up to 40 feet or more. During high-flow and low-flow conditions, Railroad Creek gains flow from groundwater discharge in the reach along the LWA, tailings pile 1, and the western portion of tailings pile 2 (Figure 1-7). Railroad Creek transitions to a losing condition (i.e., loses flow to groundwater) in the reach along tailings piles 2 and 3 (Figure 1-7). The losing conditions are attributed to surface water from Railroad Creek discharging to highly permeable alluvial deposits (from previous creek channel alignments) that intersect the reach of Railroad Creek and in response to increasing thickness of the alluvial aquifer.

Vertical groundwater gradients in native materials across the Site are downward, most notably east of tailings pile 3 where the alluvial deposits thicken with distance downstream. The groundwater flow model developed and calibrated for the Site to evaluate current conditions and simulate remedial alternatives is presented in Appendix E and a conceptual schematic of the model layers is shown on Figure 1-8. Groundwater elevation contours and flowpaths predicted by the model for high-flow and low flow conditions are illustrated on Figures 1-9 and 1-10, respectively. These simulations show that groundwater in the area of the east and west waste rock piles, tailings pile 1, and the western portion of tailings pile 2 generally flows toward and discharges into Railroad Creek, whereas shallow groundwater in the area of tailings pile 3 and the eastern portion of tailings pile 2 flows downward into deeper groundwater zones (model layers 2 and 3) and then beneath Railroad Creek and down valley (Figures 1-9 and 1-10).

Groundwater within the intermediate and deep zones beneath and east of tailings pile 3 is believed to discharge to Railroad Creek downstream of station RC-5 and upstream of station RC-10 (Figure 1-11), where Railroad Creek flows directly atop bedrock. Additional hydrogeologic field investigations are ongoing to identify the location(s) where groundwater discharges to Railroad Creek east of the Site.

1.6 GEOTECHNICAL ANALYSIS OF EXISTING TAILINGS PILE AND WASTE ROCK PILE CONDITIONS

A summary of the geotechnical characterization and analysis of existing conditions for tailings piles 1, 2, and 3 and the east and west waste rock piles is provided in the following subsections. The stability of the tailings and east and west waste rock piles was assessed through a geotechnical field program and related technical analyses completed in 2008 and early 2009. The results of the geotechnical analyses are provided in the Draft Geotechnical Technical Memorandum included as Appendix C (URS, 2009b). Additional geotechnical data collection and analysis is planned for the summer and fall of 2009, and these data will be provided to the Agencies when they are received.

1.6.1 *Geotechnical Characterization and Analysis of the East and West Waste Rock Piles*

During mining operations, waste rock was removed from the underground mine and end-dumped on either side of the mill building (Figure 1-2). The waste rock was placed directly on the natural slope consisting of a relatively thin soil and/or colluvium underlain by relatively low permeability, compact glacial till. Water that infiltrates the piles collects at the sloped contact with the glacial till. The water travels downslope along the steep contact and discharges as intermittent seeps at the base of the piles.

Based on existing topographic data, the east waste rock pile covers 4.2 acres and reaches a maximum height of 143 feet. The east waste rock pile slope angles have been observed to be 30 to 40 degrees (their angle of repose). The uppermost surface of the pile is relatively level and near the same elevation as the 1500-level main mine portal. The west waste rock pile covers 3.9 acres and reaches a maximum height of 165 feet, with slope angles also observed to be 30 to 40 degrees (their angle of repose). The uppermost surface of the west pile is relatively level and near the same elevation as the top surface of the east pile. The west waste rock pile contains several timbered crib walls near the lower northwest-facing side slopes that are in varying stages of decomposition.

The waste rock piles have stood with steep exterior slopes for over 60 years without significant failure except for isolated cases that were related to strong erosive forces from hillside drainage. Some sloughing of the west waste rock pile has occurred on the east side and the western half is held in place by wooden retaining structures that are in need of repair. Given the history of long-term slope stability, stability analyses of the existing pile conditions were performed to verify the material strength properties assigned based on field and laboratory data. The evaluation of existing conditions included a sensitivity analysis with the angle of internal friction of the waste rock varied from 35 to 39 degrees. Results of these sensitivity analyses indicate that the angle of repose piles at limit equilibrium at the lower bound of 35 degrees, but were marginally stable at the realistic assumed strength of 37 degrees. The results of the stability analyses indicate that the piles are only marginally stable under static conditions in their existing configurations (Appendix C).

Because the piles were deposited at their angle of repose, moderate to low levels of shaking during an earthquake could cause some sloughing of the slope surfaces. The results of the simplified method of deformation analysis used to calculate deformation of the piles under seismic loading conditions show that the piles are likely unstable under seismic conditions (Appendix C).

1.6.2 *Geotechnical Characterization and Analysis of the Tailings Piles*

The locations of tailings piles 1, 2, and 3 are shown on Figure 1-2. Groundwater within the tailings piles is recharged by infiltration of precipitation and mountain front runoff. Following periods of high recharge (i.e., the spring snowmelt), groundwater occurs in isolated perched zones in the upper portions tailings piles and in a laterally continuous zone near the base of the piles. Groundwater levels in the tailings piles decrease during the summer and fall, and by the fall the central and southern portions of the tailings piles become dry.

In their current configuration, cemented tailings are exposed on most of tailings piles 1, 2, and 3 slopes and the tailings pile side slopes have angles ranging from 42 to 80 degrees. Despite the steep exterior side slopes, the tailings piles have stood for up to 50 years without failure except for isolated local slides and slumps associated with strong erosive forces from hillside drainage and flooding of Railroad Creek.

The historical construction records strongly suggest that the outer perimeters of the tailings piles were bounded by starter dams that were constructed on firm alluvium soils cleared of loose surficial soil, woody debris and organics. The starter dams were reportedly built of alluvium materials that most likely were obtained from the Railroad Creek relocation excavations and from nearby within the tailings pile footprint. The piles were raised with the coarsest fraction of tailings deposited along the crest and finest fraction deposited inward from the crest towards the hillside. Single and double dikes were constructed initially by hand and later by machinery around the outer edge of the tailings piles, ahead of the tailings disposal, to contain the tailings solids and water and provide freeboard, especially during the winter months. The historical records indicate that tailings pile 1 contains more coarse tailings than tailings piles 2 and 3 because tailings pile 1 was built of all the tailings that were produced, known as “total” tailings. Tailings piles 2 and 3 did not always receive the “total” tailings because the coarsest fraction of the tailings was used in the mine as stope backfill for the underground workings.

The results of the geotechnical investigations indicate that the tailings gradations and strengths vary by distance from the perimeter dike, which is consistent with the method of tailings deposition. The tailings are finer and their shear strength decreases with distance from the pile slope. Overbank deposits, a relatively low strength native soil, are present beneath most of the tailings piles. The historical record strongly suggests that the overbank deposits are not present beneath the starter dams that were built along the toe of each tailings pile. This material generally has a lower shear strength than the overlying tailings and is susceptible to liquefaction. Thus, the presence of the overbank deposits tends to govern the stability of the tailings piles (Appendix C).

The results of the stability analyses on existing conditions indicate that tailings pile 1 may have adequate static and seismic factors of safety for current state-of-the-practice, while tailings piles 2 and 3 do not. This is consistent with the fact that tailings pile 1 is lower in height and received total tailings while tailings piles 2 and 3 did not always receive the coarser fraction of the tailings. Likewise, the results of the deformation analyses indicate that tailings pile 1 may experience tolerable deformations under the Maximum Design Earthquake (MDE), while tailings piles 2 and 3 are vulnerable to "more-than-acceptable" seismically-induced deformation, instability and flow failure (Appendix C).

1.7 SUMMARY OF THE NATURE AND EXTENT OF CONTAMINATION

The results of the DRI and subsequent investigations indicate that historic mining operations at the Site are causing an ongoing release of hazardous substances to site surface water, groundwater, soil, and sediment at the Site. The releases are caused, in part, by acid rock drainage generated from weathering (e.g., chemical oxidation) of sulfur- and iron-bearing materials exposed in the underground mine, waste rock piles, tailings piles and in residual mining-related materials present in the mill-building and other site areas.

The following subsections describe the nature and extent of contamination detected at the Site through the investigations completed to date. Note that site investigation activities and related technical analyses are ongoing. Information obtained from the work to be completed in 2009 may be pertinent to final remedy selection and the new data will be provided to the Agencies as they become available.

1.7.1 Surface Water

Surface water sampling data show seasonal exceedances of potential surface water quality criteria (SWQC) for the protection of aquatic life for aluminum, cadmium, copper, iron, and zinc in Railroad Creek. The potential SWQC are discussed in Section 2.2. Railroad Creek sampling locations are shown on Figure 1-11. The ranges of metals concentrations detected in Railroad Creek samples for those constituents that exceed potential SWQC (referred to as PCOCs) are provided in Table 1-2. No PCOCs were identified for Copper Creek or Lake Chelan, because metals concentrations are below potential regulatory criteria in those surface water bodies.

Surface water and groundwater flow is the primary mechanism transporting PCOCs into Railroad Creek at the Site and metals enter Railroad Creek as seep flow, underground mine portal drainage flow, surface water diversion flow, and diffuse groundwater discharge. A plan view of site surface water runoff and groundwater seep locations is provided on Figure 1-12. Groundwater discharging to Railroad Creek in the western portion of the Site contains elevated concentrations of primarily cadmium, copper, and zinc as a result of precipitation, snowmelt, and/or shallow groundwater from upslope areas coming into contact with the underground mine workings, unprocessed ore, waste rock, or mineral salts in rock and soils. West area groundwater also contributes some iron and aluminum to Railroad Creek. The 1500-level main portal drainage contains elevated concentrations of primarily cadmium, copper, and zinc, with lesser concentrations of aluminum and iron, and serves as a transport pathway for these metals from the mine to west area groundwater and Railroad Creek. The results of the baseline loading analysis presented in the DFFS show that the portal drainage contributes the majority of cadmium, copper, and zinc loading from the Site to Railroad Creek.

Groundwater and seeps from the eastern portion of the Site (tailings piles) are the primary source of aluminum and iron loading to Railroad Creek. The tailings piles also contribute some cadmium, copper, and zinc to site groundwater and surface water. The results of the baseline loading analysis presented in the DFFS show that tailings pile 1 contributes the majority of iron and aluminum load from the Site to Railroad Creek, and is the primary source of cadmium, copper, and zinc loading to Railroad Creek from the east area, although the overall contribution of cadmium, copper, and zinc from the east area is much less than from west area sources.

During the spring melt (high-flow condition), cadmium, copper, and zinc concentrations increase at station RC-4, which is downstream of the confluence of the portal drainage with Railroad Creek, and remain steady or decrease as Railroad Creek flows across the eastern portion of the Site (stations RC-2, RC-13, and RC-5). The cadmium, copper, and zinc concentrations generally decrease with distance downstream of the Site (stations RC-10, RC-8, and RC-3). Concentrations of cadmium, copper, and zinc in Railroad Creek are lower during low-flow conditions, when there is a lower metals load discharging from the underground mine in the 1500-level main portal drainage.

For both high-flow and low-flow conditions, iron and aluminum concentrations remain relatively constant from upstream of the Site (station RC-6) across the west area (station RC-4), and then increase across the eastern portion of the Site (stations RC-2, RC-5, and RC-13). As observed for copper, cadmium, and zinc, the concentrations of aluminum and iron generally decrease with distance downstream of the Site (stations RC-10, RC-8, and RC-3).

1.7.2 Groundwater

Concentrations of cadmium, copper, lead, manganese, nickel, and zinc have been detected in site groundwater above potential human-health based groundwater criteria. The specific areas of elevated metals concentrations in groundwater include:

- Cadmium, copper, lead, manganese, and zinc concentrations in the LWA;
- Cadmium, copper, manganese nickel, and zinc concentrations beneath tailings pile 1;[1]
- Cadmium, copper, and manganese beneath tailings piles 2 and 3; and
- Manganese in one sample east of tailings pile 3.[2]

Table 1-3 provides a summary of metals concentrations for PCOCs that exceed potential human-health based groundwater criteria.[3] Groundwater sampling locations are shown in Figure 1-13.

As described in Section 2.2, it was determined in the DFFS and SFS that it is not practicable to meet potential groundwater quality criteria throughout the Site within a reasonable restoration time frame. Therefore, a CPOC would be established for site groundwater under any of the

---

[1] Additional sampling to assess lead concentrations in site groundwater is planned for 2009, because detection limits for some of the previous groundwater sampling events were above the potential regulatory criteria.

[2] Well NRC-3D was sampled twice in 2008. The July 2008 sample (774 ug/L manganese) slightly exceeded the lowest potential drinking water criterion of 747 ug/L. Concentrations in the August 2008 sample were below the potential criteria.

[3] Areas where potential human-health based groundwater criteria are exceeded include the LWA, tailings piles 1 through 3, and the area immediately east of tailings pile 3.

proposed remedial alternatives. Because Railroad Creek and Copper Creek abut the Site, a CPOC that is located within surface water at the point or points where groundwater flows into surface water may be established by Ecology. Concentrations would need to meet potential surface water criteria for the identified surface water PCOCs (aluminum, cadmium, copper, iron, and zinc) at the CPOC.

Based on the findings of the RI, subsequent groundwater investigations, and the groundwater flow model developed for the Site (Appendix E), groundwater impacted by mining activities is expected to discharge to Railroad Creek under current conditions from the following areas:

- Former SRA (seep SP-26);
- 1500-level main portal drainage;
- Groundwater seeps downslope of the Honeymoon Heights waste rock piles (seeps SP-12 and SP-23);
- Diffuse groundwater/seeps from LWA;
- Diffuse groundwater/seeps from tailings pile 1;
- Diffuse groundwater/seeps from the western portion of tailings pile 2;
- SP-21;[4] and
- Diffuse groundwater associated with tailings piles 2 and 3 that discharges to Railroad Creek downgradient of tailings pile 3.

Water quality data are currently not available in surface water at the point(s) where groundwater discharges to surface water downgradient (east) of the Site. Relatively high concentrations of PCOCs have been detected in shallow wells immediately adjacent to the northeast toe of tailings pile 3 (e.g., wells DS-2, DS-7S and NRC-3I) since wells were installed in this area in 2001. However, concentrations in well pairs approximately 750 feet downgradient of tailings pile 3 have shown significant decreases in PCOC concentrations since 2001 and no longer exceed potential surface water criteria at wells DS-3S/D and DS-4S/D. These decreases in PCOC concentrations in groundwater correspond with increasing pH (Figure 1-14).

The principal processes causing the declining concentrations at wells DS-3S/D and DS-4S/D are advection, dispersion and surface water influx

[4] Based on the findings of the DRI, surface drainage at location SP-21 is comprised of surface runoff from tailings piles 2 and 3 and possibly seasonal groundwater seepage from tailings pile 3.

to the aquifer. Surface water enters the groundwater system along Copper Creek and along the losing reach of Railroad Creek north of tailing pile 2 and 3. Consequently, the concentrations decline substantially with distance from the source area. Data obtained from these downgradient monitoring wells from 2001 through 2009 show concentrations have declined to only a small fraction of the source area concentrations measured in 1997. Moreover, as shown on Figure 1-14, throughout the monitoring period for these wells, the concentration trends have been steadily downward overall, without any observed trend in precipitation or streamflow. Together these observations strongly suggest that mass loading rates from the tailing piles are declining through time.

Additional hydrogeologic field investigations are ongoing to more fully characterize the nature and extent of the eastern groundwater plume, and to locate where groundwater discharges to Railroad Creek to the east of the Site. Monitoring wells installed further to the east in 2009 (DS-9S/I/D and DS-10S/I/D) also confirm that shallow groundwater quality downstream of wells DS-3 and DS-4 meets potential surface water quality criteria and that downward vertical hydraulic gradients are present in the aquifer system. These data continue to indicate that compliance with potential surface water criteria at a CPOC located to the east of tailings pile 3 could be accomplished through natural attenuation. Additional data collected in 2009 will be provided to the Agencies when it is available.

1.7.3 Soil

Soil samples were collected from the following AOIs[5] (Figures 1-15a and 1-15b):

- Areas downslope of Honeymoon Heights waste rock piles;
- Former SRA;
- Holden Village;
- LWA – west;
- LWA – east;

[5] Sampling has also been performed at the tailings piles and waste rock piles at the Site. As tailings and waste rock are not soil, the results from sampling performed at these areas are not discussed here. A summary of potential risks to ecological receptors associated with metals concentrations in the tailings piles and waste rock piles is provided in Section 1.8.

- Lagoon area;
- Maintenance yard;
- Area of windblown tailings; and
- Ballfield/wilderness boundary.

The soil sampling data summarized herein are from depths ranging from 0 to 6 feet below ground surface (bgs). The soil analytical data were compared to the lowest potential soil criteria identified in Section 2.2 for the protection of human health via direct contact pathway and for the protection of groundwater in areas where potential human-health based criteria are exceeded in groundwater[6] (Table 1-4). The potential soil criteria identified for the protection of groundwater are provided as conservative screening values only. If site soils having concentrations above these conservative screening levels remain in areas where potential groundwater criteria are exceeded and groundwater is not collected and treated, site-specific soil concentrations for the protection of groundwater will be evaluated.

The evaluation of site soils with respect to the protection of ecological receptors is ongoing and potential cleanup levels for the protection of ecological receptors are under development. Preliminary ecological indicator soil concentrations (EISCs) calculated based on the findings of the draft TEE are presented in Appendix I. Revised EISCs that are more relevant to site-specific conditions are being evaluated using one or more of the alternative methods provided in 173-340-7493(3)(a) through (g), and will be provided in the final TEE report for the Site.

The potential soil criteria for the protection of human health via direct contact and/or the conservative potential soil screening criteria for the protection of groundwater are exceeded in the following AOIs:

- *Areas downslope of Honeymoon Heights waste rock piles* – Soil samples from the areas downslope of the Honeymoon Heights waste rock piles exceed the conservative soil screening values for the protection of groundwater for cadmium and copper.
- *Lagoon area* - The lagoon soils exceed the conservative soil screening values for the protection of groundwater for cadmium, copper, and

6 As described in Section 1.7.2, groundwater PCOCs for the protection of human health include cadmium, copper, lead, manganese, nickel, and zinc.

zinc; the MTCA Method A values for diesel-range hydrocarbons; and the MTCA direct contact values for cadmium and copper.

- *LWA-west* – Surface soil samples from the LWA-west exceed the MTCA Method A value for arsenic.[7]
- *LWA-east* – Soil samples from the LWA-east exceed the conservative soil screening values for the protection of groundwater for cadmium, copper, and zinc; the MTCA Method A values for arsenic; and the MTCA direct contact values for cadmium and lead (in deeper soils only).
- *Maintenance yard* - Soils in the maintenance yard exceed the conservative soil screening values for the protection of groundwater for cadmium and copper; and the MTCA Method A values for arsenic, gasoline-range hydrocarbons, diesel-range hydrocarbons, and heavy oils.

Due to safety concerns, no soil samples have been collected to date from within the former mill building. However, surface water and seep sampling data indicate the presence of materials within the mill building that likely contain metals concentrations above potential soil criteria.

1.7.4 Sediment

Chemical and bioassay testing performed on sediment samples collected from Railroad Creek and the Lucerne bar, located in Lake Chelan at the mouth of Railroad Creek, show that sediment quality in Railroad Creek and Lake Chelan complies with the Washington State Sediment Management Standards (SMS) (Chapter 173-204 Washington Administrative Code [WAC]). The Railroad Creek and Lake Chelan sediment bioassay results are summarized in the following subsections.

---

[7] Note that arsenic concentrations were detected above the MTCA Method A value of 20 mg/kg in shallow soil samples in the LWA. However, arsenic concentrations were also detected above the MTCA Method A value at background locations sampled during the RI and in 2008. There are no documented arsenic-bearing minerals in the ore body. Tailings and waste rock samples indicate low arsenic concentrations, suggesting a low arsenic content in the pyrite. Isolated occurrences of naturally elevated arsenic are not uncommon in the region, and the relatively uniform concentrations of arsenic measured in the west area soils and soils near the Forest Service guard station are consistent with well mixed sediment from a distant source. Therefore, arsenic is not considered to be a soil PCOC.

1.7.4.1 *Railroad Creek Sediment*

Sediment sampling within Railroad Creek upstream, adjacent to, and downstream of the Site showed that metals concentrations in sediments increased adjacent to the Site, downstream of the portal drainage (Ecology 1997). However, based on the results of bioassay tests conducted on the amphipod *Hyalella azteca* and the bioluminescent bacteria Microtox® (Table 1-5), Ecology concluded that, although some metals concentrations were elevated above sediment guidance values, "the metals concentrations Railroad Creek sediments are not at toxic levels." The bioassay assay results also show compliance with the SMS (Chapter 173-204 WAC). Therefore, Railroad Creek sediment is not one of the areas/media considered for remediation at the Site.

1.7.4.2 *Lake Chelan Sediment*

Sediment samples from Lake Chelan near the mouth of Railroad Creek at Lucerne (referred to as the Lucerne bar) and from a reference site located at the northern end of the lake near Stehekin were collected for chemical analysis and bioassay testing. The bioassay testing included 21-day *Hyalella azteca* tests, 10-day *Chironomus tentans* tests, and Microtox® tests. The results of the bioassay testing show that metals concentrations in Lucerne bar sediment do not result in adverse biological impacts (Table 1-5) and that sediment at this location meets the SMS. Therefore, Lucerne bar sediment is not one of the areas/media considered for remediation at the Site.

1.8 *SUMMARY OF SITE RISKS*

A summary of the nature and extent of potential risks to human health and ecological receptors by historical mining activities at the Site is provided in the following subsections.

1.8.1 *Human Health*

The results of the Site baseline HHRA presented in the 1999 DRI showed no significant potential risks to human health for both Holden Village residents and visitors due to site exposure. The HHRA found no existing unacceptable risk to Holden Village residents or visitors based on current reasonable maximum exposures to PCOCs within soil, surface water, groundwater, sediments, and air at the Site. Since completion of the 1999 DRI, additional samples of surface and subsurface tailings and waste rock have been collected at the Site, and at the Agencies' request, a supplemental human health evaluation was conducted to assess current conditions and activities under Alternative 13M related to site tailings and waste rock. Results of the supplemental human health evaluations are presented in the Draft Supplemental Human Health Risk Evaluations for the Tailings and Waste Rock Piles (Appendix F, URS, 2009e).

Surface and subsurface tailings data from 0 to 16 feet and available waste rock data from 0 to 7 feet were combined and evaluated in the supplemental assessment. The standard point of compliance (POC) for evaluating MTCA Method B criteria based on human exposure via direct contact or other exposure pathways where contact is required to complete the pathway is 0 to 15 feet. With consideration of the new data, cadmium, copper, and/or lead were detected in the tailings and waste rock at concentrations exceeding the MTCA Method B criteria for the protection of human health (ingestion and dermal contact).[8] However, further evaluation of the frequency and magnitude of exceedances for the three metals at each of the three distinct site exposure areas (i.e., tailings piles, east and west waste rock piles, and Honeymoon Heights waste rock piles), led to the final selection of copper (tailings piles only) and lead (waste rock piles only) as PCOCs (Appendix F).

The primary current and expected future use of the tailings and waste rock piles is recreational (e.g., limited to occasional recreational hiking or playing Frisbee golf). In support of the Alternative 13M remedial activities, future maintenance and construction workers are also anticipated to be working on the tailings and east and west waste rock piles. Based on these land uses, remediation levels (RLs) were calculated to be protective of recreational, maintenance, and construction worker populations exposed to copper in the tailings piles and lead in the east and west waste rock piles. For Honeymoon Heights, the applicable lead RL was based on a recreational scenario only. The calculated RLs are very health protective for both recreational and working populations in that they assume much more regular exposure than is likely to actually occur (e.g., daily child exposures to Honeymoon Heights lead, 100 day per year exposures to copper in the tailings piles).

The results of the supplemental human health risk calculations demonstrate that the current and future recreational land use and future construction and maintenance worker activities associated with the

[8] Note that tailings pile data were not compared to the MTCA Method B criteria in the DFFS because it is Intalco's position that tailings piles are not "soil" and therefore MTCA Method B criteria, including human health values, are not an ARAR.

tailings and waste rock piles would be protective of human health. The 95-percent upper confidence limit copper concentrations in the tailings piles (0 to 16 feet bgs) and the average lead concentrations in the waste rock piles (0 to 7 feet bgs) are below the MTCA Method A and Method B criteria (250 mg/kg for lead and 2,700 mg/kg for copper) as well as the calculated RLs (Appendix F).

1.8.2 Ecological Receptors

Available surface water chemistry data from Railroad Creek show seasonal exceedances of potential surface water criteria for the protection of aquatic life for dissolved cadmium, copper and zinc and for total aluminum and iron (Table 1-2).[9]

Chemical and bioassay testing performed on sediment samples collected from Railroad Creek and the Lucerne bar, located in Lake Chelan at the mouth of Railroad Creek, show that sediment quality in Railroad Creek and Lake Chelan complies with the Washington State SMS (Chapter 173-204 WAC) (Table 1-5).

The results of the ecological risk assessment (ERA) completed as part of the DRI showed that metals concentrations in site soils may present a low potential risk in isolated locations to terrestrial wildlife and vegetation. The DRI ERA was conducted in accordance with available guidance and was consistent with the State of Washington 1997 MTCA. However, MTCA, including provisions related to the performance of TEEs, was later amended in 2001 (MTCA was again revised in 2007; however, no changes were made to the TEE process in the 2007 revisions.)

In March 2008, the Agencies' requested that the ERA be updated to address the current MTCA regulations and to include a broader list of PCOCs and soil AOIs. A draft TEE was subsequently completed (Appendix G, ERM-West, Inc. [ERM], 2009a) to characterize potential risks to terrestrial biota that may be exposed to site-related constituents. The TEE was completed for the following AOIs in accordance with the procedures under the 2007 MTCA regulations (WAC 173-340-7490 through -7494) (Figures 1-15a and 1-15b):

---

9 Intalco has submitted technical documentation in the DFFS demonstrating that the SWQC are based upon sensitive species that would not naturally inhabit Railroad or Copper Creeks and thus, potential justification for a modification to the SWQC (Hansen 2003a). Intalco also submitted technical documentation in the DFFS demonstrating that the NRWQC for site PCOCs are outdated and/or based upon species that do not inhabit Railroad or Copper Creeks and thus, are not relevant and appropriate to the Site (Hansen 2003a; Hansen 2003b; Hansen 2004b).

- Tailings piles 1, 2, and 3;
- Area of windblown tailings;
- East and west waste rock piles;
- Honeymoon Heights waste rock piles;
- Areas downslope of Honeymoon Heights waste rock piles;
- LWA-east;
- LWA-west;
- Holden Village; and
- Ballfield/wilderness boundary area.

As described further in Section 3, the remedial actions proposed under Alternatives 11 and 13M for the lagoon area, maintenance yard, former mill building, and the former SRA, including capping and/or soil removal, would mitigate potential exposure pathways for terrestrial ecological receptors. Therefore, these AOIs met the criteria under MTCA for exclusion from the TEE and were not evaluated further.[10] AOI-specific TEEs were completed for the remaining AOIs, and evaluated the potential for adverse impacts for the following terrestrial receptors:

- Plant communities;
- Soil invertebrate communities;
- Herbivorous, insectivorous, and carnivorous bird populations; and
- Herbivorous, insectivorous, and carnivorous mammal populations.

A summary of the draft AOI-specific risk characterizations is provided in the following subsections and in Tables 1-6 to 1-14. Preliminary EISCs, calculated based on the results of the draft AOI-specific TEEs are also provided in Appendix I. The assessment of ecological risks and calculation of potential EISCs for the protection of terrestrial receptors at the Site is ongoing; therefore the risk summaries and EISCs presented below and the Appendix I should be considered preliminary. Revised EISCs that are more relevant to site-specific conditions are being developed using one or more of the alternative methods provided in 173-

[10] WAC 173-340-7491[1] identifies criteria wherein areas may be excluded from a TEE. The specific TEE exclusions that pertain to Site AOIs relate to: 1) the depth of soil contamination; 2) covering or capping of contaminated soils; and 3) comparison with background concentrations. Additional details related to the exclusion of site AOIs from the TEE are provided in Appendix G.

340-7493(3)(a) through (g) and will be provided to the Agencies when they are available.

1.8.2.1 Tailings Piles 1, 2, and 3

Tailings piles 1, 2, and 3 are located along the south side of Railroad Creek, to west of the mine portal, and have a combined area of approximately 70 acres (Figures 1-15a and 1-15b). Currently, flat surfaces atop each of the three of the tailings piles consist of nearly 50 percent bare ground or sparse patches of perennial grass. Vegetation on the top of the three tailings piles is similar and consists primarily of pine trees and shrubs less-than 6 feet tall, and scattered patches of grasses/forbs. Most of the vegetation was observed in small stands, in many cases corresponding to locations where historical re-vegetation efforts were conducted. Eastside mixed conifer forest vegetation is observed on the native slope immediately to south of the tailings piles and appears to be re-colonizing the southern boundary of all three tailings piles. Overall, the physical attributes of the substrate and the patchily distributed habitat on the top flats of the tailings piles is considered to offer marginal refuge and foraging habitat (as compared to surrounding habitat) for most wildlife. However, sparse vegetation at the tailings piles may provide some refuge for prey species (e.g., snowshoe hare, small mammals) and may aid prey acquisition by predators.[11] Existing habitat is considered adequate to provide some cover for movement by wildlife.

At the toes of the tailings piles, thickets of alders, willows, cottonwood, and other shrubs were observed along the bank of Railroad Creek. All the plants appear healthy and show indications of recent growth. Red cedars were observed in the area at the base of the tailings pile 1 where more flat space existed between the toe of the tailings piles and Railroad Creek. Habitat at the toe of the tailings piles is contiguous and is considered to provide suitable cover as a movement corridor for wildlife. The area at the toe is also considered to provide suitable refuge and foraging habitat for small-bodied wildlife and limited habitat for large wildlife.

Based on the findings of the draft TEE, potential risks are predicted for the following terrestrial biota (Appendix G and Table 1-6):

- Plant communities due to exposures to several metals; and
- Soil invertebrate communities due to exposures to copper and zinc.

---

[11] Surrounding minimally disturbed habitat is suitable for supporting breeding populations for carnivorous wildlife.

Residual concentrations of PCOCs may contribute to the limited recruitment and re-establishment of vegetation observed at the tailings piles. However, based on the findings of the draft TEE, PCOC concentrations at the AOI pose no risk to bird and mammal populations.

1.8.2.2 *Area of Windblown Tailings*

The area of windblown tailings AOI includes the area north and east of tailings pile 3 where wind has transported and dispersed fine-grained tailings from the tailings piles. This AOI covers an area of approximately 77 acres, with 31 acres north of the gravel road to Lucerne and 46 acres south of the gravel road to Lucerne (Figure 1-15b). Windblown tailings were observed to cover what appear to be native soils, with the thickest windblown tailings layer generally observed in the area south of the gravel road to Lucerne and nearest tailings pile 3.

The area of windblown tailings supports a moderately dense mixed conifer tree canopy with an open understory of scattered shrubs and grasses/forbs. Areas north of the gravel road to Lucerne are characterized by relatively large conifer trees and a dense understory. This vegetation suggests minimal disturbance and the lack of logging in recent years. Evidence of recent logging (physical disturbance) was observed in areas south of the gravel road to Lucerne, between the road and Railroad Creek. This area is characterized by younger trees and an open understory. No visible indications of plant stress or inhibited growth were observed.

A narrow strip of eastside riparian wetland habitat that is dominated by extensive willow and alder thickets is found along Railroad Creek that borders the southern margin of this AOI.

Based on the findings of the draft TEE, potential risks were predicted for the following terrestrial biota (Appendix G and Table 1-7):

- Plant communities due to exposures to molybdenum; and
- Soil invertebrate communities due to exposures to copper.

Much of the area south of the road supported eastside mixed conifer forest habitat comparable to the background area. However, some areas south of the road exhibited vegetation consistent with recent physical disturbance (e.g., logging). Given the level of recent physical disturbance, it is uncertain whether/to what degree residual concentrations of PCOCs may affect the recruitment and re-establishment of native vegetation in this area of the AOI. The TEE suggested that minimally disturbed vegetation found in nearby surrounding areas may enhance recovery of the physically disturbed area.

Based on the findings of the draft TEE, PCOC concentrations at this AOI do not pose a risk to bird and mammal populations.

1.8.2.3 East and West Waste Rock Piles

The east and west waste rock piles AOI is comprised of two waste rock piles covering approximate 8.1 acres. The east waste rock pile is approximately 3.9 acres in size and located to the east of the former mill building (Figure 1-15a). The west waste rock pile is approximately 4.2 acres in size and located to the west of the former mill building. The top surfaces of the waste rock piles are currently used by the Holden Village to store refuse and other materials, with the east pile used to a lesser extent than the west pile.

Currently, only the occasional pine is observed at the east and west waste rock piles. A thin veneer of top soil is observed on both piles. Attractive undisturbed eastside mixed conifer forest is found in areas immediately surrounding this AOI to the south, east and west. Based on these recent observations, the top surfaces of the waste rock piles are not considered to provide attractive habitat or support native wildlife populations. However, the sides and toes of the waste rock may provide potential habitat for pika[12] and may support a portion of native small mammal populations.

Based on the findings of the draft TEE, potential risks are predicted for the following terrestrial biota (Appendix G and Table 1-8):

- Plant communities due to exposures to several metals; and
- Soil invertebrate communities due to exposures to copper, mercury, and zinc.

Residual concentrations of PCOCs may contribute to the limited recruitment and re-establishment of vegetation and soil invertebrates observed at the east and west waste rock piles. However, substrate characteristics (e.g., coarse grain) alone are considered to be inhospitable/not conducive for the recruitment and establishment of plants and soil invertebrates.

[12] Function as artificial talus slopes (pers. comm., Ms. Lenz, USFS).

Based on the findings of the draft TEE, PCOC concentrations at this AOI pose no risk to bird and mammal populations.

1.8.2.4 *Honeymoon Heights Waste Rock Piles*

The Honeymoon Heights waste rock piles AOI is comprised of five waste rock piles located near the following mine portals (Figure 1-15a):

- 1100-level portal,
- 800-level portal,
- 700-level portal,
- 550-level portal,
- 550-level portal, and
- 300-level portal.

The Honeymoon Heights portals and waste rock piles are located on the steep valley wall and cover approximately 5 acres in total. The largest of the Honeymoon Heights waste rock piles are associated with the 1100-level and 800-level portals, and cover a total area of approximately 1.4 acres.[13] Currently, only the occasional pine is observed on the piles and only a thin veneer of top soil is typically observed. Attractive undisturbed eastside mixed conifer forest is found in areas immediately surrounding this AOI. Based on these recent observations, the top surfaces of the waste rock piles are not considered to provide attractive habitat or support native wildlife populations. However, the sides and toes of the waste rock may provide potential habitat for pika and may support a portion of native small mammal populations.

Based on the findings of the draft TEE, potential risks are predicted for the following terrestrial biota (Appendix G and Table 1-9):

- Plant communities due to exposures to several metals; and
- Soil invertebrate communities due to exposures to copper, lead, mercury, and zinc.

Residual concentrations of PCOCs may contribute to the limited recruitment and re-establishment of vegetation observed at this AOI. However, substrate characteristics (e.g., coarse grain) alone are considered

---

[13] The 1100-level portal waste rock pile covers an area of 0.64 acres, while the 800-level portal waste rock pile covers an area of 0.73 acres.

to be inhospitable/not conducive for the recruitment and establishment of plants and soil invertebrates.

Based on the findings of the draft TEE, PCOC concentrations at this AOI pose no risk to most bird and mammal populations, with the possible exception of insectivorous bird populations due to exposures to lead. Overall, risks to terrestrial wildlife were generally considered to be minimal.

1.8.2.5 *Areas Downslope of Honeymoon Heights Waste Rock Piles*

The areas located directly downslope of the five Honeymoon Heights waste rock piles (at the 300-, 550-, 700-, 800-, and 1100-level portals) were identified by the Agencies and Intalco as a single AOI during the TEE field program (Figure 1-15a). This AOI encompasses a total of approximately 3 acres. The largest of these areas is an avalanche chute bordering and downslope of the 800- and 1100-level waste rock piles that covers approximately 0.9 acres. Intermittent surface water and eastside riparian wetland vegetation (e.g., willows, alders) were observed within this avalanche chute, which experiences seasonal, physical disturbance.

As observed in the eastside riparian wetland background area, the most common plant types at this AOI were willow and alder shrubs, which are plants typical of areas that receive periodic disturbance (i.e., flooding or rock/snow slides). This AOI supports moderately dense grass/forb cover and other areas have small groups of young conifers. Early succession vegetation observed in the avalanche chute may provide attractive foraging and hiding habitat for some species of wildlife and their associated predators. These continually regenerating habitats located within larger forested landscapes support relatively higher productivity that may be attractive foraging habitat for wildlife. Note that habitat observed in the avalanche chute located in the areas downslope of Honeymoon Heights waste rock piles do not provide unique habitat within Railroad Creek Valley as numerous avalanche chutes were observed in the valley during the TEE field investigation. The overall cover and plant species richness is significantly lower than that observed in the eastside riparian wetland background area; however, in the opinion of the expert botanist, this is likely due to the seasonal physical disturbance of the area.

Based on the findings of the draft TEE, potential risks are predicted for the following terrestrial biota (Appendix G and Table 1-10):

- Plant communities due to exposures to several metals; and

- Soil invertebrate communities due to exposures to copper, mercury, and zinc.

Residual concentrations of PCOCs may contribute to the limited recruitment and re-establishment of vegetation observed in the areas downslope of the Honeymoon Heights waste rock piles. However, in the opinion of an expert botanist, the periodic disturbance associated with avalanches in these chutes was considered to be a strong factor in determining the recruitment, establishment, composition, and cover of vegetation.

Based on the findings of the draft TEE, PCOC concentrations at the AOI pose no risk to most bird and mammal populations, with the possible exception of insectivorous mammal populations due to exposures to copper. Overall, risks to terrestrial wildlife were generally considered to be minimal.

1.8.2.6 Lower West Area

The LWA covers approximately 15 acres and includes the relatively flat area south of Railroad Creek and west of tailings pile 1. The LWA is downgradient of the underground mine and the west waste rock pile (Figure 1-15a). This AOI supports mixed (deciduous and coniferous) forest with a sparse understory. Dense willow and alder thickets are present along the south bank of Railroad Creek in this AOI. The LWA is subjected to different levels of physical disturbance (e.g., clearing of vegetation, large vehicular traffic). The western portion of the AOI (west of the lagoon area) is less disturbed and supports a combination of eastside mixed conifer forest and riparian wetland habitats. The eastern portion of the AOI (east of the lagoon area, extending to the base of tailings pile 1) is highly disturbed and supports disturbed vegetation of both habitat types. Based on differing soil concentrations, characteristics, and land use, and where appropriate, subsequent discussion is separated in terms of two subareas: 1) the LWA-east, and 2) the LWA-west.

Lower West Area-East

Based on the findings of the draft TEE, potential risks are predicted for the following terrestrial biota at the LWA-east (Appendix G and Table 1-11):

- Plant communities due to exposures to several metals; and
- Soil invertebrate communities due to exposures to cadmium, copper, lead, and zinc.

Residual concentrations of PCOCs may contribute to the limited recruitment and re-establishment of vegetation observed in the LWA-east. Based on the findings of the draft TEE, PCOC concentrations at this AOI pose no risk to most bird and mammal populations, with the possible exception of:

- Insectivorous bird populations due to exposures to copper and lead; and
- Herbivorous, insectivorous, and carnivorous mammals populations due to exposures to copper.

Lower West Area-West

Based on the findings of the draft TEE (Appendix G and Table 1-12), potential risks are predicted for plant communities at the LWA-west due to exposures to arsenic. However, PCOC concentrations in soils at this AOI pose no risk to terrestrial soil invertebrate communities, bird populations, or mammal populations.

1.8.2.7 Holden Village

Holden Village covers approximately 11 acres on the north side of Railroad Creek, and includes approximately 25 buildings (Figure 1-15a). Holden Village is currently operated as an interdenominational retreat with approximately 50 to 60 year-round residents and reportedly 5,000 to 6,000 visitors each year. The grounds of Holden Village are landscaped with maintained lawns and ornamental trees, shrubs, and flowers. These grounds are not intended or maintained to support natural plant communities and wildlife populations. The planed future land use for the Holden Village includes continued use as an interdenominational retreat, with continued maintenance of lawns and ornamental plants on the grounds.

Most of the vegetation in the Holden Village has low structural complexity due to active management of lawn and ornamental shrubs and trees. A few areas along the perimeter contain native trees and shrubs, but also have relatively simple vegetation structure. Though transient wildlife is not discouraged, the grounds are maintained in a manner that is not intended, is not conducive, and is unlikely to support native wildlife populations.

Based on the findings of the draft TEE (Appendix G and Table 1-13), PCOC concentrations pose no risk to bird and mammal populations. Given the current and planned land use, non-native ornamental plants and soil invertebrates were not considered terrestrial receptors of concern and were not evaluated in the draft TEE.

1.8.2.8 Ballfield/Wilderness Boundary Area

The ballfield/wilderness boundary area AOI is located north of Railroad Creek in the western portion of the Site (Figure 1-15a). The Glacier Peak Wilderness boundary (referred to as the "wilderness boundary area") is located several hundred feet west of the ballfield. The ballfield covers approximately 1 to 2 acres, is located approximately one-half mile to the west of Holden Village, and appears to have been constructed utilizing soil removed from a cut slope immediately north of the field. The wilderness boundary area is an area of undefined size located immediately to the west of the ballfield on the north side of Railroad Creek.

The forested portion of the ballfield/wilderness boundary area contains dense plant cover with high species richness and structural complexity, similar to that seen at the eastside mixed conifer forest background area. The ballfield portion of this area is currently overgrown with grasses and has low structural complexity because it appears to be maintained to keep trees and shrubs from establishing. However, this mowed area has an herbaceous cover made up of a mixture of several species of native and introduced weeds and grasses. It is anticipated that the ballfield will remain in the current maintained state by the Holden Village and will not be returned back to the natural surrounding habitat.

Based on the findings of the draft TEE, PCOC concentrations in soils at the ballfield/wilderness pose no risk to terrestrial plants and soil invertebrate communities (Table 1-14). Concentrations of PCOCs at this AOI also were considered to pose no risk to bird and mammal populations, with the possible exception of insectivorous mammal populations due to exposures to copper.

1.9 CURRENT AND ANTICIPATED FUTURE LAND USE

The Site is situated within the Wenatchee National Forest. Areas outside of the Holden Village and associated facilities are infrequently visited by occasional hikers and campers (in designated areas). Railroad Creek is utilized occasionally by Holden Village residents and visitors for recreational purposes such as sport fishing during the warmer summer months, as well as occasional religious rituals. The current land uses at Site AOIs include the following:

- *Holden Village* - The Holden Village is operated as an interdenominational religious retreat under a Conditional Use Permit issued by the USDA Forest Service. All of the buildings in the village are located on National Forest System managed land. Approximately 50 to 60 Holden Village staff resides at the village year round. In addition, approximately 5,000 to 6,000 people reportedly visit the facility each year, each person typically staying from 2 to 7 days. Facilities at the Holden Village include buildings, access roads and paths, and maintained landscaping.
- *Tailings piles 1, 2, and 3* - The evacuation area for the Holden Village is located on tailings pile 1. The tailings piles are also used occasionally for material storage, access to hiking trails, Frisbee golf, and other light recreational uses.
- *East and west waste rock piles* - The top surfaces of the east and west waste rock piles are currently used by the Holden Village for the storage of miscellaneous refuse and materials and are also infrequently visited by hikers and other recreational users. The east waste rock pile is used to a lesser extent than the west waste rock pile.
- *Honeymoon Heights waste rock piles* - The Honeymoon Heights waste rock piles are not routinely utilized; however, hikers and other recreational users occasionally visit these waste rock piles.
- *Areas downslope of Honeymoon Heights waste rock piles* – The areas downslope of Honeymoon Heights waste rock piles are not currently utilized with the exception of a hiking trail that passes beneath the 1100-level and 800-level waste rock piles.
- *Former SRA* - The former SRA is not currently utilized.
- *LWA* - The LWA is bisected by a road providing the primary access to the maintenance yard and site features associated with mine operations (waste rock piles, former mill building, 1500-level main portal, and tailings piles). Large vehicle traffic regularly occurs through the LWA. The Holden Village operates a firewood cutting /storage yard and hydroelectric power plant in the eastern portion of the LWA.
- *Lagoon feature* – The lagoon feature is not currently utilized, other than for occasional vehicle storage in the flat area immediately north of the lagoon.
- *Maintenance Yard* - The maintenance yard is currently used by the Holden Village for equipment maintenance and storage.

- *Area of windblown tailings* – Lucerne Road, which provides access to the Site from Lake Chelan, crosses the area of windblown tailings and sustains occasional vehicle traffic. The Holden Village operates a septic system in the area of windblown tailings. Hikers and other recreational users also utilize or cross the area of windblown tailings to access Railroad Creek and a footbridge crossing Railroad Creek east of tailings pile 3.
- *Ballfield / wilderness boundary* – The ballfield is occasionally utilized by the Holden Village for recreation and religious ceremonies. The wilderness boundary is utilized by hikers and campers, and a campground is maintained in this area by the USDA Forest Service.

Anticipated future land use at the Site is expected to be generally consistent with current land use for the majority of the Site. However, following remedy implementation, some site features may no longer exist (e.g., features that are removed or covered) and some areas of the Site may have new or modified uses, such as areas where groundwater collection or water treatment systems are constructed and operated, and areas where treatment system residues would be disposed.

2.0 PROPOSED REMEDIAL ACTION OBJECTIVES AND CLEANUP REQUIREMENTS

The proposed RAOs and potential cleanup requirements for the Site are discussed in the following subsections.

2.1 PROPOSED REMEDIAL ACTION OBJECTIVES

RAOs specify the contaminants and media of concern, potential exposure pathways, and remediation goals for protecting human health and the environment (40 Code of Federal Regulations [CFR] 300.430[e][2][i]). Preliminary RAOs were developed by the Agencies and Intalco during the scoping process for the RI/FS and were subsequently modified by the Agencies in their submittal to the USEPA National Remedy Review Board (USDA Forest Service et al., 2005) and Final Draft Proposed Plan. As described under 40 CFR 300.430(e)(2)(i), preliminary RAOs are to be modified, as necessary, as more site information becomes available during the RI/FS. Based on additional site information obtained in 2008 and 2009, modified RAOs are proposed and presented below. The proposed RAOs, which describe the requirements that must be met by the selected remedial alternative, include:

1. Meet surface water ARARs or alternative risk-based concentrations that are protective of human health and aquatic life in Railroad Creek and Copper Creek within a reasonable restoration time frame.
2. Meet ARARs or alternative risk-based concentrations that are protective of human health and aquatic life at CPOCs in surface water where groundwater enters Railroad Creek and Copper Creek within a reasonable restoration time frame.
3. Meet Washington State sediment quality requirements that are protective of human health and the environment within a reasonable restoration time frame.
4. Attain surface soil quality that is protective of human health and terrestrial ecological receptors.
5. Stabilize tailings and waste rock pile side slopes, as needed, to satisfy ARARs, prevent future releases of tailings or waste rock into surface water, and protect human health.
6. Prevent access to underground mine workings and reduce the potential for human exposure to hazardous substances remaining on

site following remedy implementation, including through use of groundwater as a drinking water source.

7. Perform appropriate NRDA activities as agreed by the Parties to evaluate the potential for coordinated remediation and natural resource restoration activities.
8. Implement the remedial action in a manner that protects human health and the environment, including the Holden Village residential community during and after construction.

Potential ARARs are identified and discussed in Section 2.2. Final RAOs will be determined when the remedy is selected and presented in the Record of Decision (ROD) for the Site.

2.2 *POTENTIAL CLEANUP REQUIREMENTS*

Remedial actions under CERCLA must meet standards, requirements, criteria, or limitations that are determined to be ARARs and that are not waived. The following subsections present potential chemical-specific, action-specific, and location-specific ARARs for the Site. Other items to be considered (TBCs) in developing cleanup requirements, including non-promulgated advisories or guidance issued by federal or state governments that are not legally binding and do not have the status of potential ARARs, are also presented. The state and federal laws and regulations discussed in this memo are identified as potential ARARs. The final determination of ARARs will be made as part of the final remedy selection.

CERCLA 121(d)(4), 42 U.S.C. 9621(d)(4), provides that ARARs may be waived under certain circumstances. The waiver criteria include the following:

- The remedial action is being conducted as an interim measure;
- Compliance with the ARAR would result in greater risk to health and the environment;
- Compliance with the ARAR is technically impractical;
- Equivalent standard of performance;
- Inconsistent application of state requirements; and
- Fund balancing (applicable to Superfund-funded sites only).

No ARAR waivers are specifically identified or requested in this memo. However, Intalco reserves the right to submit documentation supporting such waivers if they are deemed necessary based on remedy performance and site conditions.

2.2.1 *Key Potential Chemical-Specific ARARs*

Chemical-specific ARARs are health-based or risk-based numerical values[14] that specify the acceptable amount or concentration of a hazardous substance that may be found in or discharged to the environment. Potential cleanup levels were identified as the lowest potential chemical-specific ARAR for a given PCOC and media, the background concentration, or the analytical laboratory practical quantitation limit (PQL), whichever is greater. Site PCOCs are identified as those substances that exceed a potential cleanup level.

Potential cleanup levels for site PCOCs are summarized in Table 2-1. Note that for site soils, potential cleanup levels for the protection of ecological receptors are under development. Preliminary EISCs for the protection of terrestrial ecological receptors are included in Appendix I for screening purposes only while potential cleanup levels are being developed.

The locations at the Site where potential cleanup levels must be met, referred to as POCs, are summarized in Table 2-2. A comparison of site surface water, groundwater, and soil data against potential cleanup levels is provided in Section 1.7.

2.2.1.1 *Safe Drinking Water Act (42 USC 300(f) et. seq.); National Primary Drinking Water Regulations (40 CFR Part 141.61[a] and [c], 141.62[b]) and National Maximum Contaminant Level Goals (40 CFR Part 141.50[b] and 141.51[b])*

The federal primary drinking water regulations establish health-based maximum contaminant levels (MCLs) for public water systems. Although site groundwater and surface water, including Railroad Creek, Copper Creek downstream of the Holden Village water structure, and Lake Chelan, are not public water systems, the Agencies contend that the federal MCLs are potentially relevant and appropriate requirements for these waters. Railroad Creek, Copper Creek, and Lake Chelan are not specifically listed in the Washington State Water Quality Regulations

---

[14] Chemical-specific ARARs can also include standards, which when applied to site-specific conditions, result in establishment of numerical values.

(Chapter 173-201A WAC), but are generally categorized as having a potential designated use as a domestic water supply per WAC 173-210A-600. The MCLs are not exceeded in site surface waters.

MCL Goals (MCLGs) are non-enforceable health goals for public water systems. CERCLA 121(d)(2)(A) and the National Contingency Plan (40 CFR 300) require consideration of non-zero MCLGs where such goals are relevant and appropriate under the circumstances of the release. The Agencies contend that these non-enforceable goals are potentially relevant and appropriate to groundwater and surface water at the Site. Non-zero MCLGs for the PCOCs in site groundwater and surface water are equal to the MCLs.

2.2.1.2 Washington State Drinking Water Standards (RCW 70.19A; WAC 246-290-310[3] and [8])

The Washington Department of Health (WDOH) primary drinking water regulations establish primary MCLs for public water systems. The Agencies contend that those state MCLs that are more stringent than federal primary MCLs are potentially relevant and appropriate to groundwater and surface water at the Site. Nickel is the only Washington State MCL that is more stringent than the federal MCL. The state MCL for nickel is not exceeded in Railroad Creek, Copper Creek or Lake Chelan.

2.2.1.3 Safe Drinking Water Act (42 USC 300(f) et. seq.) National Secondary Drinking Water Regulations (40 CFR 143.3); Washington State Secondary Drinking Water Standards (RCW 70.119A; WAC 246-290-310[3])

The USEPA and WDOH have established secondary drinking water requirements for public water systems. These secondary MCLs are not health-based standards, but are based upon aesthetic criteria. These federal and state secondary MCLs are not potential ARARs for groundwater or surface water at the Site.

2.2.1.4 Washington State Water Quality Standards for Surface Waters (WAC 173-201A-240 [3] and [5], and WAC 173-201A-600)

Under Section 303(c) of the Clean Water Act (CWA), states are required to designate water body uses and adopt state SWQC based those uses. In promulgating SWQC, states are to consider national recommended water quality criteria (NRWQC) published by the USEPA under Section 304(a) of the CWA.

The State of Washington has designated beneficial uses for surface water bodies of the state and established SWQC for the protection of human health and aquatic life. The designated beneficial uses for Railroad Creek and Copper Creek under WAC 173-201A-600 are:

- 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.

The state of Washington regulations require that Railroad and Copper Creeks be protected for its designated beneficial uses (WAC 173-201A-200 and -600).

The SWQC for the protection of aquatic life adopted by the state of Washington are listed in WAC 173-201A-240(3).[15] WAC 173-201A-240(3) identifies the concentrations of toxic substances protective of aquatic life in fresh and marine waters of the state. For several metals, the SWQC are hardness dependent and based on the dissolved-phase concentrations. In addition, under WAC 173-201A-240(4) and (5), the USEPA Quality Criteria for Water, 1986, revised NRWQC are to be used in the interpretation of listed SWQC for the protection of aquatic life[16] and considered in determining appropriate concentrations for toxic, and other substances with toxic properties not on the listed SWQC. While reserving objections, Intalco has agreed to evaluate the SWQC as potentially applicable to surface water at the Site. As such, where hazardous substances in groundwater are likely to reach surface water, the SWQC are evaluated as potentially relevant and appropriate to groundwater at the Site.

For human health-based water quality criteria, the state of Washington has adopted by reference in WAC 173-201A-240(5) the concentrations presented in 40 CFR 131.36 known as the National Toxics Rule (NTR). No human-health standards have been established under the NTR for the

---

[15] Although Intalco believes that a modification of the SWQC is not necessary at this time, Intalco has submitted technical documentation in the DFFS demonstrating that the SWQC are based upon sensitive species that would not naturally inhabit Railroad or Copper Creeks and thus, the potential justification for a modification to the SWQC (Hansen 2003a).

[16] As previously expressed by Intalco, under the Washington State non-delegation doctrine, future or "as revised" versions of federal guidance cannot be incorporated by reference; thus, the 1986 Water Quality Criteria shall be used in the state of Washington in the use and interpretation of the toxic substance values listed in WAC 173-201A-240(3).

identified surface water or groundwater PCOCs at the Site; therefore, the NTR has not been identified as a potential ARAR.

As discussed in more detail below, a mixing zone would be established for any point source discharges to surface waters at the Site under MTCA (WAC 173-201A-400).

2.2.1.5 Federal Clean Water Act (33 USC 1251-1376)/ National Recommended Water Quality Criteria (1999, 2002, 2006 and 2007)

The NRWQC is guidance established by the USEPA for evaluating toxic effects on human health and aquatic organisms. NRWQC have been published and updated since the early 1980s. The NRWQC evaluated as part of the Holden Mine RI/FS include the NRWQC published in 1999, 2002, and 2006.[17] As described for the SWQC, for several metals, the NRWQC are hardness dependent and based on dissolved-phase concentrations. While reserving objections, Intalco has agreed to evaluate the NRWQC as potentially relevant and appropriate to site surface water. As such, where hazardous substances in groundwater are likely to reach surface water, the NRWQC are evaluated as potentially relevant and appropriate to site groundwater.

In 2007, USEPA issued new NRWQC guidance for the development of aquatic life freshwater quality criteria for copper using the biotic ligand model (BLM). The BLM is a metal bioavailability model that uses receiving water body characteristics and monitoring data to develop site-specific water quality criteria. Input data for the BLM include: temperature, pH, dissolved organic carbon, major cations (Ca, Mg, Na, and K), major anions (SO_4 and Cl), alkalinity, and sulfide. Site-specific data are being collected in 2009 to evaluate the relevance and appropriateness of establishing potential surface water criteria for Railroad Creek using this method. The aquatic life freshwater quality criteria for copper based on the 2007 NRWQC guidance will be included as an ARAR, if determined to be relevant and appropriate to site conditions.

[17] Intalco has submitted to the Agencies technical documentation in the DFFS demonstrating that the NRWQC for Site PCOCs are outdated, and/or based upon species that do not inhabit Railroad Creek or Copper Creek and thus, the NRWQC are not relevant and appropriate to the Holden Mine Site (Hansen 2003a; Hansen 2003b; Hansen 2004b).

2.2.1.6 *National Toxics Rule (33 USC 1251; 40 CFR 131.36[b][1] and [d][14]; WAC 173-201A-240[5])*

The NTR establishes water quality criteria for toxic substances for freshwater aquatic life and human health. The State of Washington has adopted by reference only the human-health based criteria as referenced in 40 CFR 131.36(d)(14) (WAC 173-201A-240[5]). The NTR freshwater aquatic life criteria have not been adopted by the state of Washington and are not potentially applicable or relevant and appropriate. Only the human-health based standards specified in 40 CFR 131.36(d)(14) are potentially applicable to site surface water and are potentially relevant and appropriate to hazardous substances in groundwater that are likely to reach surface water. No human-health standards have been established under the NTR for the PCOCs in site surface water or groundwater; therefore, the NTR is not considered a potential ARAR.

2.2.1.7 *Washington Model Toxics Control Act (RCW 70.105D, Chapter 173-340 WAC)*

The Washington MTCA regulations specify criteria for setting cleanup standards for groundwater, surface water and soils and are potentially applicable to setting cleanup standards for the Site. The MTCA Method B is the universal standard and may be used to establish cleanup standards at any site. MTCA Method B cleanup levels for individual identified hazardous substances consider potentially applicable federal and state laws and risk equations. Under MTCA, cleanup standards consider the cleanup level, POC and other regulatory requirements that apply to the Site because of the type of action or location (WAC 173-340-700[3]).

Potential MTCA Surface Water Requirements. The following MTCA Method B requirements are potentially applicable to evaluating cleanup standards for Railroad Creek:

- *Federal and State Laws.* Under WAC 173-340-730(3)(b)(i), potential MTCA Method B cleanup levels will consider concentrations specified under state and federal laws. These potential laws include: SWQC specified in Chapter 173-201A WAC; NRWQC unless it can be demonstrated that such criteria are not relevant and appropriate for a specific surface water body or hazardous substance; and the NTR (40 CFR 131.36[d][14]).
- *Environmental Effects***.** Under WAC 173-340-730(3)(b)(ii), where environmental effects-based concentrations have not been established under applicable federal and state law, concentrations that are

estimated to result in no adverse effects on protection and propagation of wildlife, fish and other aquatic life.[18]

- *Risk-Based Adjustment of Potential MTCA ARARs.* Under WAC 173-340-730(5)(b), MTCA specifies that potential surface water ARARs have a human health based risk that is 1 x 10^{-5} or less for carcinogens or a hazard quotient (HQ) of 1 or less for non-carcinogens. If the identified potential ARAR does not meet these standards, then the potential ARAR must be adjusted downward using the equations in Tables 730-1 and 730-2.
- *Human-Health Based Values.* Under WAC 173-340-730(3)(b)(iii), where no federal or state standards exist for a contaminant, then the MTCA states that the preliminary cleanup standard will be the MTCA Method B cleanup levels for carcinogenic and non-carcinogenic substances.[19]
- *Domestic Water Supply Values.* Under WAC 173-340-730(3)(b)(iv), where surface waters are designated as a potential domestic water supply use under Chapter 173-201A WAC, the potential cleanup standards for groundwater (WAC 173-340-720) may be considered. Railroad Creek is generally categorized in Chapter 173-201A WAC as having a potential designated use as a domestic water supply.[20]
- *Adjustment for PQL and Background.* Under WAC 173-340-730(5)(c), MTCA specifies that potential cleanup levels shall not be set below the PQL or natural background concentrations, whichever is higher.[21]
- *Conditional Point(s) of Compliance.* Under WAC 173-340-730(6), MTCA specifies that the POC for surface water cleanup will be the point or points at which hazardous substances are released to surface waters unless a mixing zone is established in accordance with WAC 173-200A-400. Potential CPOCs for surface water are described in Table 2-2.

---

[18] Environmental-effects based concentrations (protection of aquatic life) have been established for all Site PCOCs.

[19] Federal and/or state surface water standards exist for all the Site PCOCs.

[20] Although the Chapter 173-201A WAC generally categorizes these water bodies as potential domestic water supply uses, there is no present, planned, or intended foreseeable future use of these water bodies for drinking water as discussed above.

[21] Potential ARARs identified for the surface water PCOCs are above natural background and the PQL, with the exception of the NRWQC for aluminum and cadmium. Available surface water quality data indicate that natural background concentrations of dissolved cadmium and total aluminum may seasonally exceed the NRWQC. Therefore, in evaluating the NRWQC for cadmium and aluminum in Site surface waters, these cleanup levels may need to be adjusted upward.

Potential MTCA Groundwater Requirements. The following MTCA Method B requirements are potentially applicable to evaluating groundwater cleanup standards at the Site:

- *Potential Federal and State Laws.* Under WAC 173-340-720(4)(b)(i), potential MTCA Method B cleanup levels consider concentrations specified under state and federal laws. These potential ARARs include: MCLs established under the Safe Drinking Water Act (40 CFR 141); MCLGs established under the SDWA (40 CFR 141) and MCLs established by the WDOH (Chapter 246-296 WAC).

- *Risk-Based Adjustment of Potential MTCA ARARs.* Under WAC 173-340-720(7)(b), MTCA specifies that potential groundwater ARARs have a human health based risk that is 1 x 10^{-5} or less for carcinogens or a HQ of 1 or less for non-carcinogens. If the potential ARAR does not meet these standards, then the potential ARAR must be adjusted downward using the equations in Tables 720-1 and 720-2.

- *Potential Surface Water Beneficial Use***.** Under WAC 173-340-720(4)(b)(ii), MTCA specifies that the potential concentrations established in accordance with the methods specified in WAC 173-340-730 (for surface water described above) may be applicable to groundwater cleanup where it is determined that the hazardous substances in the groundwater are likely to reach surface water.

- *Potential Human-Health Based Values***.** Under WAC 173-340-720(4)(b)(iii), where no federal or state standards exist for a contaminant, then the MTCA states that the preliminary cleanup standard will be the MTCA Method B cleanup levels for carcinogenic and non-carcinogenic substances.[22]

- *Adjustment for PQL and Background.* Under WAC 173-340-720(7)(c), MTCA requires that cleanup levels shall not be set below the PQL or natural background concentrations, whichever is higher.

- *Conditional Point(s) of Compliance.* Under WAC 173-340-720(8)(d), MTCA specifies that a CPOC may be established for groundwater cleanup at sites where it is not practicable to meet potential chemical-specific ARARs within groundwater under portions of the site. The CPOC may be established in surface water at the point where groundwater enters surface water if the criteria provided under WAC

[22] Potential ARARs exist for all of the groundwater PCOCs at the Site except manganese.

173-340-720(8)(d)(i) are satisfied.[23] Potential CPOCs for groundwater are described in Table 2-2.

Potential MTCA Soil Requirements. The following MTCA Method B requirements are potentially applicable to evaluating soil cleanup standards at the Site. These requirements are not potential ARARs for tailings piles and waste rock piles which will be addressed under the Solid Waste Handling regulations (Chapter 173-351 WAC):

- *Potential Federal and State Laws.* Under WAC 173-340-740(3)(b)(i), potential MTCA Method B cleanup levels are to consider concentrations specified under federal and state laws.[24]
- *Human Health Protection.* Under WAC 173-340-740(3)(b)(iii), where no federal or state standards exist for a contaminant, then the MTCA states that the preliminary cleanup standard will be a concentration that protects human health as determined by evaluating pathways for groundwater and dermal contact.[25] For groundwater, the regulation requires that PCOCs in soil will not cause contamination of groundwater at levels that exceed the human-health based groundwater cleanup levels using the methods specified in WAC 173-340-747. Soil values were calculated using the three-phase partitioning model under WAC 173-340-747 for the potential human-health based groundwater ARARs and are presented in Tables 1-4 and 2-1.[26] The potential human-health based soil values for the protection of groundwater do not apply in areas where human-health based groundwater cleanup levels are met.[27] The MTCA Method B values calculated for the direct contact pathway are potentially applicable.
- *Adjustments to Potential Human-Health Based Values*. Under WAC 173-340-740(5)(b), MTCA specifies that potential ARARs have a human health based risk that is 1 x 10^{-5} or less for carcinogens or a HQ of 1 or

---

[23] Justification for establishing a CPOC for Site groundwater is provided in Section 4.2.

[24] No potential federal or state ARARs specify standards for soils.

[25] Under WAC 173-340-740(1)(d), MTCA generally specifies that potential soil cleanup levels will be established at concentrations that do not directly or indirectly cause violations of surface water cleanup standards established under MTCA and state and federal laws. MTCA does not require that potential numerical ARARs be established for the soil to surface water pathway or for any non-human health based purpose, and thus, no potential numerical chemical-specific ARAR for this pathway is included in Tables 1-4 or 2-1.

[26] Site-specific values may be evaluated under MTCA during design, based on actual Site soil characteristics.

[27] During the remedial design, potential human-health based soil ARARs for the protection of groundwater would be established, if necessary, based upon the remedy selected, using other, alternative methods outlined under WAC 173-340-747.

less for non-carcinogens. If the identified potential ARARs do not meet these standards, then the potential ARAR must be adjusted downward.

- *No Significant Adverse Terrestrial Ecological Risk.* Under WAC 173-340-740(3)(b)(ii), MTCA requires that concentrations of hazardous substances result in no significant adverse effects on the protection and propagation of terrestrial ecological receptors unless it is determined that establishing such soil concentration is not necessary.

  MTCA provides exemptions from calculating potential soil concentrations based upon terrestrial ecological receptors under the following conditions:

  - Soils contaminated with hazardous substances are, or will be, located below the POC.[28]
  - Soils contaminated with hazardous substances are, or will be, covered by buildings, paved roads, pavement or other physical barriers that will prevent plants or wildlife from being exposed. This exemption is potentially applicable to several site AOIs, including but not limited to the lagoon area, maintenance yard, and mill building.
  - Land use at the site and surrounding area makes substantial wildlife exposure unlikely.
  - No potential exposure pathway from soil contamination to soil biota, plants or wildlife exists. For instance for areas with industrial uses, there would not be an exposure pathway for plants or soil biota, only potential exposure pathways to wildlife. Likewise, in instances where man-made physical barriers exist, there is an incomplete pathway for plants, soil biota and wildlife.
  - The site includes less than 1.5 acres of contiguous undeveloped land on the site or within 500 feet of any area of the site (WAC 173-340-7491[1] and WAC 173-340-7492[2]).

  A site-specific TEE in conformance with WAC 173-340-7490 through -7494 is under development for site AOIs. However, the TEE is not yet complete and potential cleanup levels for the protection of ecological receptors are not yet available. As such, preliminary conservative

[28] The standard POC under MTCA is 15 feet bgs. However, for sites with institutional controls to prevent excavation of deeper soil, a CPOC may be set at the biologically active zone, assumed to extend to a depth of 6 feet. Ecology may approve a site-specific depth based on a demonstration that it is more appropriate to the Site (WAC 173-340-7490[4][a]).

EISCs for the protection of terrestrial receptors have been calculated based on the draft TEE and are presented for screening purposes only in Appendix I. Proposed cleanup levels and/or RLs for the protection of ecological receptors will be proposed to the Agencies as soon as the TEE is completed.

- *Adjustment for PQL and Background***.** Under WAC 173-340-740(5)(c), MTCA specifies that cleanup levels need to be adjusted so that they are not set below the PQL or natural background concentrations, whichever is higher. Site-specific background soil data collected during the RI and 2008 TEE were used to establish natural background levels for the site PCOCs. These values are presented in Table 1-4 and Appendix I. This requirement is potentially applicable in evaluating soil cleanup levels for cadmium.
- *Conditional Point(s) of Compliance.* Under WAC 173-340-740(6) and WAC 173-340-7490(4), MTCA specifies points of compliance for soils which are based upon protection of groundwater, protection from vapors, and human exposure via direct contact or other exposure pathways, based upon ecological considerations or CPOCs. A discussion of potential POCs and CPOCs for soil is provided in Table 2-2.

2.2.1.8 Washington State Sediment Management Standards (Chapter 173-204 WAC)

There is currently no promulgated state or federal standards for freshwater sediment quality and final freshwater sediment quality values have not been selected by Ecology. Under WAC 173-204-310(2), Ecology allows the use of confirmatory biological testing on freshwater sediment with concentrations greater than sediment screening guidance values to determine compliance with the state SMS. Agency-approved sediment chemistry and bioassay testing results on Railroad Creek sediment (Ecology, 1997) and sediment in Lake Chelan at the Lucerne bar (URS, 2002, and URS, 2003) showed that site sediment meets the sediment quality standards of WAC 173-204-340. As such, potential cleanup levels for site sediment are not presented in this memorandum.

2.2.2 *Key Potential Action-Specific ARARs*

Potential action-specific ARARs are typically technology- or activity-based requirements or restrictions on actions taken with respect to hazardous substances. These potential requirements are triggered by the particular remedial alternative and set performance, design or other standards that will be used to implement the proposed remedial action. A complete list of potential action-specific ARARs is presented in Table 2-3, and descriptions of the key potential action-specific ARARs are presented below. Potential action-specific ARARs will continue to be evaluated and refined as the selected remedy is developed and finalized.

2.2.2.1 *Washington MTCA (RCW 70.105D, Chapter 173-340 WAC)*

The MTCA specifies requirements that potentially affect implementation of a remedial design/remedial action (RD/RA) at a site. The regulations identified below are potentially applicable requirements for implementation of the selected remedy at the Site.

Natural Attenuation. WAC 173-340-370(7) provides that natural attenuation is expected to be appropriate at a site where:

- Source control (including removal and/or treatment of hazardous substances) has been conducted to the maximum extent practicable;
- Leaving contaminants on site during the restoration time frame does not pose an unacceptable threat to human health or the environment;
- There is evidence that biodegradation or chemical degradation is occurring and will continue to occur at a reasonable rate at the site; and
- Appropriate monitoring is conducted to ensure that the natural attenuation process is taking place and that human health and the environment are protected.

As described in WAC 173-340-200, natural attenuation is defined under MTCA as "…a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of hazardous substances in the environment. These in situ processes include: natural biodegradation; dispersion; dilution; sorption; volatilization; and chemical, or biological stabilization, transformation, or destruction of hazardous substances." Natural attenuation is and will continue to occur at the Site. These MTCA requirements are potentially applicable to the proposed remedial alternatives.

Reasonable Restoration Timeframe. MTCA requires that remedial actions provide for a reasonable restoration time frame (WAC 173-340-360[2][b][ii]). The requirements and procedures for determining whether a remedial action provides for a reasonable restoration time frame are described under WAC 173-340-360(4)and include consideration of the following:

- Potential risks posed by the site to human health and the environment.
- Practicability of achieving a shorter restoration time frame.
- Current uses of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site.
- Potential future use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site.
- Availability of alternative water supplies.
- Likely effectiveness and reliability of institutional controls.
- Ability to control and monitor migration of hazardous substances from the site.
- Toxicity of the hazardous substances at the site.
- Natural processes that reduce concentrations of hazardous substances have been documented to occur at the site or under similar site conditions.

Institutional Controls. Under WAC 173-340-440, MTCA specifies potential requirements for institutional controls where active cleanup measures will not attain potential MTCA cleanup levels or where a cap is used to contain hazardous substances above cleanup standards. This requirement is potentially applicable to the remedial alternatives evaluated in the memorandum.

Compliance Monitoring. Under WAC 173-340-410, WAC 173-340-720(9), 173-340-730(7), and WAC 173-340-740(7), MTCA provides requirements for monitoring groundwater, surface water, and soil to demonstrate compliance with potential cleanup standards identified in the decision document. These requirements are potentially applicable to the proposed remedial alternatives. Documentation will be developed during the remedial design to address these potentially applicable requirements.

Use of an Ecology Accredited Laboratory. Under WAC 173-340-830, MTCA requires that an Ecology accredited laboratory (WAC 173-50) be used to analyze environmental samples. These requirements apply only to surface water, groundwater, sediment, sludge, and other water or water-related samples, and they are potentially applicable to investigation and response activities.

2.2.2.2 *Resource Conservation and Recovery Act; Dangerous Waste Act and Regulations (42 USC 6901; RCW 70.105; Chapter 173-303 WAC, select provisions)*

Washington State has been authorized to implement portions of the Hazardous and Solid Waste Amendment and non-Hazardous and Solid Waste Amendment provisions of the Resource Conservation and Recovery Act (RCRA). In some instances, Washington State's authorized program is more stringent than the federal RCRA program.

The Washington State Dangerous Waste regulations are more stringent then the federal RCRA program regarding mining wastes. Washington State did not adopt the Bevill Amendment, a provision exempting certain mining wastes from regulation under RCRA Subtitle C. Instead, Washington adopted a limited exemption from dangerous waste regulation for "mining overburden returned to the mining site." Remedial activities involving active management, treatment and disposition of soils, tailings or other solid wastes must consider applicability of the dangerous waste regulations. The potential applicability of these requirements is triggered only when the materials are actively managed; for instance, soils are excavated and located to a different area of the Site. The following are potentially applicable requirements that may need to be considered during the remedial design for the selected remedial alternative.

- *Solid Waste Identification and Exclusions.* Under WAC 173-303-016, -070, -071, and –090 through 104, the regulation specifies requirements for determining whether a waste is a solid waste and thus, subject to other provisions of the regulation; for designating dangerous wastes, for identifying wastes that are excluded from the dangerous waste regulations, including samples sent for analysis, mine overburden returned to the mine site, and waste water discharges subject to National Pollutant Discharge Elimination System (NPDES) permits; and for identifying criteria for dangerous waste characteristics which includes the federal ignitability, corrosivity, reactivity and toxicity criteria as well as Washington State specific designations.
- *Dangerous Waste Designation.* Under WAC 173-303-170, the Dangerous Waste regulations specify requirements for generators to follow including responsibility for designating dangerous and extremely hazardous waste, and an allowance for treating dangerous waste in tanks or containers without triggering permit requirements.
- *Dangerous Waste Accumulation.* Under WAC 173-303-200, the Dangerous Waste regulations specify requirements for accumulating dangerous waste on site. The substantive requirements of this

regulation are potentially applicable to accumulation of containers and tanks storing dangerous waste on site; except that the provision limiting accumulation for 90-days is an administrative requirement and therefore, not an ARAR.

- *Container Requirements***.** Under WAC 173-303-630, the Dangerous Waste regulations specify standards for the use and management of containers. Substantive provisions of this regulation may be potentially applicable to the storage or treatment of dangerous waste on site in containers. The specific requirements would be identified, if necessary, during the remedial design.
- *Tank Requirements***.** Under WAC 173-303-640, the Dangerous Waste regulations specify requirements for the design, construction and management of tanks that store dangerous waste. These standards may be potentially applicable if the remedial alternative includes storing or treating dangerous waste in tanks. The specific requirements would be identified, if necessary, during the remedial design.
- *Corrective Action Management Units***.** Under WAC 173-303-64650, 64660 and 64690, the Dangerous Waste regulations allow development of corrective action management units for the management and consolidation of dangerous waste. This requirement is potentially applicable to soils that are determined to be characteristic wastes after being actively managed (i.e. excavated and moved to another contaminated area on site) and require treatment prior to disposition in an engineered containment area on site. Ex situ treatment in a container, tank or staging pile and placement in a corrective action management unit does not trigger land disposal restrictions.

The following dangerous waste requirements are not ARARs for site activities but may be applicable if dangerous or hazardous waste is transported off site:

- Notification numbers for generator, transporter and disposal facilities under WAC 173-303-060.
- Land disposal restrictions under WAC 173-303-140.
- Treatment, storage and disposal of dangerous waste under WAC 173-303-141.
- Manifest for off-site transport of dangerous waste under WAC 173-303-180.
- Preparation of waste for shipment, including labeling, marking, packaging, placarding under WAC 173-303-190.

- Generator record keeping and reporting under WAC 173-303-210 and –220.
- Dangerous waste transportation off site under WAC 173-303-240.

2.2.2.3 *Construction in State Waters, Hydraulic Code Rules (RCW 77.55.061 and 77.55.021; WAC 220-110-040, -050, -070, -080, -120, -130, -150, -170, -190)*

Hydraulic Project Approval and associated requirements for construction projects in state waters have been established for the protection of fish and shellfish. Any form of work that uses, diverts, obstructs, or changes the natural flow or bed of any fresh water or saltwater of the state, requires a Hydraulic Project Approval from the Washington Department of Fish and Wildlife (WDFW). Compliance with this requirement is determined after WDFW is consulted for the appropriate mitigation measures applicable to this project. Technical provisions and timing restrictions, "fish windows," are established by the WDFW after consultation. Substantive requirements of this potential ARAR are potentially applicable to alternatives involving construction activities in Railroad or Copper Creeks, installation of culverts, and/or Railroad Creek diversion.

2.2.2.4 *Clean Water Act Section 402, National Pollutant Discharge Elimination System Regulations (33 USC 1342)*

The CWA regulates the discharge of pollutants from point sources into waters of the United States which is administered by the USEPA under the NPDES permit program for federal land. The NPDES program provides conditions for authorizing direct point source discharges to surface waters and specifies point source standards for such discharges into waters of the state. A discharge is defined as "any addition of any pollutant to navigable waters from any point source." A "point source" is defined as "any discernible, confined and discrete conveyance, including, but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock…from which pollutants are or may be discharged."

CERCLA 121(e) requires that only the substantive provisions of a permit requirement be complied with for on-site discharges. Substantive requirements include technology-based effluent controls based upon the best available technology (BAT) that is economically achievable, effluent limitations, monitoring, and compliance with SWQC, including establishment of a mixing zone. Federal and state regulations require that effluent limitations set forth in a NPDES permit must be evaluated on a technology or water quality basis. Technology-based limitations use available treatment methods to reduce specific pollutants. Technology-based limitations are set by regulation or developed on a case-by-case basis (40 CFR 125.3 and Chapter 173-220-130 WAC). Due to the remote nature of the Site, lack of available power, and elevated background concentrations of some PCOCs in surface water that are above or nearly equal to potential ARARs, technology-based limitations may need to be established on a case-by-case basis for the Site. This would include consideration of the proposed low energy treatment system demonstrating BAT as a substantive requirement under potential federal NPDES ARARs, and demonstrating AKART under potential Washington State ARARs.

NPDES permit equivalency may establish water quality-based limitations that may include meeting potential surface water quality ARARs. In addition to the potential water quality-based ARARs, the effluent discharge may also need to meet any applicable narrative water quality criteria (WAC 173-201A-260(2) and the Washington State anti-degradation policy (WAC 173-201A-300-through 330). The narrative criteria limit the toxic, radioactive, or other deleterious material concentrations that may discharge to levels below those which have the potential to:

- Adversely affect designated water uses;
- Cause acute or chronic toxicity to biota;
- Impair aesthetic values; or
- Adversely affect human health.

The narrative criteria protect the specific designated uses of all fresh waters (WAC 173-201A-600, and WAC 173-201A-602) in the State of Washington. The Antidegradation Policy (WAC 173-201A-300 through 330) is intended to:

- Restore and maintain the highest possible quality of the surface waters in the State of Washington;
- Describe situations under which water quality may be lowered from its current condition;
- Apply to human activities that are likely to have an impact on the water quality of surface water; and
- Ensure that all human activities that are likely to contribute to a lowering of water quality, at a minimum, apply AKART.

2.2.2.5 *Chapter 173-204 WAC, Construction of Waste Water Facilities*

Chapter 173-240 WAC establishes requirements for Ecology's review of plans, specifications, and engineering reports; review and approval of proposed methods for operation and maintenance (O&M) of industrial wastewater facilities; and approval of construction modifications. As a CERCLA action, only substantive compliance with the requirements of this potential ARAR would be needed. These substantive requirements will be met through consultation with Ecology. Review of the engineering report would be conducted in association with Ecology's CWA Section 401 review.

The engineering report would include an analysis of the treatment system discharge(s), a mixing zone analysis, and an AKART analysis in accordance with Chapter 173-240 WAC. The engineering report submitted during remedial design is anticipated to include a low-energy treatment system to fulfill the USEPA BAT and Washington State's AKART requirements, and dilution in a mixing zone(s) based upon revised effluent quality and more detailed mixing zone analysis.

2.2.2.6 *Washington State Water Quality Standards for Surface Waters – Mixing Zone Discharges (WAC 173-201A-400)*

Washington State allows establishment of a mixing zone. The criteria for establishing the size and location of the mixing zone is described in the Washington State Water Quality Standards regulations (WAC 173-201A-400). It is anticipated that mixing zones under WAC 173-201A-400 would be established in Railroad Creek downstream of the water treatment system outfall(s). If it is determined that compliance at the edge of the mixing zone(s) is not feasible, potential exemptions may need to be evaluated for the water treatment systems.

2.2.2.7 *Clean Water Act Section 404 (33 USC 1344[a] – [d]; 40 CFR 230 and 33 CFR 330)*

Section 404 of the CWA requires a permit for the discharge of dredged or fill material into waters of the United States, including filling or construction activities in navigable waters and wetlands. Substantive compliance with Section 404 permit requirements would be determined in consultation with the Army Corps of Engineers, USEPA, United States Fish and Wildlife Service, and WDFW. The potentially applicable substantive requirements are specified in USEPA and United States Army Corps regulations at 40 CFR 230 and 33 CFR 320 and 330. These requirements are potentially applicable to selected alternatives involving diversion, construction, and installation of culverts and riprap, dredging and filling of streams, creeks or wetlands. Nationwide permits exist for some of these activities. Since these discharges would occur on site, no permit would be required and only substantive compliance with this potential ARAR would be required.

2.2.2.8 Federal Clean Water Act Section 401 Water Quality Certification (33 USC 1341 and WAC 173-225-010)

Section 401 of the Federal Water Pollution Control Act requires that applicants for a license or permit from the federal government relating to any activity that may result in any discharge into navigable waters obtain a certification from the state that the water quality standards will be met. Although a certification is not required for on-site CERCLA activities, substantive compliance with 401 Certification is required if a federal permit requirement is identified as an ARAR.

The substantive requirements of the Section 401 Certification will be met for the point source discharge(s) under an NPDES permit equivalency. The substantive compliance evaluation would include:

- Determination that AKART have been applied to the discharge based upon review of an engineering report developed in accordance with WAC 173-240-130 and -160;
- Assess pollutants in the discharge for compliance with the potential surface water quality ARARs;
- Calculate revised water quality-based limits; and
- Develop mixing zone(s) in accordance with WAC 173-201A-400.

2.2.2.9 Temporary Modification of Water Quality Criteria and Other Requirements to Modify Water Quality Criteria (RCW 90.48; WAC 173-201A-410 through –450)

Chapters 173-201A-410 through -450 specify requirements for modifying SWQC on a site-specific basis. These requirements include establishment of short-term water quality modification, variance, site-specific water criteria, and water quality offsets. Construction activity in or adjacent to surface waters that will unavoidably cause violations of the Washington SWQC may obtain a Short-term Water Quality Modification. For CERCLA actions, the substantive provisions of this requirement are met through consultation with Ecology. The Agencies identified this requirement as potentially applicable to remedial alternatives involving dredging, filling, and construction in, or adjacent to, wetlands and streams on the Site.

2.2.2.10 *Criteria for the Classification of Solid Waste Disposal Facilities and Practices (40 CFR 257); Washington State Standards for Solid Waste Handling (RCW 70.95; WAC 173-350-400[3][e][i][A] through [H], -400[7][a], and -710[7][a])*

Subtitle D of RCRA establishes a framework for controlling the management of nonhazardous solid waste. The federal regulations establish guidelines under which states develop regulations for solid waste landfills. Washington State has established regulations that meet or exceed the federal solid waste disposal design criteria. These regulations set minimum performance standards for the handling of solid waste and limited purpose landfills.

Tailings and Waste Rock Piles

The tailings piles and waste rock piles do not constitute landfills as tailings and rock were not considered a solid waste when placed on the land in these areas. Moreover, even if considered landfills, these areas were closed prior to the applicable date of these regulations, 10 February 2003. Closure of these areas occurred when the operations ceased and subsequently, when the USDA Forest Service implemented reclamation activities to grade, cover and vegetate the tailings piles. For these reasons, these requirements are not applicable. However, some provisions of Chapter 173-350 WAC are potentially relevant and appropriate to the reclamation of these areas.

For proposed remedial alternatives that include consolidation of tailings and soils from other parts of the Site onto the existing tailings, such activity does not constitute disposal in a landfill since under CERCLA movement of soils and materials within an area of contamination does not constitute disposal.

The Agencies have identified the requirements listed below related to limited purpose landfills as potentially relevant and appropriate to the remedial activities for the tailings and waste rock piles. The specific relevance and appropriateness of these requirements will be further evaluated during the remedial design.

- The closure system design should prevent exposure of waste, minimize infiltration, prevent erosion from wind and water, be capable of sustaining native vegetation, address anticipated settlement with a goal of no less than two to five percent slope, provide sufficient stability and mechanical strength and address potential freeze-thaw and desiccation, provide for the management of run-on and run-off preventing erosion or otherwise damaging the closure cover, and minimizes the need for post-closure maintenance (WAC 173-350-400[3][e][i][A] through [H]).

- The presumptive final closure cover for limited purpose landfills is presumed to meet the performance goals specified above. An alternative final closure cover may be used when the nature of the waste, the disposal site or other factors are incompatible with the presumptive final closure cover system. The presumptive cover includes an anti-erosion layer consisting of a minimum of 2 feet of earthen material of which at least 12 inches of the uppermost layer is capable of sustaining native vegetation, seeded with grass or other shallow rooted vegetation, and a geomembrane with a minimum of thirty mil thickness or a greater thickness that is commensurate with the ability to join the geomembrane material and site characteristics such as slope, overlaying component foundation (WAC 173-350-400(3)(e)(ii)).

- Post-closure requirements to allow for continued facility maintenance and monitoring of air, land, and water for a period of 20 years, or as long as necessary for the landfill to stabilize and to protect human health and the environment. Post-closure care includes maintaining the integrity and effectiveness of any final closure cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion or other events; maintaining the vegetative cover; preventing run-on and run-off from eroding or otherwise damaging the final closure cover; general maintenance of the facility and structures; and performing appropriate monitoring 173-350-400(7)(a).

- The variance provisions under WAC 173-350-710(7)(a) are potentially relevant and appropriate to proposed remedial alternatives where potentially relevant and appropriate requirements cannot be met at the Site. The variance requirements are expected to be demonstrated during the remedial design, and include showing that the proposed remedial design or location do not endanger public health, safety or the environment and that compliance with the section from which variance is sought would result in hardship without equal or greater benefits to the public.

Disposal of Treatment System Residuals

Sludge generated during the treatment of collected site waters is anticipated to be a solid, non-hazardous waste under Chapter 173-350 WAC. Both Alternatives 11 and 13M, include the disposal of water treatment sludge in a disposal facility constructed on one of the tailings piles. The design, construction and closure of the sludge disposal area would need to meet the requirements for a limited purpose landfill under WAC 173-350-400, including the design standards of WAC 173-350-400(3) and general performance standards of WAC 173-350-040. This would include consideration of the: characterization of the waste, soil (or tailings, if the material is disposed on the tailings piles), hydrogeologic conditions, hydraulic conditions, contaminant fate and transport, topography, climate, seismic conditions, total capacity of the cell, anticipated leachate characteristics and quantity, operational controls; and environmental monitoring systems.

Generally, limited purpose landfills are required to be designed with a liner system and leachate control systems. However, depending upon the characterization and consistency of the sludge, a liner and leachate control system may not be required, as the water/leachate generated during sludge dewatering will have an elevated pH and may be beneficial for the tailings below. If a liner is not included, the requirements of WAC 173-350-400(3)(b)(ii) would need to be evaluated to demonstrate that a liner and leachate control systems are not required.

During the active life of the proposed sludge cell on the tailings pile(s), operation of the cell would need generally to meet the requirements of WAC 173-350-400(4) which would include:

1. Controlling public access and prevent unauthorized vehicular traffic, illegal dumping of wastes, and keep animals out by using artificial barriers, natural barriers, or both, as appropriate to protect human health and the environment.
2. Providing approach and exit roads of all-weather construction, with traffic separation and traffic control on site, and at the site entrance.
3. Ensuring no liquid waste or liquids are placed in disposal facilities.
4. Ensuring appropriate personnel are available.
5. Providing communication between employees working at the landfill and management offices, on site and off site, sufficient to handle emergencies.
6. Controlling fugitive dust.

7. Ensuring that reserve operational equipment shall be available to maintain and meet these standards.
8. Ensuring that operations do not endanger any containment or monitoring structures such as liners, leachate collection systems, surface water control systems, gas management, cover systems and monitoring wells.

Final closure of the cell would need to meet the closure and post-closure requirements under WAC 173-350-400(3)(e) and substantive requirements of WAC 173-350-400(6) and -400(7). At closure, the cell would either be equipped with a presumptive or alternative final cover. An alternative final closure cover may be used when the nature of the waste, the disposal site or other factors are incompatible with the presumptive final closure cover system. Post-closure requirements to allow for continued facility maintenance and monitoring of air, land, and water for a period of 20 years, or as long as necessary for the landfill to stabilize and to protect human health and the environment (173-350-400[7][a]).

The requirements for design, construction, operation, closure and post-closure of a disposal cell for the disposition of sludge from the water treatment systems would be evaluated in the RD. If it is determined that the sludge is a Washington State dangerous waste, requirements under Chapter 173-303 WAC would need to be evaluated for potential on-site disposal.

2.2.3 Key Potential Location-Specific ARARs

Potential location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because the substances occur or activities are conducted in specified locations. These requirements may limit the type of remedial action that can be implemented or may impose additional constraints on remedial alternatives. Potential location-specific ARARs are summarized in Table 2-4 and key potential location-specific ARARs are described below. The potential location-specific ARARs will continue to be evaluated and refined as the selected remedial action is developed and finalized.

2.2.3.1 Endangered Species Act (16 USC 1531-1543, 50 CFR 402, 50 CFR 17)

The Endangered Species Act protects fish, wildlife and plants that are threatened or endangered with extinction. It also protects habitat designated as critical to the conservation of the species. The act requires consultation with resource agencies for remedial actions that may affect these species. This requirement is potentially applicable if federally–listed candidate species are present in the areas impacted during remedy implementation.

2.2.3.2 National Forest Management Act (16 USC 1600[6])

Congress enacted the National Forest Management Act of 1976 (NFMA) for National Forest System land and resource management. NFMA requires the USDA Forest Service to manage the National Forest System lands according to Land and Resource Management Plans (LRMPs) that provide for multiple uses and sustained yield in accordance with MUSYA (Multiple Use - Sustained Yield Act, 16 U.S.C. 538 through 539) (16 U.S.C. 1604[e] and [g][1)]). In developing and maintaining these plans, NFMA calls for "integrated consideration of physical, biological, economic and other sciences" (16 U.S.C. 1604 [b]).

This requirement is potentially applicable to assessing the candidate remedial alternatives. The potentially applicable requirements will be identified during remedial design in consultation with the USDA Forest Service.

2.2.4 *To Be Considered Criteria*

TBCs are non-promulgated advisories or guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. The following potential TBCs will be considered in selection and implementation of the final remedy, along with the ARARs identified above.

2.2.4.1 Washington Department of Ecology Background Soil Concentrations (Yakima Basin). Publication #94-115, October 1994

This document provides general background metal concentrations for regions in the State of Washington. The values for the Yakima Basin are potential TBCs if specific natural background soils data are not available for the Site.

2.2.4.2 Executive Order 11990, "Protection of Wetlands"

Executive Order 11990 requires consideration of impacts to wetlands in order to minimize their destruction, loss or degradation and to preserve/enhance wetland values. Executive Order 11990 requires that impacts occur only when no practicable alternative exists, requires consideration of impacts to wetlands such that impacts are minimized and provides for the preservation/enhancement of wetland values. Activities that involve construction must include all practicable means of minimizing harm to wetlands. This document contains provisions that are potential TBC for any alternatives involving dredging within Railroad Creek or site wetlands. The specific provisions that may be TBC would be further identified in the ROD document.

2.2.4.3 *Executive Order 11988, "Protection of Floodplains"*

This Executive Order requires consideration of impacts to floodplain areas in order to reduce flood loss risks, minimize flood impacts on human health, safety and welfare and preserve/restore floodplain values. This document contains provisions that are potential TBC for activities within 100-year floodplain on the Site. Specific provisions that may be TBC would be further identified in the ROD.

2.2.4.4 *Superfund Remedial Design and Remedial Action Guidance (USEPA OSWER Directive 9355.0-4A, June, 1986)*

This guidance is TBC during implementation of the RD/RA. It suggests a process for design initiation, reviews and approvals. It also provides guidance for compliance with permitting requirements and community relations. Since a ROD has not been signed, the project has not yet entered into the RD/RA phase. However, aspects of the guidance relating to design initiation and reviews would be considered during the remedial design.

2.2.4.5 *Land and Resource Management Plan for Wenatchee National Forest (USDA Forest Service 1990)*

The 1990 LRMP as amended by the 1994 Pacific Northwest Forest Plan (NWFP) and subsequent amendments of the NWFP (2001, 2004, and 2007) specify how the Wenatchee National Forest lands and resources will be managed. Portions of the standards and guidelines included in the LRMP (and the NWFP amendments to the LRMP) are TBC for actions at the Site. Specific provisions that have been identified by the Agencies for further evaluation include standards and guidelines relating to 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 have been identified by the Agencies for tailings and waste rock piles located within Riparian Reserves at the Site include provisions 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.

2.2.5.6 *Guidelines Developed by the Washington Department of Ecology Dam Safety Office and United States Committee on Large Dams*

Ecology's Dam Safety Office (DSO) has developed guidelines for the development of seismic design criteria and performing seismic hazard analysis for dams. These guidelines include the Ecology DSO Dam Safety Guidelines Part IV: Dam Design and Construction (DSO 1993) and the following:

- DSO Dam Safety Guidelines Technical Note 1: Dam Break Inundation Analysis and Downstream Hazard Classification, revised October 2007 (DSO 2007).
- DSO Dam Safety Guidelines Technical Note 2: Selection of Design/Performance Goals for Critical Project Elements (DSO 1992).
- Internal DSO clarifications provided by Mr. Jerald LaVassar, P.E., DSO Geotechnical Engineer, via e-mail (DSO 2009).

Portions of these guidelines may be TBCs in developing seismic design criteria and performing the seismic hazard analysis for the tailings piles. The east and west waste rock piles do not meet the definition of a dam and, therefore, the DSO Dam Safety Guidelines are not a TBC for the east and west waste rock piles.

The United States Committee on Large Dams (USCOLD) has also developed guidelines for developing seismic design criteria and performing seismic hazard analysis for dams (Updated Guidelines for Selecting Seismic Parameters for Dam Projects, prepared by USCOLD Committee on Earthquakes [USCOLD 1999]). Portions of these guidelines may be TBCs in developing seismic design criteria and performing the seismic hazard analysis for the tailings piles. The east and west waste rock piles do not meet the definition of a dam, and therefore the USCOLD guidelines are not a TBC for the east and west waste rock piles.

2.2.5.7 *Ecology's Permit Writer's Guidance*

The following chapters of Ecology's Permit Writer's Guidance - Publication Number 92-109, Revised July 2006 are considered as a potential TBC in the evaluation of the remedial action's water treatment systems:

- *Chapter IV – Technology-Based Limitations*, which include analysis and application of AKART.
- *Chapter VI – Water-Quality Based Standards*, which include the identification of water quality criteria and standards, evaluation of mixing zone criteria, and a method for predicting impact and defining effluent limits for numeric criteria.
- *Chapter IX – Deriving Effluent Limits for the Protection of Aquatic Sediments*, which includes impacts of the proposed discharge to surface waters on the quality of aquatic sediments and limits the concentrations of pollutants that cause an exceedance of the sediment quality standards. It is anticipated that monitoring of the effluent and Railroad Creek following remedy implementation would be conducted to assess compliance with this potential TBC.
- *Chapter XIII – Monitoring Guidelines*, which would be addressed as part of the compliance monitoring program developed during the RD.
- *Appendix 6 – Guidance for Conducting Mixing Zone Analyses*. Provides guidance for conducting detailed mixing zone analyses for discharges from water treatment systems.

3.0 DESCRIPTION OF ALTERNATIVE 13M (THE PROPOSED CLEANUP ACTION)

Alternative 13M is a modified version of Alternative 13, which was presented to the Agencies in October 2007. A number of the Alternative 13 remedial components included under Alternative 13M were refined and/or modified based on the results of the additional field investigations and technical analyses completed as required by the Agencies in their 11 March 2008 letter. The additional work, completed in 2008 and early 2009, greatly improved the overall understanding of site conditions and the nature and extent of contamination. The Alternative 13M remedy components were developed using the new site data and were presented to the Agencies during a project meeting held on 6 through 8 May 2009.

Notable revisions to Alternative 13 that are reflected in Alternative 13M include the addition of stability and closure actions for the west and east waste rock piles; modifications to the location and length of the west area barrier wall; modifications to groundwater collection actions adjacent to tailings piles 1, 2 and 3; and refinements to the conceptual designs of the Railroad Creek realignment, tailings pile slope stability actions, former SRA actions, and water treatment systems. The principal remedy components included under Alternative 13M are shown on Figure 3-1.

Alternative 13M was developed by Intalco to provide an equally effective and less costly alternative to Alternative 11, which was presented by the Agencies in the Final Draft Proposed Plan. The following subsections briefly describe the Alternative 13M remediation components that are common to Alternative 11, and provide a more detailed discussion of the remediation components unique to Alternative 13M.

3.1 REMEDY COMPONENTS COMMON TO ALTERNATIVE 11

The principal remedy components included under Alternative 11 are shown on Figure 3-2. There are many remedy components common to both Alternatives 11 and 13M, including the following:

- Implementation of institutional controls, such as proprietary controls on private property or land use restrictions, to limit potential exposures to groundwater or source materials that could impact human health or the environment and to prevent activities that may interfere with the effectiveness of the remedy components;

- Installation of air-flow restrictions within open underground mine portals in Honeymoon Heights and other potential locations as determined during remedial design to reduce oxygen transport through the mine;
- Installation of physical access controls such as mine access restrictions, security fencing, and signage to provide protection from potential physical hazards associated with mine features;
- Diversion of upgradient (clean) surface run-on and near-surface groundwater around mining features;
- Closure (plugging) of the tailings pile 1 decant tower to reduce water inflow and contact with tailings;
- Surface drainage improvements on the tailings and waste rock piles to reduce water infiltration;
- Excavation and permanent, on-site disposal of contaminated soils associated with the former SRA and lagoon feature;
- Cover soils in the maintenance yard with a concrete slab or impermeable liner and gravel;
- Demolition of the mill building superstructure and removal and/or covering of contaminated materials remaining on the mill building foundation;
- Stabilize the Copper Creek channel to mitigate the potential for future migrations that would erode tailings piles 1 or 2;
- Portal drainage flow retention and equalization using hydrostatic bulkheads installed within the 1500-level of the mine (if feasible);
- Installation of a low-head bulkhead in the 1100-level portal to direct seasonal drainage from the portal back into the underground mine workings;
- Discrete collection of the 1500-level portal drainage and seeps downgradient of the Honeymoon Heights waste rock piles and mine workings (SP-12 and SP-23);[29]
- Collection of diffuse west area groundwater and seeps using a barrier wall and collection trench installed at the south bank of Railroad Creek in the LWA;

[29] Based on data collected during the RI, the 1500-level portal drainage and SP-23 together contribute the majority of dissolved copper, cadmium, and zinc loading to Railroad Creek during high-flow conditions.

- Collection of diffuse groundwater and seeps associated with tailings pile 1 using a barrier wall and collection trench installed at the south bank of Railroad Creek;[30]
- Collection of diffuse groundwater associated with western portion of tailings pile 2, and seeps associated with tailings piles 2 and 3 (if present), although different technologies would be used by Alternatives 11 and 13M;
- Treatment of collected groundwater and seeps using low-energy alkaline precipitation systems;
- Disposal of sludge generated during water treatment in a disposal cell constructed on one of the tailings piles;
- Regrade and stabilize the tailings pile side slopes;
- Regrade and stabilize the west and east waste rock pile side slopes;
- Natural attenuation processes to reduce the magnitude of metals releases from site sources over time and achieve potential surface water criteria in Railroad Creek;
- Development of local rock and gravel source(s);
- Power generation for remedy implementation; and
- Compliance monitoring of site media and remedy components.

3.2 *ALTERNATIVE 13M UNIQUE REMEDY COMPONENTS*

The remedy components unique to Alternative 13M include the following:

- Approach for east and west waste rock pile closure;
- Approach for tailings pile closure;
- Groundwater collection adjacent to the LWA and tailings pile 1;
- Railroad Creek realignment;
- Copper Creek improvements;
- Approach for diffuse groundwater collection adjacent to the western portion of tailings pile 2 and seep collection adjacent to tailings piles 2 and 3;

[30] Based on analyses provided in the DFFS, tailings pile 1 contributes the majority of the aluminum and iron loading to Railroad Creek from site sources. Differences in the barrier wall configurations adjacent to tailings pile 1 are described in Section 3.2.4.

- West and east water treatment systems;
- Honeymoon Heights waste rock pile actions;
- Actions for other soil AOIs;
- Natural attenuation for groundwater in the eastern portion of the Site; and
- Contingent remedy components, if needed.

The principal Alternative 13M remedy components are shown on Figure 3-1. Descriptions of the principal remedy components unique to Alternative 13M are presented in the following subsections.

3.2.1 East and West Waste Rock Pile Closure

Under Alternative 13M, the east and west waste rock piles would be stabilized, covered with soil, and vegetated. The Alternative 13M east and west waste rock pile closure actions are described in the following subsections and compared to the actions included under Alternative 11, as presented in the Final Draft Proposed Plan. The Alternative 13M actions would meet the proposed RAOs and potential ARARs for the east and west waste rock piles.

3.2.1.1 East and West Waste Rock Pile Slope Stability Actions

Under both Alternatives 11 and 13M, the east and west waste rock pile side slopes would be regraded for stability. Under Alternative 13M, the excess rock generated from the regrading actions would be relocated onto the former mill building foundation and tailings pile 1. Under Alternative 11, it is assumed that all the excess rock would be placed onto tailings pile 1. Based on the existing data and results of the slope stability analyses, final side slopes of 2H:1V would provide adequate static and seismic factors of safety and are proposed under Alternatives 11 and 13M for the east and west waste rock piles.[31] Based on the static stability analyses, the minimum static long-term steady-state factors of safety for 2H:1V slopes were determined to be adequate and represent only shallow, surficial failures. The results of the analyses indicate that the 2H:1V slopes would be stable under long-term steady-state conditions (Appendix C).

[31] Additional field work and geotechnical analyses planned for 2009 will further evaluate the stability of steeper waste rock pile side slope configurations for Alternative 13M. The additional data and geotechnical analysis results will be provided to the Agencies when they become available.

The results of simplified, chart-based deformation analyses conducted to estimate earthquake-induced permanent deformations for the east and west waste rock piles indicate maximum deformations of 7 inches or less for both piles in response to the MDE. Based on this assessment, damage to the piles under Alternative 13M in response to the MDE is expected to be limited to 7 inches of deformation in the soil cover. Repairs of the potential damage could be completed with the use of local resources and standard earth moving equipment. Additional details related to the static and seismic geotechnical analyses for the west and east waste rock piles are provided in Appendix C.

3.2.1.2 *East and West Waste Rock Pile Cover Actions*

Alternative 13M differs from Alternative 11 in the type of closure cover provided for the east and west waste rock piles. Alternative 13M includes a vegetated, soil cover that is 6 inches on the top surface and 8- to 12-inches thick on the side slopes (Figure 3-3). The cover soil for Alternative 13M is assumed to be processed alluvium obtained from the Railroad Creek realignment excavation with PCOC concentrations below those determined to be protective of terrestrial ecological receptors. Following slope stabilization and covering, the piles would be vegetated with native plants. The objectives of the east and west waste rock pile cover actions under Alternative 13M include reducing the infiltration of precipitation and snowmelt, thereby reducing PCOC loading from the waste rock piles to groundwater and the water treatment system over time; promoting the growth of native vegetation for aesthetic purposes; and to meet provisions A through H of the Limited Purpose Landfill Final Closure Performance Standard (WAC 173-350-400[3][e][i]). Under Alternative 13M, the top surface of the west waste rock pile would be used to provide access to the 1500-level main portal and support water treatment infrastructure.

Alternative 11 includes the presumptive cover under the Washington State Limited Purpose Landfill Regulation (WAC 173-340-400[3][e][ii]) (Figure 3-4). The conceptual design for the Alternative 11 cover that was assumed for purposes of the geotechnical evaluations includes 6 inches of imported Dan's Camp soil to provide an even subgrade that is free of voids and angular protrusions; a low-permeability geomembrane between two double-sided geocomposites; and 24 inches of cover soil. The cover soil was assumed to consist of processed alluvium or imported Dan's Camp soil. Following construction, the Alternative 11 cover would be vegetated with shallow-rooted plants.

The results of the slope stability analysis presented in Appendix C indicate that the Alternative 13M soil covers would be statically stable for the maximum pile height of 165 feet. The soil covers would behave like the waste rock under seismic conditions and any damage caused to the covers during a seismic event could be repaired with the use of local resources and standard earth moving equipment.

In contrast, with a side slope of 2H:1V and a maximum vertical height of 165 feet, benching and an anchored geogrid reinforcement would be required to satisfy the minimum static and seismic factors of safety for the Alternative 11 cover configuration. The benching would involve construction of an under drain collection system at the start of the bench and an anchor trench at its terminus (Figure 3-4). In order to satisfy the minimum seismic factor of safety requirements, the maximum vertical heights of the piles would need to be limited, through benching, to 78- and 38-foot sections for the 475- and 2,475-year earthquake return periods, respectively. Alternatively, if the waste rock pile side slopes were reduced to 3H:1V, the minimum static factor of safety would be satisfied for most conditions without the use of veneer reinforcement or benching. However, to satisfy the minimum seismic factor of safety for the 2,475-year earthquake, geogrid reinforcement would be required and the maximum slope height would need to be decreased to 65 feet with benching. Special materials, equipment, and skilled labor would need to be procured and mobilized from across the United States for installation, maintenance, or repair of the Alternative 11 cover. The work could only be completed within specific temperature ranges and low-wind weather conditions.

3.2.2 *Tailings Pile Closure*

Under Alternative 13M, the three tailings piles would be stabilized, covered with soil/gravel and wood slash, and vegetated. The Alternative 13M tailings pile closure actions are described in the following subsections and compared to the actions included under Alternative 11, as presented in the Final Draft Proposed Plan. The Alternative 13M actions would meet the proposed RAOs and potential ARARs for the tailings piles.

3.2.2.1 *Tailings Pile Slope Stability Actions*

Under Alternative 13M, the tailings pile side slopes would be regraded for stability. Based on the existing data and results of the slope stability analyses, final side slopes of 2H:1V would provide adequate static and seismic factors of safety and are proposed under Alternative 13M for the tailings piles.[32] The tailings would be regraded from the current toe of the piles, allowing most of the starter dam and stronger outer tailings (referred to as Zone 1) to remain in place. Tailings removed from the pile slopes would be placed on top of tailings piles 1 and 3 and/or be used within a composite compacted tailings and rockfill buttress at the toe of the slopes. The construction of a shear key at the toe of the slopes is also included in the Alternative 13M conceptual design. The Alternative 13M conceptual design is shown for the tailings pile toes in Figures 3-5 through 3-7. The results of the simplified, chart-based deformation analyses and the nonlinear dynamic stability analyses indicate acceptable maximum earthquake-induced permanent deformations for tailings piles 1, 2, and 3 under Alternative 13M (Appendix C).

Under Alternative 11, the tailings pile side slopes would be regraded to 2H:1V and to create a 45-foot bench adjacent to the existing south bank of Railroad Creek and east bank of Copper Creek. The Alternative 11 side slope configuration would establish a new toe location for the tailings pile slopes and remove the original starter dam and stronger outer Zone 1 tailings. The additional regrading required to create the 45-foot bench would also likely expose the lower-strength overbank deposits (referred to as Zone 4) that were left in place during tailings deposition, but which were likely removed during construction of the original starter dam. The 45-foot bench is included under Alternative 11 to allow the construction of a subsurface barrier wall along the toe of the three piles. Tailings removed from the slope during regrading would be placed on top of tailings piles 1 and 3. For purposes of the geotechnical analyses, Alternative 11 was assumed to include a rockfill buttress and shear key at the toe of the three tailings piles.[33]

Results of the stability analyses of the three piles under Alternative 11 indicate that regrading the slopes to 2H:1V would provide adequate long-term static factors of safety. The results of the analyses indicate acceptable maximum earthquake-induced permanent deformations for tailings pile 1 under Alternative 11; however, Alternative 11 requires further evaluation for tailings piles 2 and 3 because predicted shaking-induced deformations, even with a large rock buttress, exceed 10 feet and the post-earthquake stability factors of safety are less than 1.1 (Appendix C).

---

[32] Additional field work and geotechnical analyses planned for 2009 will further evaluate the stability of steeper tailings pile side slope configurations for Alternative 13M. The additional data and geotechnical analysis results will be provided to the Agencies when they become available.

[33] A rockfill buttress or shear key was not specified under Alternative 11 in the Draft Final Proposed Plan (Forest Service 2007a).

3.2.2.2 *Tailings Pile Cover Actions*

Alternative 13M differs from Alternative 11 in the type of closure cover provided for the tailings piles. Under Alternative 13M, a cover consisting of 6 inches of soil/gravel and wood slash would be placed on the top surfaces and 8- to 12-inches of soil/gravel placed on the tailings pile side slopes (Figure 3-3). The tailings pile regrading actions conducted under Alternative 13M would be implemented in such a manner as to preserve as much of the existing vegetation as possible. Following implementation, vegetation on the top surfaces would be enhanced and the side slopes would be vegetated with native plants. The additional cover soil material needed under Alternative 13M was assumed to be processed alluvium obtained from the excavation of the Railroad Creek realignment with PCOC concentrations below those determined to be protective of terrestrial ecological receptors. The objectives of the tailings pile cover actions under Alternative 13M include reducing the infiltration of precipitation and snowmelt, thereby reducing PCOC loading from the tailings piles to groundwater and the water treatment system over time; promoting the growth of native vegetation for aesthetic purposes; and to meet provisions A through H of the Limited Purpose Landfill Final Closure Performance Standard (WAC 173-350-400[3)][e][i]). The top surfaces of the tailings piles would continue to provide an emergency evacuation location for the Holden Village, and would serve as a location for the disposal of water treatment system residues.

The results of the slope stability analyses presented in Appendix C indicate that the Alternative 13M soil covers would be statically stable and that the static stability is relatively insensitive to cover thickness. The analyses show that the soil covers would behave like the tailings under seismic conditions, with deformations of the underlying tailings predicted to be approximately 5 feet under MDE loading. Therefore, some maintenance/repairs of the slopes and cover would be anticipated following an MDE.

Alternative 11 includes the presumptive cover under the Washington State Limited Purpose Landfill Regulation (WAC 173-340-400[3][e][ii]) (Figure 3-8). The conceptual design for the Alternative 11 cover that was assumed for purposes of the geotechnical evaluations includes 6 inches of imported Dan's Camp soil to provide an even subgrade; a low-permeability geomembrane between two double-sided geocomposites; and 24 inches of cover soil. The cover soil was assumed to consist of processed alluvium or imported Dan's Camp soil. Following construction, the Alternative 11 cover would be vegetated with shallow-rooted plants.

Three stability scenarios were evaluated for the tailings pile covers under Alternative 11: dry conditions, wet conditions, and wet conditions with snow load (Appendix C). The results of the stability analyses indicate that anchored geogrid reinforcement would be necessary to achieve adequate factors of safety for static and seismic conditions for the three different conditions. In addition, as described for the east and west waste rock piles, benching would be required to satisfy the minimum seismic factor of safety for the Alternative 11 cover configuration. The benching would involve construction of an under drain collection system at the start of the bench and an anchor trench at its terminus (as shown for the waste rock pile cover on Figure 3-4). To satisfy the minimum factor of safety requirements, the maximum vertical heights of the piles would need to be limited, through benching, to 78- and 38-foot sections for the 475- and 2,475-year earthquake return periods, respectively. Alternatively, if the waste rock pile side slopes were reduced to 3H:1V, the minimum static factor of safety would be satisfied for most conditions without the use of veneer reinforcement or benching. However, to satisfy the minimum seismic factor of safety for the 2,475-year earthquake, geogrid reinforcement would be required and the maximum slope height would need to be decreased to 65 feet with benching. Special materials, equipment, and skilled labor would need to be procured and mobilized from across the United States for installation, maintenance, or repair of the Alternative 11 cover. The work could only be completed within specific temperature ranges and low-wind weather conditions.

3.2.3 *Rock Requirements and Sources*

Competent rock will be required under both Alternatives 11 and 13M for the implementation of remedy components such as Railroad and Copper Creek channel/bank stabilization; tailings pile slope stabilization buttresses; upgradient water diversion channel armoring; and groundwater collection and conveyance channel armoring and possible drop structure construction. Preliminary calculations estimate approximately 160,000 cy and 120,000 cy of rock will be needed for implementation of Alternatives 11 and 13M, respectively. The primary reason for the higher estimated rock volumes under Alternative 11 is the relatively large volumes of rock needed for the tailings pile slope stabilization buttresses under Alternative 11 (Appendix C).

Some competent rock would be generated under Alternative 13M during construction of the realigned Railroad Creek channel adjacent to tailings piles 1, 2, and 3, including rock generated during blasting for portions of the new channel adjacent to tailings pile 2 and existing river rock present within the existing channel alignment. It is estimated that a total of approximately 35,000 cy of rock may be generated during channel construction for use in Alternative 13M; reducing the overall rock required from other sources to approximately 85,000 cy. During remedial design, potential rock sources within the Railroad Creek valley will be evaluated for possible rock quarry development. Potential locations that may be evaluated include the former Forest Service quarry at Lightning Ridge, located near Lake Chelan, and other areas with apparent bedrock outcropping in the vicinity of 10-Mile Creek.

3.2.4 *Groundwater Collection Adjacent to the Lower West Area and Tailings Pile 1*

Based on the analyses provided in the DFFS, diffuse groundwater and seeps associated with the LWA and tailings pile 1 contribute a majority of the total aluminum and iron loading from the Site to Railroad Creek. This area also contributes a majority of the remaining cadmium, copper, and zinc loading to Railroad Creek after consideration of the 1500-level main portal drainage and seep SP-23.[34] Alternative 13M includes the installation of a fully penetrating barrier wall and open collection trench along the south bank of Railroad Creek adjacent to the LWA and tailing pile 1 to collect groundwater and seepage for treatment prior to discharge to Railroad Creek. Adjacent to tailings pile 1, a portion of the barrier wall and groundwater collection system would be constructed within the existing Railroad Creek channel. The collected groundwater would be conveyed beneath Copper Creek via an enclosed siphon and would flow along the toe of tailings piles 2 and 3 in a pipe and/or lined channel to the east water treatment system (Figure 3-1). The objective of the Alternative 13M groundwater collection actions adjacent to the LWA and tailings pile 1 is to meet the proposed RAOs for surface water and groundwater.

The Alternative 13M barrier wall/collection system would extend from the approximate location of the existing portal drainage conveyance channel in the LWA to the southeastern toe of tailings pile 1. The barrier wall would wrap around the toe of tailings pile 1, and extend to the south along Copper Creek for approximately 250 feet (Figure 3-9). It is anticipated that a majority of the Alternative 13M barrier wall would consist of soil-bentonite construction; however, due to the subsurface conditions at the western edge of the barrier wall alignment and along the toe of tailings pile 1, portions of the wall would likely need to be constructed of cement-bentonite using panel construction techniques

[34] As described in Section 3.1, the 1500-level portal drainage and seeps SP-23 and SP-12 are discretely collected and conveyed to the west treatment system under Alternative 13M.

(Figure 3-9). The wall would extend vertically to the low-permeability till or bedrock, located at depths ranging from approximately 30 to 100 feet bgs. Additional information related to the Alternative 13M barrier wall conceptual design is provided in Appendix C.

The alignment and extent of the Alternative 13M barrier wall and groundwater collection system along the LWA and tailings pile 1 is similar to the alignment assumed under Alternative 11 (Figure 3-10). However, along the north side of tailings pile 1, it is anticipated that the barrier wall would be constructed within the former Railroad Creek channel to facilitate access to the alignment and significantly reduce the grading requirements for the adjacent tailings pile. The location would also reduce the potential surcharge (load) from tailings pile 1 on the slurry trench during construction (Appendix C).

The barrier wall segment extending to the south along Copper Creek is shorter under Alternative 13M than shown under Alternative 11, because of difficult access and constructability concerns, which would likely make extension of the wall further south infeasible. Based on the conceptual site model and the results of the groundwater model developed for the Site, the extent of the Alternative 13M wall adjacent to Copper Creek would be effective in preventing impacted water beneath tailings pile 1 from entering the creek, because water level elevations indicate that Copper Creek is a losing stream in this area (Appendix E). The final barrier wall alignment would be determined during final design.

Construction of the barrier walls under alternatives 11 and 13M would require some clearing of forested areas. It is estimated that a total of 2.9 acres would require clearing under Alternative 13M compared to approximately 4.2 acres under Alternative 11 (Appendix C). The additional clearing under Alternative 11 would be needed to extend the barrier wall up the slope along the west bank of Copper Creek.

The barrier walls included under Alternatives 11 and 13M would likely raise the groundwater levels (i.e., the phreatic surface) beneath tailings pile 1. The expected rise in the phreatic surface was taken into account in the slope stability analyses for tailings pile 1. The results of the slope stability analysis indicate that the slope regrading and buttressing actions under Alternatives 11 and 13M would provide long-term stability for tailings pile 1 (Appendix C).

3.2.5 *Railroad Creek Realignment*

Alternative 13M includes the realignment of Railroad Creek to the north from the approximate midpoint of tailings pile 1, upstream of the point where iron-staining is observed on the creek streambed and rocks. The new channel would rejoin the existing channel approximately 1,200 feet downstream of tailings pile 3 (Figure 3-1). Alternative 11 would not include Railroad Creek realignment. A detailed description and analysis of the proposed realignment is provided in the Draft Proposed Railroad Creek Realignment Technical Memorandum (Appendix D, URS, 2009a)

Railroad Creek realignment is an important component of Alternative 13M, supporting achievement of the RAOs developed for surface water, groundwater, and the tailings piles. The objectives of the Alternative 13M Railroad Creek realignment include the following:

- Develop a new stream channel with long-term geomorphic, hydrologic, and hydraulic functions equal to or better than the existing channel while promoting natural, habitat-forming processes;
- Provide long-term lateral and vertical stability;
- Provide aquatic and riparian habitat;
- Allow for the collection of groundwater at the south bank of Railroad Creek, and minimize the extent of tailings pile regrading required to construct groundwater collection systems and stabilize the tailings pile side slopes;
- Hydraulically isolate Railroad Creek from shallow groundwater in the eastern portion of the Site and minimize the potential for impacted groundwater to enter the creek;
- Provide room for construction of the east water treatment system; and
- Maximize the distance between the new stream channel and Holden Village and minimize potential impacts to the Holden-Lucerne road.

The Railroad Creek realignment under Alternative 13M includes the basic alignment presented under Alternative 13 in October 2007, with adjustments to the portion of the alignment adjacent to tailings pile 2 and modifications for:

- Increased sinuosity;
- Added connectivity to low areas for overbank flow;
- Avoidance of large boulders/rock mounds; and
- Decreased impact to large-diameter trees and riparian habitat.

The realigned channel would be configured with as much meander as possible within the area available. Adjacent to tailings pile 2, the valley narrows and limited space is available to the north of the existing channel.

Here the new creek channel would partially overlap with the current channel, and structural measures would be required to stabilize the hillside. For purposes of the conceptual design, an approximately 1,000-foot long retaining wall up to 14 feet high was assumed adjacent to the Holden Village road across from tailings pile 2.[35] The location and configuration of the realigned channel between Holden-Lucerne road and tailings pile 2 were developed to ensure sufficient space for the buttress, berm, and temporary construction platform needed for tailings pile 2 stabilization under Alternative 13M.

Conceptual channel cross sections at tailings piles 1, 2, and 3 are provided on Figures 3-5 through 3-7. The new channel would be completely lined with a low-permeability lining system to minimize groundwater-surface water interactions and covered with riprap to minimize potential erosion and maintain long-term channel stability. Details of the channel and bed lining are included on Figure 3-11.

The hydraulic design parameters for the Alternative 13M channel realignment are provided in Appendix D. The design parameters were selected to mimic the results of the hydraulic modeling for existing channel conditions and to meet desired fish passage criteria. The width of the channel bottom was set at 30 feet, based on the average width of the existing channel. Channel side slopes of 2H:1V are assumed in earth, ¾ H:1V in cut bedrock, and 1.5H:1V in rock riprap. The conceptual design channel bankfull widths were set to between 40 and 50 feet, providing a width to depth ratio of approximately 15 throughout most of the new channel configuration, unless a smaller ratio is required to manage fish passage velocities. In certain areas, the bankfull width was constrained to allow for bank overtopping during peak flow as some channel interaction with the surrounding floodplain is desired to allow for wetland habitats and more natural channel behavior.

The overall channel gradient would be maintained between 1.0 to 1.6 percent, similar to the existing channel. The design water depth for low flow conditions was set at 1-foot minimum with 2 feet of depth provided, where feasible, and the maximum design velocity for high flow conditions was set at 4 fps to allow for fish passage. The stream power in the new channel alignment was set similar to the existing channel to allow the new channel to carry a similar sediment load.

---

[35] Aesthetic compatibility with the surrounding environment would be a key design element for the retaining wall. Retaining wall options that may be considered during final design include reinforced slopes (e.g., mechanically stabilized earth or soil nail reinforcement) as well as retaining walls (e.g., gabions, rock walls, and timber crib).

Native soil would be placed on the rock slopes above the ordinary high water mark and the slopes would be planted with native vegetation, as appropriate. The conceptual design includes the placement of native stream-bank materials to fill voids in the bank below the ordinary high water mark and other aquatic habitat measures, such as the placement of large woody debris, logs, and boulders. Details showing habitat considerations are included on Figure 3-12. The riparian area on both sides of the new stream channel would be revegetated through a combination of seeding, native plantings, and live stake plantings.

The Alternative 13M Railroad Creek alignment is anticipated to provide enhanced aquatic and riparian habitat compared to existing conditions. Overall, the new channel would improve the water quality within the creek immediately upon completion, and provide enhanced habitat quality within a relatively short timeframe. In addition, because the realigned creek channel would be lined, contaminated groundwater would not report to the new channel; thereby preventing the occurrence of ferricrete, iron oxyhydroxide precipitation and iron staining within the realignment as observed in the existing channel.

3.2.6 *Copper Creek Improvements*

The overall Copper Creek channel geometry would remain the same under both Alternatives 11 and 13M, with the exception of an approximate 400-foot extension of Copper Creek to the north to convey Copper Creek to the realigned Railroad Creek channel under Alternative 13M. Both Alternatives 11 and 13M include measures to stabilize the Copper Creek channel to minimize the potential for erosion of tailings piles 1 and 2, although a conceptual design for Copper Creek stabilization measures under Alternative 11 was not specified by the Agencies in the Draft Final Proposed Plan.

Under Alternative 13M, the upper reach of Copper Creek would be modified to provide long-term erosion control, channel stabilization, and energy dissipation. The lower reach of Copper Creek would be modified to convey water and sediment past the groundwater collection and conveyance trenches. The general locations of Copper Creek improvements under Alternative 13M are shown on Figure 3-1 and a plan view of the Copper Creek modifications is shown on Figure 3-13.

Copper Creek is not a fish rearing or travel channel due to steepness and considerable debris and bedload during spring runoff events and is considered to be a source of fish food (benthic macroinvertebrates, etc.)

only. As such, the primary objectives of the Copper Creek improvements under Alternative 13M include:

- Manage avulsion at and near the head of the Copper Creek alluvial fan that starts approximately 500 feet upstream of the tailings pile access road;
- Protect the tailings piles by managing potential runoff across tailings pile 1, protecting the toes of the tailings piles 1 and 2 embankments, and repairing the head cut downstream of the road to reduce loading of sediment and tree debris to the lower reaches of Copper Creek, as necessary;
- Convey water and sediment past the groundwater collection and conveyance trenches to Railroad Creek without resulting in avulsion of Copper Creek to the siphon; and
- Provide for the re-establishment of a connected channel-riparian zone such that terrestrial and benthic macroinvertebrates re-colonize the reach and are produced in sufficient biomass to be ecologically useful as far downstream as Railroad Creek.

Key conceptual design criteria elements for Copper Creek under Alternative 13M include the following:

- Maintain bankfull width of 10 feet and width to depth ratios of approximately 10 without increasing velocity.
- Minimize erosion outside of the main channel by armoring historic avulsion channels to allow their continued use.
- Repaired side slopes of 2H:1V in earthen materials, ¾H:1V in cut bedrock, and 1.5H:1V in rock riprap.
- Maximum velocities of less than 2 fps in earthen materials and greater than 10 fps only in competent bedrock and rock riprap with D_{100} greater than 24-inches in diameter.
- Channel stability for an approximate 10-year flow (Channel Stability Flow) with overall stability during an approximate 100-year flow (Overall System Stability Flow).
- Grade control to maintain sediment transport without scour, head cuts, or major avulsion that would jeopardize the tailings piles, collection trench, or other infrastructure.

Based on the objectives, design criteria, and considerations listed above, the following actions are included for the Copper Creek channel under Alternative 13M:

- Remove an existing log jam and improve the existing berm along the channel above the access road between tailings piles 1 and 2 to help prevent avulsion during significant high-flow events.
- Maintain the overflow channel built during the 2003 flood event to allow Copper Creek access to both of the existing 72-inch diameter corrugated metal pipe culverts under the access road between tailings piles 1 and 2. Maintenance would be needed to keep the culvert entrances cleared after remedy implementation.[36]
- Protect the access road between tailings piles 1 and 2 with rock to prohibit further erosion of the tailings piles.
- Backfill the historical side channels that are used by Copper Creek during high flows with rock, as needed to prevent further gross erosion and rapid delivery of wood and sediment to Railroad Creek. The channels would tie back in to the main channel of Copper Creek above the current mouth location.
- Line the lower reach of Copper Creek where it transitions to Railroad Creek with a low-permeability base protected by large rock and a constructed streambed of rounded rock. Berms with impermeable cores will be used on either side of the channel to retain up to 350 cfs of flow. The design would include both boulder steps and isolated large boulders (36-inches and larger) to break up the flow and dissipate energy.
- Line the channel up to the 350 cfs flow water surface elevation with 24-inch diameter riprap to stabilize the banks and bed to reduce the potential for lateral movement of the creek channel during extreme flow events and prevent head-cutting.
- Regrade, stabilize and revegetate the left bank of the overflow channel adjacent to tailings pile 1 (between tailings piles 1 and 2) and raise the bed elevation of the overflow channel several feet using large rock.
- Install a sediment "cleanout" area accessible to equipment in the area between tailings piles 1 and 2. Sediment and large woody debris would be allowed to accumulate and be removed from this area on a regularly scheduled basis.

Additional information related to the conceptual design of the Copper Creek channel improvements is provided in Appendix D.

[36] During final design, a cost/benefit analysis of potential actions to increase the capacity of the culverts may be performed, such as improving inlet conditions and/or raising the road elevation.

3.2.7 *Groundwater and Seep Collection Adjacent to Tailings Piles 2 and 3*

As described in Section 1.5, the conceptual site model indicates that shallow groundwater beneath the western portion of tailings pile 2 discharges to Railroad Creek adjacent to the tailings piles, whereas shallow groundwater in the area of tailings pile 3 and the eastern portion of tailings pile 2 flows downward into deeper groundwater zones and then beneath Railroad Creek and down valley. Groundwater sampling data indicate that groundwater discharging to Railroad Creek adjacent to western portion of tailings pile 2 contains PCOC concentrations above potential surface water ARARs.[37]

Under Alternative 13M, shallow groundwater along the western portion of tailings pile 2 would be collected with a collection trench constructed within the former Railroad Creek channel. The objective of the collection trench is to collect water in areas where gaining conditions exist (i.e., groundwater discharges to surface water) throughout the year to meet the proposed RAOs for surface water and groundwater. It is anticipated that the collection trench would extend from the vicinity of Copper Creek to an area near Railroad Creek station RC-7, where losing conditions are estimated to occur throughout the summer and fall. The extent of the collection trench would be further evaluated during Remedial Design.

The groundwater collection trench would be excavated into the former Railroad Creek channel approximately 3 feet to enhance the collection rates and provide a more defined channel to convey the flow to the east. The collected groundwater from tailings pile 2 would be combined with collected groundwater from the LWA and tailings pile 1 in a lined conveyance channel, which would then transfer the water to the east treatment system located downgradient and east of tailings pile 3. If present, surface seeps flowing from the toes of tailings piles 2 and 3 would also be directed into the lined conveyance trench for treatment east of tailings pile 3.

Diffuse groundwater collection adjacent to tailings pile 3 and the eastern portion of tailings pile 2 is not included under Alternative 13M, because available data indicate that Alternative 13M would meet potential surface water ARARs at a CPOC(s) downgradient (east) of the Site where this groundwater discharges to Railroad Creek through source control and natural attenuation (see Section 3.2.11). Therefore, groundwater collection

[37] Based on the analyses included in the DFFS, groundwater adjacent to tailings pile 2 represents a relatively small portion of the overall PCOC loading to Railroad Creek from the Site.

at the south bank of Railroad Creek along the reach adjacent to tailings pile 3 and the eastern portion of tailings pile 2 is not anticipated to be needed to achieve the surface water and groundwater RAOs. If, after an extended period of monitoring, PCOC concentrations do not meet surface water ARARs at the established CPOC(s), contingent actions would be evaluated (see Section 3.2.12).

As shown on Figures 3-2 and 3-10, groundwater collection adjacent to tailings pile 2 with a fully-penetrating barrier wall and open collection trench is included under Alternative 11. The Alternative 11 barrier wall would extend from the southwest corner of tailings pile 2 to the southeast corner of tailings pile 3 and is discussed in more detail below in Section 3.2.11.

3.2.8 West and East Water Treatment Systems

Under Alternative 13M, the 1500-level main portal drainage and site seeps and groundwater with PCOC concentrations above potential ARARs would be collected for on-site treatment using conventional, low-energy alkaline precipitation systems prior to discharge to Railroad Creek. The objective of the Alternative 13M water treatment actions is to meet the proposed RAOs for surface water and groundwater.

Similar to Alternative 13, Alternative 13M includes a west and east water treatment system. Key features of the two systems are shown on Figure 3-1. The 1500-level portal drainage and groundwater seeps downslope of Honeymoon Heights (SP-12 and SP-23) would be directed to the treatment system located in the LWA. Groundwater collected adjacent to Railroad Creek, from the approximate confluence of the portal drainage with Railroad Creek to approximately two-thirds of the way along tailings pile 2 would be conveyed to the treatment system located to the east of tailings pile 3.

As shown on Figure 3-2, water collected under Alternative 11 would be conveyed to a single low-energy treatment system located on the north side of Railroad Creek, to east of tailings pile 3. Due to the Site topography, groundwater collected adjacent to tailings piles 2 and 3 would need to be pumped under Railroad Creek and up to the proposed Alternative 11 treatment system location. Because sufficient power is not currently available at the Site for treatment system operations, both Alternatives 11 and 13M propose the use of low-energy treatment systems consisting of pH adjustment through chemical addition (e.g., lime), mixing, aeration, sedimentation in open ponds, and filtration/polishing (if needed) for additional solids removal prior to discharge. The primary differences between the two alternatives include the number of systems, the system locations, and the use of lined settling ponds under Alternative 11 and unlined settling ponds for Alternative 13M.

The preliminary conceptual designs for the Alternative 13M west and east water treatment systems are described in the Draft Water Treatment System Performance Evaluations Report (Appendix H, ERM, 2009b) and are summarized in the following subsections. The conceptual designs are based on the expected influent water characteristics for the west and east systems, which were calculated using available site data and the preliminary results of predictive simulations performed using the site groundwater flow model.[38] The conceptual designs presented herein will be refined based on the results of bench- and pilot-scale testing planned for the fall of 2009 and spring of 2010. The testing results will be used to assess the performance of various chemical additives (hydrated lime, pelletized quick lime, polymers, etc.); solids characteristics; system component sizing; as well as overall system performance and compliance with potential ARARs.

3.2.8.1 *West Water Treatment System*

The conceptual design for the Alternative 13M west water treatment system consists of chemical addition, mixing, and aeration, followed by sedimentation and filtration (if needed) for particulate removal. The west treatment system would receive water collected from the 1500-level portal drainage and seasonal groundwater seeps downslope of Honeymoon Heights. Key components of the west treatment system are shown on Figure 3-14 and include the following:

- Collection and conveyance of the portal drainage and discrete west area seeps (SP-23 and SP-12) to the treatment system via open trenches or closed pipes.
- Influent flow rates estimated to range between 410 gallons per minute (gpm) in the spring and 90 gpm in the fall/winter, assuming the placement of a hydrostatic bulkheads within the 1500-level main and ventilator portals is feasible.
- Chemical addition (e.g., pelletized quick lime or hydrated lime slurry) to achieve a target pH of 8.5.

[38] The estimated Alternative 13M groundwater collection rates presented to the Agencies during the May 2009 project progress meeting were used for purposes of the preliminary conceptual designs and performance evaluations. Additional details related to estimated influent flow characteristics are provided in Appendix H.

- Mixing and aeration of the pH adjusted water in a riprap lined channel with drop structures and/or by using other methods.
- Solids separation and removal in two or more settling/sedimentation ponds. Based on the estimated influent characteristics, a total capacity of 714,000 gallons would provide a minimum detention time of 20 hours at peak flow, with consideration of expected annual sludge accumulations in the ponds.
- Total anticipated sludge accumulation volume of 1,100 cy per year, assuming 5-percent solids.
- Bypass piping or conveyance channels constructed around each sedimentation pond to allow for water diversion and sludge removal during periods of low-flow.
- Additional polishing/solids removal (as needed) using two parallel granular media filters, each with a 0.1 gpm/feet^2 filtration rate.
- Discharge to Railroad Creek or to the east area system for additional treatment, depending on performance.

3.2.8.2 *East Water Treatment System*

Similar to the west water treatment system, the conceptual design for the Alternative 13M east system consists of chemical addition, mixing, and aeration, followed by sedimentation and filtration/polishing (if needed) for particulate removal. The east water treatment system would receive groundwater collected adjacent to Railroad Creek, from the approximate confluence of the portal drainage with Railroad Creek to approximately two-thirds of the way along tailings pile 2. Key components of the east system are shown on Figure 3-15 and include the following:

- Collection of groundwater from the LWA, tailings pile 1, and the western portion of tailings pile 2 using open collection trenches.
- Conveyance of collected groundwater water to the east treatment system via closed pipe and/or lined conveyance trench. Water collected adjacent to the LWA and tailings pile 1 would be conveyed beneath Copper Creek using an inverted siphon.
- Influent flow rates estimated to range between 1,200 gpm in the spring and 900 gpm in the fall/winter.
- Chemical addition (e.g., pelletized lime or hydrated lime slurry) to achieve a target pH of 8.0.
- Mixing and aeration of the pH adjusted water in a riprap lined channel with drop structures and/or by using other methods.

- Solids separation and removal in settling/sedimentation ponds. Based on the estimated influent characteristics, a total capacity of 7.5-million gallons would provide a minimum detention time of 20 hours at peak flow, with consideration of expected annual sludge accumulations in the ponds.
- Total anticipated sludge accumulation volume of 30,000 cy per year, assuming 5-percent solids.
- Bypass piping or conveyance channels constructed around each sedimentation pond to allow for water diversion and sludge removal during periods of low-flow.
- Additional polishing/solids removal (as needed) in an engineered wetland.
- Collection of runoff from tailings piles 2 and 3, and diversion to the engineered wetland.
- Discharge to Railroad Creek.

3.2.9 *Honeymoon Heights Waste Rock Pile Actions*

Alternative 13M includes the collection and treatment of Honeymoon Heights seeps SP-23 and SP-12, which currently flow into Railroad Creek with PCOC concentrations above potential surface water quality ARARs. The Alternative 13M actions would thereby mitigate the transport of PCOCs from Honeymoon Heights to site surface water. The discrete collection and treatment of seeps SP-23 and SP-12 is also included under Alternative 11. The objective of these actions is to meet the proposed RAOs for surface water and groundwater.

Monitored natural recovery would be implemented under Alternative 13M for the Honeymoon Heights waste rock piles. The supplemental human health risk calculations provided in Appendix F demonstrate that the metals concentrations associated with the Honeymoon Heights waste rock piles are protective of human health under current and anticipated future recreational land use. The results of the draft TEE (Appendix G) show that protective metals concentrations for most bird and mammal populations currently exist in Honeymoon Heights, with the possible exception of insectivorous bird populations due to exposures to lead. However, residual concentrations of PCOCs may contribute to the limited recruitment and re-establishment of vegetation observed at this AOI. Monitored natural recovery for this area is assumed to include regular inspections of progress, periodic evaluations of whether more aggressive actions are required.

Alternative 11 includes the excavation and placement of the Honeymoon Heights waste rock piles onto the tailings piles. The Honeymoon Heights area is situated on a steep slope that is mostly underlain by shallow bedrock. Relocation of the Honeymoon Heights waste rock piles would require re-establishment and expansion of the existing primitive access road up to the 550-level mine portal and construction of a new road up to the 300-level mine portal. Due to the steep topography and shallow bedrock depths in the area of Honeymoon Heights, access road construction would likely require drilling, blasting, and the placement of fill materials.

It is estimated that approximately 5 acres of eastside mixed conifer forest/eastside riparian habitat would need to be cleared to access and remove the Honeymoon Heights waste rock piles. This estimate includes road construction and clearing that would be required around each pile to access the rock with earthmoving equipment. The results of the Draft Honeymoon Heights Near-Surface Stope Mapping provided in Attachment B-1 to Appendix B (URS, 2009c) confirmed the presence of near-surface stopes that are coincident with portions of the access road and the three upper waste rock piles (300-, 550- and 700-levels). Based on the relatively shallow nature of the crown pillars that separate the stopes from the ground surface (reported to be on the order of 50-feet thick in the mapping conducted by Howe Sound Company in 1957), any above-ground related efforts are considered a risk for potential crown pillar collapse. There are no realistic measures to mitigate the potential risk of collapse other than avoidance of the upper three waste rock piles.

3.2.10 *Actions for Other Soil Areas of Interest*

As described in Section 1.8.2, the Agencies requested the evaluation of the following additional soil AOIs with respect to the protection of terrestrial ecological receptors:

- Areas downslope of Honeymoon Heights;
- Former SRA;[39]
- Former mill building;
- LWA;
- Lagoon area;
- Maintenance yard;

- Holden Village;
- Ballfield/wilderness boundary area; and
- Area of windblown tailings.

The results of the site-specific TEEs completed for the above AOIs are summarized in Section 1.8.2 and presented in Appendix G. Specific remedial actions were not identified for many of these areas under Alternative 11 in the Final Draft Proposed Plan or SFS; however, it was specified that, "…there is some uncertainty over the extent of additional adverse effects, due to mining, on soils and terrestrial receptors at the Site, which needs to be addressed as part of the remedy." Remedial actions included under Alternative 13M for each of the additional soil AOIs listed above, are described in the following subsections. The objective of the Alternative 13M actions for these soil AOIs is to meet the proposed RAO for site soil.

3.2.10.1 *Areas Downslope of Honeymoon Heights*

Based on the findings of the draft TEE described in Section 1.8.2, PCOC concentrations in soils at the areas downslope of Honeymoon Heights are pose no risk to most bird and mammal populations, with the possible exception of insectivorous mammal populations due to exposures to copper. Overall, risks to terrestrial wildlife were generally considered to be minimal in this AOI. As such, monitored natural recovery, including regular inspections of progress and periodic evaluations of whether more aggressive actions are required, is proposed for this AOI under Alternative 13M.

The Honeymoon Heights area is situated on a steep slope that is mostly underlain by shallow bedrock. As described for the Honeymoon Heights Waste Rock Piles, active removal or covering of the areas downslope of the Honeymoon Heights waste rock piles would require re-establishment and expansion of the existing primitive access road up to the 550-level mine portal and construction of a new road up to the 300-level mine portal. Due to the steep topography and bedrock depths in the area of Honeymoon Heights, access road construction would likely require drilling, blasting, and the placement of fill materials.

It is estimated that more than approximately 5 acres of eastside mixed conifer forest/eastside riparian habitat would need to be cleared for equipment to access the Honeymoon Heights waste rock piles and the areas downslope of the Honeymoon Heights piles. The cleared areas would be subjected to increased erosion, exposure of bedrock, and unlikely long-term recovery of vegetation/succession (Appendix G). Additionally, based on the locations and relatively shallow nature of the crown pillars that separate several near-surface stopes from the ground surface in this area, any above-ground related efforts are considered a risk for potential crown pillar collapse. There are no realistic measures to mitigate the potential risk of collapse other than avoidance of the upper three waste rock piles Attachment B-1 to Appendix B. The Alternative 13M actions for this AOI are assumed to require a long-term effort, but are unlikely to require physical disturbance and/or clearance of any habitat at the AOI or in nearby areas.

3.2.10.2 *Former Surface Water Retention Area*

Under both Alternatives 11 and 13M, soils within the former SRA with concentrations above potential cleanup levels established for the protection of terrestrial ecological receptors would be excavated down to the CPOC of 6 feet and disposed in a permanent disposal facility likely constructed on one of the three tailings piles. Native soils from the surrounding area, or other excavation actions on site, would be used as fill following completion of the excavation.[40]

3.2.10.3 *Former Mill Building*

Materials remaining on the former mill building foundation have not been sampled due to safety concerns associated with the remaining superstructure. Under Alternative 13M, the remaining tanks and steel superstructure would be removed to the extent needed to safely complete the remedial action. The area would then be filled with excess waste rock generated during regrading of the west waste rock pile side slopes, covered with a minimum of 6 inches of soil, and vegetated. Under Alternative 13M, residual materials with concentrations above potential cleanup levels for the protection of ecological receptors would either be removed or located below the CPOC of 6 feet (after covering with waste rock). If materials with concentrations above potential human-health based levels are left in place on the building foundation, institutional controls and access restrictions may be needed to mitigate potential exposures.

[40] Available groundwater data downgradient of the surface water retention area (SP-26) indicate that groundwater concentrations meet potential ARARs established for the protection of human health. Therefore, the establishment of cleanup levels for soils for the protection of groundwater is not necessary in this area.

Under Alternative 11, residual materials located within the former mill building footprint and having concentrations above potential risk-based cleanup levels would be excavated and disposed in a permanent on-site disposal area. Additional actions for the former mill building were not specified under Alternative 11.

Groundwater associated with this AOI would be contained and collected under both Alternatives 11 and 13M by the fully-penetrating barrier wall and collection system located the south bank of Railroad Creek. The collected water would be treated in the east treatment system prior to discharge. Therefore, the establishment of cleanup levels for soils for the protection of groundwater is not necessary in this area. However, during remedial design, the removal and on-site disposal of residual ore, concentrate, and pulverized rock located on the building foundation would be evaluated under Alternative 13M to reduce PCOC loadings from this area to the water treatment system.

3.2.10.4 Lower West Area

Based on differing soil concentrations, characteristics, and land use, the LWA AOI was divided into two areas: the LWA-west and the LWA-east. The LWA-west is defined as the portion of the AOI located to the west of the lagoon area and the LWA-east extends from the lagoon area to the east to the base of tailings pile 1. Each of these areas is discussed separately below. The lagoon area is discussed in Section 3.2.10.5.

Groundwater associated with this AOI would be contained and collected under both Alternatives 11 and 13M by the fully-penetrating barrier wall and collection system located the south bank of Railroad Creek. Therefore, the establishment of cleanup levels for soils for the protection of groundwater is not necessary in this area.

Lower West Area-West

Based on the findings of the draft TEE (Appendix G), PCOC concentrations in soils in the LWA-west AOI do not pose a risk to plant communities (with the possible exception of arsenic), soil invertebrate communities, bird populations, and mammal populations, and a mid- to late-stage eastside wetland riparian habitat is anticipated to further establish at this AOI without active remediation. Based on these findings, monitored natural recovery, including regular inspections of progress and periodic evaluations of whether more aggressive actions are required, is proposed for plants in the LWA-west under Alternative 13M.

Under both Alternatives 11 and 13M, groundwater would be collected downgradient of the LWA at the south bank of Railroad Creek. Therefore, the establishment of cleanup levels for soil for the protection of groundwater is not necessary, and soil in this area will continue to be inundated with contaminated groundwater following remedy implementation.

Lower West Area-East

Based on the results of the draft TEE (Appendix G), PCOC concentrations in the LWA-east soil pose no risk to most bird and mammal populations, with the possible exception of insectivorous bird populations due to exposures to copper and lead; and herbivorous, insectivorous, and carnivorous mammals populations due to exposures to copper. Residual concentrations of PCOCs may contribute to the limited recruitment and re-establishment of vegetation observed in the LWA-east. Based on these findings, a majority of the west water treatment system infrastructure and settling ponds would be located in the LWA-east; thereby removing or covering soils in portions of this AOI and reducing potential exposures to terrestrial ecological receptors. Monitored natural recovery, including regular inspections of progress and periodic evaluations of whether more aggressive actions are required, is proposed for the remainder of this AOI under Alternative 13M.

The LWA-east is situated upgradient of the proposed barrier wall and groundwater collection system installed at the south bank of Railroad Creek under both Alternatives 11 and 13M. Therefore, the establishment of cleanup levels for soils for the protection of groundwater is not necessary, and soils in this area will continue to be inundated with contaminated groundwater following remedy implementation.

3.2.10.5 *Lagoon Area*

Under both Alternatives 11 and 13M, soils within the lagoon area footprint (i.e., within the footprint of the bermed area) having PCOC concentrations above potential cleanup levels established for the protection of terrestrial ecological receptors would be excavated down to the CPOC of 6 feet and disposed in a permanent disposal facility likely constructed on one of the three tailings piles. The excavated areas would be backfilled with native soils or used for construction of a portion of the west water treatment plant (e.g., one or more sedimentation ponds). The proposed actions for the lagoon area would mitigate the potential exposure pathways for terrestrial ecological receptors in this AOI.

3.2.10.6 *Maintenance Yard*

Like the lagoon area, the maintenance yard is a well-defined area, bounded by the former mill building and west waste rock pile to the south, a steep hillside to the west and north, and tailings pile 1 to the east. The maintenance yard is currently used by the Holden Village for equipment/vehicle storage and maintenance and includes several buildings and a gravel-covered yard that is devoid of native vegetation and wildlife populations.

Under both Alternatives 11 and 13M, soils within the maintenance yard would be covered to mitigate the potential exposure pathways to terrestrial receptors. Under Alternative 11, the Agencies specified the placement of a concrete or asphalt cover over this AOI. Under Alternative 13M, the economics and feasibility of using concrete, asphalt, and/or an impermeable liner covered with gravel would be assessed during remedial design. It is anticipated that the maintenance yard would continue to be used by the Holden Village for vehicle storage and maintenance and potential water treatment activities after remedy implementation.

Groundwater associated with this AOI would be contained and collected under both Alternatives 11 and 13M by the fully-penetrating barrier wall and collection system located the south bank of Railroad Creek. Therefore, the establishment of cleanup levels for soils for the protection of groundwater is not necessary in this area; however, the placement of a low-permeability cover would likely reduce the infiltration of water through the maintenance yard soils and potential PCOC loadings from this area to the water treatment system.

3.2.10.7 *Holden Village*

It is anticipated that the Holden Village will continue to be used as an interdenominational retreat following remedy implementation and that the landscaped grounds, including lawns and ornamental plants will continue to be maintained. Based on the existing and anticipated future land use, the Holden Village grounds are not intended or maintained to support natural plant communities or wildlife populations. Based on the findings of the draft TEE (Appendix G), PCOC concentrations pose no risk to birds and mammals that may pass through the area. Therefore, no actions are proposed for this AOI under Alternative 13M. If and when the Holden Village discontinues use of the Village and grounds, the area may be re-evaluated to determine if remedial actions are required at that time for the protection of native plant and invertebrate communities.

3.2.10.8 *Ballfield/Wilderness Boundary Area*

The forested portion of the ballfield/wilderness boundary area contains dense plant cover with high species richness and structural complexity, similar to that seen at the eastside mixed conifer forest background area. The ballfield has an herbaceous cover made up of a mixture of several species of native and introduced weeds and grasses that are consistent with current uses of this area by the Holden Village and others for recreational purposes. It is anticipated that the ballfield will remain in the current maintained state by the Holden Village and will not be returned back to the natural surrounding habitat.

Based on the findings of the draft TEE (Appendix G), PCOC concentrations in soil in the ballfield/wilderness boundary area pose no risk to terrestrial plant and soil invertebrate communities, and no risk to bird and mammal populations, with the possible exception of insectivorous mammals due to exposures to copper. Based on these findings, monitored natural recovery, including regular inspections of progress and periodic evaluations of whether more aggressive actions are required, is proposed for this AOI under Alternative 13M. If and when the Holden Village discontinues use of the Village and grounds, the area may be re-evaluated to determine if additional actions are required.

3.2.10.9 *Area of Windblown Tailings.*

The area of windblown tailings supports a moderately dense mixed conifer tree canopy with an open understory of scattered shrubs and grasses/forbs. Areas north of the gravel road to Lucerne are characterized by relatively large conifer trees and a dense understory. Based on the findings of the draft TEE (Appendix G), PCOC concentrations at this AOI do not pose a risk to bird and mammal populations. Although copper and molybdenum concentrations were above potential soil values established for the protection of plants and/or soil invertebrate communities, risks to plants and soil invertebrate communities are considered unlikely in this AOI.

Under Alternative 13M, a significant portion of the shallow soils located to the south of the Holden Village-Lucerne road will be removed and/or covered for construction of the realigned Railroad Creek channel (Figure 3-1 and Appendix D). Monitored natural recovery, including regular inspections of progress and periodic evaluations of whether more aggressive actions are required for plants and soil invertebrates, is proposed for the remainder of this AOI.

The actions to be completed to the south of the road would address areas in the portion of this AOI observed to have the thickest layer of windblown tailings. The windblown tailings thickness on the south side of the road was observed to range between 0 and 12 inches thick, compared to 0 to 4.5 inches thick on the north side of the road, during the 2008 field investigation (Appendix G).[41] Based on findings of the draft TEE and observations to date, exposures to residual PCOC concentrations in soils in the remainder of this AOI do not appear to adversely impact plants and soil invertebrate communities, and without active remediation, a mid- to late-stage mixed conifer forest and characteristic soil invertebrate community is anticipated to further establish.

3.2.11 *Natural Attenuation in Groundwater in the Eastern Portion of the Site*

Under Alternative 13M, natural attenuation would be implemented for groundwater beneath tailings pile 3 and the eastern portion of tailings pile 2. Source control actions for this area are also included under Alternative 13M, including groundwater collection adjacent to the western portion of tailings pile 2; the collection of seeps adjacent to tailings piles 2 and 3 (if present); upgradient water diversions; and surface regrading and enhanced revegetation to reduce the infiltration of snowmelt and precipitation into tailings piles 2 and 3.

Alternative 13M is expected to meet potential ARARs at a CPOC(s) where groundwater discharges to Railroad Creek downstream (east) of the Site through source control actions and natural attenuation processes. The existing data suggests the discharge point is at a location downstream of Railroad Creek monitoring station RC-5 and upstream of station RC-10. Current data also show that shallow groundwater to the east of tailings pile 3 meets potential groundwater ARARs established for the protection of human health and that downward vertical hydraulic gradients are present in this area. The Alternative 13M source control actions are expected to further reduce the mass loading of PCOCs to groundwater beneath tailings piles 2 and 3; thereby providing additional improvements to groundwater quality east of tailings pile 3 over time.

As described in Section 1.7.2, groundwater samples from wells located to the east of tailings pile 3 (i.e., DS-3S/D and DS-4S/D) show a decreasing trend in dissolved metals concentrations and an increasing trend in pH over their 8-year monitoring period (2001 to 2009). These wells appear to

---

[41] Sampling location 15 with a thickness of 4.5 inches was located a few feet to the north of the road. Excluding this sample, the maximum wind blown tailings thickness on the north side of the road was 2 inches.

be located directly downgradient of tailings piles 2 and 3, and PCOC concentrations in these two well pairs did not exceed potential surface water or groundwater ARARs during the 2008 or 2009 sampling events. Monitoring wells installed further to the east in 2009 (DS-9S/I/D and DS-10S/I/D) also confirm that shallow groundwater quality downstream of wells DS-3 and DS-4 meets potential surface water quality criteria. The available groundwater chemistry data and the CSM (Appendix E) suggest that natural attenuation mechanisms, including dispersion, advection, and surface water influx to the aquifer, combined with reductions in mass loading from the site source areas have resulted in lower concentrations of PCOCs in groundwater downgradient (east) of tailings pile 3. A potential reduction in mass loading from site sources, including the tailings piles, as a result of natural attenuation processes, is also supported by the geochemical analyses presented in the DFFS. The data and technical analyses continue to indicate that compliance with potential surface water criteria at a CPOC(s) located to the east of Tailings Pile 3 could be accomplished through natural attenuation.

The natural processes occurring in groundwater to reduce PCOC concentrations with distance east of tailings pile 3 meet the definition of natural attenuation under CERCLA and MTCA.

3.2.12 *Contingent Remedy Components*

The remediation components included under Alternative 13M are expected to contain PCOCs in groundwater beneath the LWA and tailings pile 1, and reduce PCOC concentrations in groundwater beneath tailings piles 2 and 3 over time. PCOC concentrations in shallow groundwater east of tailings pile 3 (at downgradient well locations DS-3 and DS-4) currently meet potential groundwater ARARs established for the protection of human health and are expected to meet potential surface water ARARs at a CPOC(s) where this groundwater discharges to Railroad Creek through source control actions and natural attenuation. The expected reductions in mass loading of PCOCs to groundwater beneath tailings piles 2 and 3 as a result of Alternative 13M actions should further decrease PCOC concentrations in groundwater east of tailings pile 3. However, 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.

4.0 EVALUATION OF ALTERNATIVES 11 AND 13M UNDER CERCLA

This section presents an evaluation of Alternatives 11 and 13M with respect to the evaluation criteria specified under CERCLA (40 CFR 300.430). This analysis, together with the evaluation of alternatives against the MTCA remedy selection criteria in Section 5, provides the basis for identification of a preferred remedial alternative and preparation of the Proposed Plan.

There are a total of nine evaluation criteria under CERCLA. The first two criteria are referred to as "threshold criteria" because, in general, a candidate alternative is required to meet them in order to support the statutory determinations and declarations that must be made in the ROD. Failure to satisfy either of these criteria usually means an alternative is eliminated from further consideration; however, waivers of some requirements may be allowed under certain circumstances. The two threshold criteria include:

- Overall protection of human health and the environment; and
- Compliance with ARARs (except when an ARAR is waived, as allowed under 40 CFR 300.430[f][1][(ii][C]).

The next five criteria are referred to as "primary balancing criteria" under CERCLA, and are typically used to evaluate and select a remedial action from the alternatives that meet the threshold requirements:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, and volume;
- Short-term effectiveness;
- Implementability; and
- Cost.

The last two criteria are referred to as "modifying criteria" including:

- Agency (Forest Service, State and USEPA) acceptance; and
- Community acceptance.

The modifying criteria are typically used in conjunction with the balancing criteria to evaluate and select a remedial action from those alternatives that meet the threshold requirements under CERCLA.

Considerations related to Agency and community acceptance are discussed in this section. The Agencies will evaluate and document Agency acceptance of the proposed remedial actions in the Proposed Plan and ROD and will evaluate and document community acceptance in the ROD primarily based on comments received from the public on the Proposed Plan.

As discussed in the DFFS, the AOC required Intalco to analyze the remedial alternatives using a tenth criterion, "natural resource restoration". Although the AOC includes this criterion, the Agencies stated in the SFS that it will not be relied on in determining the preferred alternative in the Proposed Plan or in selecting the alternative under CERCLA. Therefore, this additional criterion is not included in the analysis herein.

4.1 OVERALL PROTECTION OF HUMAN HEALTH AND ENVIRONMENT

The evaluation of overall protection of human health and the environment focuses on whether a specific alternative achieves adequate protection and how potential site risks posed through each pathway being addressed in the FS are eliminated, reduced, or controlled through treatment, engineering, or institutional control. This assessment draws upon results of the evaluation of other criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with potential ARARs. To satisfy this criterion, candidate alternatives must adequately address the proposed RAOs in Section 2.1.

An evaluation of the protection of human health, aquatic life, and terrestrial ecological receptors is presented in the following subsections.

4.1.1 Protection of Human Health

Alternatives 11 and 13M would fully address potential risk to human health. Results of the baseline HHRA presented in the 1999 DRI and the supplemental human health risk evaluations conducted for the tailings and waste rock in 2009 (Appendix F) indicate that PCOC concentrations associated with site soils, waste rock, and tailings are protective of human health under current and anticipated future recreational land use and future construction and maintenance worker activities. Although the baseline human health risk evaluations indicate no existing unacceptable risks to Holden Village residents or visitors from exposures to site soils, under Alternatives 11 and 13M, soils with concentrations above the

MTCA direct contact soil criteria in the lagoon area and maintenance yard would be excavated and covered, respectively. Institutional controls including land use restrictions would be implemented, as needed, to protect human health in areas where soil concentrations above potential risk-based criteria are managed in place and to mitigate potential exposure pathways to deeper soils, such as in the LWA-east.

Metals concentrations in surface water in Railroad Creek meet potential drinking water standards under current conditions, and the Holden Village obtains its drinking water from Copper Creek, upgradient from the Site. Therefore, surface water quality at the site is protective of human health. Alternatives 11 and 13M would minimize potential future risks associated with the use of groundwater as a drinking water source through the implementation of land use restrictions. The alternatives would also reduce potential physical hazards to Holden Village residents and visitors through the installation and maintenance of access restrictions in the underground mine portals and removal of the steel superstructure associated with the former mill building. The slope stability measures implemented under Alternatives 11 and 13M for the west waste rock pile would also reduce potential physical hazards associated with the steep slopes located above the 1500-level access road and portal museum.

4.1.2 *Protection of Aquatic Life*

Alternatives 11 and 13M would fully address potential risks to aquatic receptors. Both alternatives include the collection and treatment of groundwater and seeps discharging to Railroad Creek adjacent to the former mining facilities and having PCOC concentrations above potential surface water ARARs established for the protection of aquatic life. The seep and groundwater collection and treatment actions included under Alternatives 11 and 13M would immediately reduce potential risks to aquatic life due to exposure to PCOCs in site surface water. Natural attenuation processes are expected to further reduce PCOC concentrations in groundwater and surface water over time. As a result of the source control actions, collection and treatment actions, and natural attenuation, groundwater discharging to Railroad Creek under Alternative 13M is expected to meet potential surface water ARARs at the location(s) where groundwater discharges to surface water.

Chemical and bioassay testing performed on sediment samples collected from Railroad Creek and Lake Chelan at the Lucerne bar, show that existing sediment quality in Railroad Creek and Lake Chelan complies with the Washington State SMS (Chapter 173-204 WAC) established for the protection of aquatic life. In addition, the source control and groundwater collection actions included under Alternatives 11 and 13M are expected to further reduce PCOC loading to site surface water and sediment and improve sediment quality in Railroad Creek, downgradient of the new creek realignment and at the Lucerne bar over time.

Alternative 11 includes the removal of ferricrete where it occurs in the Railroad Creek channel adjacent to the Site and would collect and treat site groundwater seepage that contributes to ferricrete formation. Under Alternative 13M, Railroad Creek would be realigned to the north adjacent to the Site and would provide new creek substrate immediately upon implementation and result in improved aquatic habitat adjacent to the site relative to Alternative 11. The realigned channel would be hydraulically isolated from the surrounding groundwater to mitigate the potential for future ferricrete formation adjacent to the Site.

Both Alternatives 11 and 13M include measures to stabilize the tailings pile side slopes and mitigate the potential transport of tailings to Railroad Creek under static or seismic conditions. However, the short- and long-term stability of tailings piles 2 and 3 under Alternative 11 are less certain than under Alternative 13M because predicted shaking-induced deformations, even with a large rock buttress, exceed 10 feet and the post-earthquake stability factors of safety are less than 1.1 (Appendix C).

4.1.3 Protection of Terrestrial Receptors

Based on the findings of the draft TEE (Appendix G and Section 1.8.2), PCOC concentrations were found to pose no risk to terrestrial wildlife populations at tailings piles 1, 2, and 3; the area of windblown tailings; the east and west waste rock piles; the western portion of the LWA; the ballfield/wilderness boundary area; or Holden Village; however, PCOC concentrations may pose potential risks to some terrestrial wildlife receptors at the following AOIs:

- Honeymoon Heights waste rock piles – possible risks to insectivorous birds populations;
- Areas downslope of Honeymoon Heights waste rock piles – possible risks to insectivorous mammal populations; and
- LWA-east – possible risks to insectivorous bird populations and herbivorous, insectivorous, and carnivorous mammal populations.

Overall, the potential risks to terrestrial wildlife (birds and mammals) from exposure to site soils, waste rock and tailings were considered to be unlikely.

The findings of the draft TEE indicate that PCOC concentrations are above potential soil values established for the protection of plants and soil invertebrate communities at a majority of the site AOIs. However, for many of the site AOIs, mature vegetation and characteristic soil invertebrate communities are anticipated to further establish without active remediation.

Equivalent actions to mitigate the potential exposure pathways to terrestrial ecological receptors would be implemented under both Alternatives 11 and 13M for the lagoon area, maintenance yard, and former SRA. An evaluation of the protection of terrestrial ecological receptors for the other AOIs under Alternatives 11 and 13M is provided below. Note that specific remedial actions were not identified for many of these areas under Alternative 11 in the Draft Final Proposed Plan; therefore, a direct comparison between the alternatives is not possible for these areas.

Because the assessment of ecological risks and the calculation of potential cleanup levels for the protection of terrestrial receptors at the Site are ongoing, the following evaluations should be considered preliminary. However, based on the assessments below, Alternative 13M would provide equivalent or greater protection of terrestrial ecological receptors compared to Alternative 11 for those AOIs where actions were specified under Alternative 11.

4.1.3.1 Tailings Piles and East and West Waste Rock Piles

The results of the draft TEE (Appendix G) show that PCOC concentrations at the tailings piles and east and west waste rock piles pose no risk to bird or mammal populations. However, residual concentrations of PCOCs may contribute to the observed lower levels of vegetation at these AOIs. The Alternative 11 cover would mitigate the potential exposure of plants and soil invertebrates to PCOCs in the tailings and waste rock immediately after implementation. The Alternative 13M vegetated soil cover would also mitigate the potential exposure of soil invertebrates and the grass-/forb-dominated plant community to PCOCs immediately following implementation. Although deeper rooted plants would continue to be exposed to PCOC concentrations above potential risk-based levels on the tailings and waste rock under Alternative 13M, data and recent observations of the piles show that deeper rooted plants are re-establishing, and a plant community representative of the surrounding habitats is expected to result over time as a result of natural recovery. Under Alternative 11, the establishment of deep rooted plants would not be allowed in order to protect the integrity of the geomembrane cover.

4.1.3.2 *Honeymoon Heights Waste Rock Piles and Areas Downslope of Honeymoon Heights*

Monitored natural recovery would be implemented under Alternative 13M for the Honeymoon Heights waste rock piles and areas downslope of the Honeymoon Heights waste rock piles. Alternative 11 includes the excavation and placement of the Honeymoon Heights waste rock piles onto the tailings piles; no specific actions were identified for the areas downslope of the Honeymoon Heights waste rock piles under Alternative 11.

The results of the draft TEE (Appendix G) show that PCOC concentrations in these AOIs are unlikely to pose a risk to bird or mammal populations. However, residual concentrations of PCOCs may contribute to the lower levels of vegetation observed at the waste rock piles, and PCOC concentrations are above potential soil values established for plants and soil invertebrate communities in portions of the downgradient areas.

Removal of the waste rock piles would permanently remove residual concentrations of PCOCs and eliminate the potential for release, mobilization, and/or exposure of PCOCs to terrestrial biota. However, it is estimated that approximately 5 acres of eastside mixed conifer forest/eastside riparian habitat would need to be cleared to access and remove the Honeymoon Heights waste rock, and additional areas would need to be cleared if active measures are taken to remove or cover the downslope areas.

Due to the steep topography and shallow bedrock depths in the area of Honeymoon Heights, access road construction would likely require drilling, blasting, and the placement of fill materials. The Alternative 11 actions would likely expose bedrock beneath the waste rock piles and in portions of the other cleared areas following implementation. At this AOI, the removal of native top soil (in some cases down to exposed solid rock) would likely result in substrate attributes that are less conducive to eastside mixed conifer forest or eastside riparian wetland habitats as compared to current conditions. Succession will be slower to gain momentum when starting on bare rock (Etherington, 1975; Ricklefs, 1990; Reed, 1991; Raven et al., 1999). Moreover, exposed bedrock, can result in extremely dry, harsh environments, as water escapes quickly by runoff and evaporation, and wind and water may remove newly formed soils and associated plants, exposing bare rock and re-setting the recovery process.

In addition, severely disturbed areas serve as foci for the recruitment, growth, and reproduction of many exotic "fugitive" species. Accordingly, under Alternative 11, the re-establishment of native plant populations would require active maintenance. Moreover, given the likely "harsh" physical conditions following removal, recruitment of invasive species is likely and may prohibit recovery of native plants at the AOIs and/or impact nearby areas currently occupied by native species by outcompeting native species and/or recruiting or expanding presence in newly opened space.

Based on recent field observations by an expert botanist, plant communities at the areas downslope of Honeymoon Heights are considered to be comparable to those observed at avalanche chutes not affected by mine-related activities under existing conditions. Based on recent field observations, monitored natural recovery for the Honeymoon Heights waste rock piles would likely be a gradual process that may take decades. However, Alternative 13M is likely to support recovery of natural habitat in these AOIs on a time scale less than Alternative 11, where top soil is removed to implement the remedial action.

Alternative 13M would avoid disturbance and clearing of the existing native habitats and waste rock piles as required under Alternative 11 and Alternative 13M would provide greater overall protection of terrestrial ecological receptors and habitats in this area than Alternative 11.

4.1.3.3 Former Mill Building

Under Alternative 13M, excess waste rock generated during regrading of the west waste rock pile would be placed in the former mill building area, covered with a minimum of 6 inches of soil, and vegetated with native plants. Residual materials with concentrations above potential cleanup levels for the protection of ecological receptors (if present) would either be removed prior to covering or located below the CPOC after covering. Under Alternative 11, materials located within the former mill building footprint and having concentrations above potential cleanup levels established for the protection of ecological receptors would be excavated and disposed in a permanent on-site disposal area. Additional actions for this AOI were not specified under Alternative 11.

Alternative 11 would mitigate potential exposure pathways to ecological receptors from soil and materials located within the mill building with concentrations above potential risk-based cleanup levels (if present). However, based on the available information, it is unclear if Alternative 11 would include actions to promote the establishment of native vegetation in this area following remedy implementation.

Under Alternative 13M, residual materials with concentrations above potential cleanup levels for the protection of ecological receptors would either be removed or located below the CPOC of 6 feet. As described above in Section 4.1.3.1 for the east and west waste rock piles, the covering of the mill area with waste rock and a soil cover would protect and promote the establishment of shallow-rooted plants and soil invertebrates. Although PCOC concentrations above potential risk-based values for deep-rooted plants would remain for the waste rock/soil cover, recent observations of existing vegetation on the waste rock piles suggest some recruitment of deeper rooted plants would occur under Alternative 13M over time. Based on the findings of the draft TEE, the re-established vegetation would not pose a risk to herbivorous wildlife.

4.1.3.4 *Area of Windblown Tailings*

Under Alternative 13M, a significant portion of the shallow soils located to the south of the Holden Village-Lucerne road will be removed and/or covered for construction of the realigned Railroad Creek channel (Figure 3-1 and Appendix D). Excavated soils with concentrations below those determined to be protective of plants and soil invertebrates will be used as cover material for the tailings and waste rock. The remainder would be placed on the tailings beneath the cover. These actions would address soils in the portion of this AOI observed to have the thickest layer of windblown tailings. The thickness of windblown tailings on the south side of the road was observed to range between 0 and 12 inches, compared to 0 to 4.5 inches on the north side of the road, during the 2008 field investigation (Appendix G).[42]

Monitored natural recovery would be implemented under Alternative 13M for the remainder of the area of windblown tailings. The results of the draft TEE (Appendix G) show that PCOC concentrations in this AOI do not pose a risk to bird or mammal populations; however PCOC concentration above potential risk-based values established for the protection of plants and soil invertebrate communities would remain under Alternative 13M. Under current conditions, the southern portion of area of windblown tailings supports a moderately dense mixed conifer

---

[42] Sampling location 15, with a thickness of 4.5 inches, was located adjacent to the road. Excluding this sample, the maximum wind blown tailings thickness on the north side of the road was 2 inches.

tree canopy with an open understory of scattered shrubs and grasses/forbs. Areas north of the gravel road to Lucerne are characterized by relatively large conifer trees and a dense understory. Therefore, based on findings of the draft TEE and observations to date, exposures to residual PCOC concentrations in soils in this AOI do not appear to adversely impact plants and soil invertebrate communities, and without active remediation, a mid- to late-stage mixed conifer forest and characteristic soil invertebrate community is anticipated to be further established in this AOI.

Clearing of forested areas would be required to excavate, cover, and/or amend soils within the area of windblown tailings (estimated to be over 77 acres in size), and the cleared areas would be subjected to the following impacts:

- Destruction of native habitat;
- Erosion/loss of native soils;
- Loss of native soil invertebrate community;
- Loss of native biota and associated seed bank; and
- Likely increased expansion of invasive exotic species.

In addition to the removal of existing native vegetation, the compaction of soils resulting from vehicles, equipment, and/or other materials required to support the soil removal/covering actions may further hinder the long-term re-establishment of native vegetation in the cleared areas. In addition, severely disturbed areas serve as foci for the recruitment, growth, and reproduction of many exotic "fugitive" species. Accordingly, if significant clearing is required, the re-establishment of native plant populations would require significant long-term active maintenance and more than 50 years to recover.

Based on the TEE, protective PCOC concentrations currently exist at the AOI for bird and mammal populations, but risk-based values for plant and soil invertebrate communities in the areas outside of the Railroad Creek realignment may not be attained for several decades. However, the removal of windblown tailings in these areas is considered unlikely to appreciably improve current habitat or promote later stage eastside mixed conifer forest, because these areas currently support plant communities that are comparable to those observed in the background areas.

4.1.3.5 *Lower West Area*

An evaluation of the protection of terrestrial ecological receptors for the western and eastern portions of the LWA is provided below. Note that specific remedial actions were not identified for these AOIs under Alternative 11.

Lower West Area-West

Monitored natural recovery is proposed for the LWA-west under Alternative 13M. Based on the results of the draft TEE (Appendix G), PCOC concentrations in soils in the LWA-west AOI pose no risk to plant communities (with the possible exception of arsenic), soil invertebrate communities, bird populations, or mammal populations, and a mid- to late-stage eastside wetland riparian habitat is anticipated to be further established at this AOI without active remediation.

The removal or covering of native top soil in the portions of this AOI would result in the removal of existing eastside wetland riparian vegetation, removal/covering of shallow root systems, and removal of the native seed bank. Therefore, these actions are likely to increase the risk of invasive non-native plant species, soil erosion, and soil attributes that are less conducive to eastside riparian wetland habitat recovery as compared to current conditions.

With exception to the potential clearing required to construct groundwater collection systems in the LWA, Alternative 13M would avoid disturbance and clearing of the existing native habitats. Based on the draft TEE, risks to plant communities, soil invertebrate communities, bird populations, and mammal populations are unlikely to occur in this area under current conditions.

Lower West Area-East

Based on the results of the draft TEE (Appendix G), PCOC concentrations in soils in the LWA-east post a potential risk to insectivorous birds, mammal populations, terrestrial plants and soil invertebrate communities. Based on these findings, a majority of the west water treatment system infrastructure and settling ponds would be located in the LWA-east; thereby removing or covering soils in portions of this AOI and reducing potential exposures to terrestrial ecological receptors. Monitored natural recovery is proposed for the remainder of this AOI under Alternative 13M.

The removal or covering of native top soil in the portions of this AOI not covered or removed during construction of the west water treatment system would result in the removal of existing eastside wetland riparian vegetation, removal/covering of shallow root systems, and removal of the native seed bank. Therefore, these actions are likely to increase the risk of invasive non-native plant species, soil erosion, and soil attributes that are less conducive to eastside riparian wetland habitat recovery as compared to current conditions. The anticipated future land use in this area (water treatment, Holden Village wood storage/processing, and access to the hydroplant and maintenance yard) would also limit the achievable habitat recovery/succession in portions of the AOI if excavation and/or covering were implemented in this area.

The removal or covering of native surface soils in this AOI would mitigate potential risks to the plant community, soil biota community, and wildlife populations due to exposure to PCOC concentrations in soils. The time to attain protective levels of PCOCs would occur immediately following implementation. However, the effectiveness of soil removal measures would likely be temporary, as this area is located immediately upgradient of the LWA barrier wall and groundwater collection system and soils would continually be inundated with elevated PCOC concentrations in groundwater.[43] As a result, monitored natural recovery and the removal and/or covering of soils are considered to provide equal protectiveness with regard to residual concentrations of PCOCs.

4.1.3.6 Holden Village

No actions are proposed for this AOI under Alternative 13M and no specific actions were identified under Alternative 11. The findings of the draft TEE show that concentrations of PCOCs in soils in the Holden Village are protective of bird or mammal populations that may pass through the area under existing conditions. Based on the existing and anticipated future land use, the Holden Village grounds are not intended or maintained to support natural plant communities or wildlife populations and non-native ornamental plants and soil invertebrates are not considered terrestrial receptors of concern.

It is anticipated that the Holden Village will continue to be used as an interdenominational retreat following remedy implementation and that

[43] Post-remedy groundwater elevations will depend on a number of factors, including the bottom elevation of the groundwater collection trench, and will be further evaluated during remedial design.

the landscaped grounds, including lawns and ornamental plants will continue to be maintained. If and when the Holden Village discontinues use of the Village and grounds, the area may be re-evaluated to determine if remedial actions are required at that time for the protection of native plants or invertebrates.

4.1.3.7 *Ballfield/Wilderness Boundary Area*

Monitored natural recovery is proposed for the ballfield/wilderness boundary area under Alternative 13M. The findings of the draft TEE show that PCOC concentrations in this AOI pose no risk to terrestrial plant and soil invertebrate communities, and no risk to bird and mammal populations, with the possible exception of insectivorous mammal populations due to exposures to copper. However, overall risks to insectivorous mammals in this area are considered unlikely.

The removal and/or covering of native top soil in the portions of this AOI would result in the removal of existing eastside mixed conifer forest vegetation, removal/covering of shallow root systems, and removal of the native seed bank. Similarly, the use of soil amendments would result in the removal of existing vegetation. Therefore, these actions are likely to increase the risk of invasive non-native plant species, soil erosion, and soil attributes that are less conducive to eastside mixed conifer forest recovery as compared to current conditions.

Alternative 13M would avoid disturbance and clearing of the existing native habitats. Based on the draft TEE, PCOC concentrations in this AOI pose no risks to terrestrial plant and soil invertebrate communities and risks to wildlife are considered unlikely. Accordingly, with regard to residual concentrations of PCOCs, monitored natural recovery and the removal and/or covering of soils are considered to provide equal protectiveness in this area.

The ballfield has an herbaceous cover made up of a mixture of several species of native and introduced weeds and grasses. It is anticipated that the ballfield will remain in the current maintained state by the Holden Village and will not be returned back to the natural surrounding habitat. If and when the Holden Village discontinues use of the Village and grounds, the area may be re-evaluated to determine if remedial actions are required at that time for the protection of plants or soil invertebrate populations.

4.2 COMPLIANCE WITH ARARs

The NCP 40 CFR 300.430[e][9][iii][B]) requires that alternatives "be assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking one of the waivers under paragraph (f)(1)(ii)(c) of this section." The potential ARARs identified in Section 2.2 and discussed below for Alternatives 11 and 13M are preliminary. The final ARARs determination will be made as part of the remedy selection.

Compliance with potential chemical-specific, location-specific, and action-specific ARARs is usually required for an alternative to be considered for selection as the preferred remedy. An alternative that does not meet all ARARs may be selected if one or more of six justifications for waiving an ARAR are met. Of these six allowable waiver justifications, the following four may be considered for the Site:

- Compliance with the requirement would result in greater risk to human health and the environment than other alternatives;
- Compliance with the requirement is technically impracticable from an engineering perspective;
- Potential state ARARs are inconsistently applied; and
- The alternative will attain an equivalent standard of performance through the use of another method or approach.

Potential ARAR waivers, if necessary, would be addressed during the remedy selection process.

4.2.1 Compliance with Potential Chemical-Specific ARARs

An evaluation of compliance with potential chemical-specific ARARs for site media, including surface water, groundwater, and soil is provided in the following subsections.

4.2.1.1 *Compliance with Potential Chemical-Specific Surface Water ARARs*

Alternatives 11 and 13M would collect and treat the 1500-level portal drainage and address groundwater and seeps having PCOC concentrations above potential surface water ARARs at the CPOC(s) where groundwater discharges to Railroad Creek.[44] The water collection and treatment actions under Alternatives 11 and 13M would immediately reduce PCOC concentrations in Railroad Creek and the proposed source control actions under both alternatives are expected to further improve groundwater and surface water quality over time. Therefore, Alternatives 11 and 13M are expected to satisfy potential chemical-specific ARARs for surface water.

Both Alternatives 11 and 13M include the use of conventional low-energy alkaline precipitation treatment systems to reduce PCOC concentrations in collected site water prior to discharge to Railroad Creek. It is anticipated that mixing zones under WAC 173-201A-400 would be established in Railroad Creek downstream of the treatment system outfall(s). Treatment system performance and compliance with potential ARARs will continue to be evaluated based on the results of the ongoing bench and pilot testing of the proposed water treatment concepts. However, challenging site conditions, including elevated background PCOC concentrations above potential surface water ARARs, low hardness values in Railroad Creek, the remote site location, and lack of available power and other infrastructure present challenges related to achieving compliance with potential surface water ARARs in the short term at the edge of a potential mixing zone(s). If, based on the ongoing bench and pilot testing and the remedial design, it is determined that compliance at the edge of the acute or chronic mixing zones is not feasible, potential variance, exemptions and/or ARAR waivers may need to be evaluated for the Alternative 11 and 13M water treatment systems.

4.2.1.2 *Compliance with Potential Chemical-Specific Groundwater ARARs*

Potential ARARs for groundwater cleanup are based on federal and state MCLs, MTCA criteria for drinking water, and criteria for the protection of aquatic life where groundwater discharges to surface water. Groundwater in some portions of the Site will exceed drinking water standards into the long term under both Alternatives 11 and 13M. Therefore, both alternatives include the implementation of institutional controls to protect human health in these areas.

---

[44] For this analysis, the potential surface water ARARs include both the Washington State promulgated SWQC for the protection of aquatic life and the NRWQC. As discussed in Section 2.2, Intalco has submitted technical documentation to the Agencies demonstrating that the SWQC and NRWQC are based upon sensitive species that would not naturally inhabit Railroad Creek or Copper Creek and thus, the justification for a potential future modification to address site-specific conditions and resident aquatic life.

For groundwater that discharges to surface water, CPOCs would be established in surface water at the groundwater discharge locations. Under MTCA, the establishment of a CPOC requires that AKART be applied to all groundwater discharges before being released into surface water. Through source control actions, groundwater/seep collection, and natural attenuation processes, Alternative 13M is expected to meet ARARs at a CPOC(s) where groundwater discharges to Railroad Creek downstream of the Site, and Alternative 13M is anticipated to provide equivalent protection of aquatic life compared to Alternative 11. In addition, based on groundwater data collected at downgradient monitoring wells, groundwater is expected to meet drinking water standards to the east of tailings pile 3 under current conditions.[45] Therefore, groundwater that discharges from the Site is anticipated to meet potential chemical specific ARARs under Alternative 13M.

As described in Sections 4.3 and 4.5, constructability issues and uncertainties related to the short- and long-term stability of tailings piles 2 and 3 significantly reduce the technical implementability associated with the Alternative 11 actions, including construction of an engineered cap with an impermeable liner and the installation of a barrier wall and groundwater collection system adjacent to the two piles. Furthermore, based on the existing data, these actions are not needed for groundwater to achieve potential ARARs at the CPOC(s) east of the Site. As a result, the actions included under Alternative 13M are considered AKART for tailings piles 2 and 3.

4.2.1.3 *Compliance with Potential Chemical-Specific Soil ARARs*

A preliminary assessment of compliance with potential soil ARARs established for the protection of human health and terrestrial ecological receptors is provided in the following subsections. The potential chemical-specific soil ARARs used in this evaluation are based on the draft supplemental human health risk evaluations and draft TEE performed for the Site. Because tailings and waste rock are not considered "soils", these materials are not discussed in this section.

[45] An exceedance of the potential manganese ARAR was detected in one sample from well NRC-3D in July 2008 (774 µg/L vs 747 µg/L); however, samples from NRC-3D in August 2008 indicate concentrations are below the potential criterion.

Compliance with Potential Chemical-Specific Soil ARARs for the Protection of Human Health

Results of the baseline HHRA presented in the 1999 DRI indicate that PCOC concentrations associated with site soils are protective of human health under current and anticipated future recreational land uses and construction and maintenance worker activities. Although the baseline human health risk evaluations indicate no existing unacceptable risks to Holden Village residents or visitors from exposures to site soils, soils with concentrations above the MTCA direct contact soil criteria in the lagoon area and maintenance yard would be excavated and covered, respectively, under both Alternatives 11 and 13M. Similarly, if soils in the former mill building have concentrations above potential MTCA direct contact soil criteria, these soils will be removed and/or covered under both alternatives. As needed, institutional controls, including land use restrictions, would be also implemented under Alternative 13M to protect human health in areas where soil concentrations above potential risk-based criteria are managed in place and to mitigate potential exposure pathways to deeper soils in areas such as the LWA-east.

The MTCA also requires that PCOCs in soil do not cause contamination of groundwater at levels that exceed human-health based groundwater cleanup levels using the methods specified in WAC 173-340-747. Under Alternative 11, groundwater would be collected and treated downgradient of all site areas with groundwater concentrations above potential human-health based ARARs, and institutional controls would be implemented for areas upgradient of the barrier walls/groundwater collection systems to mitigate the potential use of groundwater as a drinking water source. Therefore, additional actions to address site soils with concentrations above potential cleanup levels are not required under Alternative 11.

Similarly, under Alternative 13M, groundwater would be collected downgradient of all site areas with groundwater concentrations above potential human-health based ARARs, with the exception of groundwater beneath tailings pile 3 and the eastern portion of tailings pile 2. Groundwater downgradient of tailings piles 2 and 3 is expected to meet potential drinking water ARARs under Alternative 13M, and institutional controls would be implemented to mitigate the potential use of groundwater as a drinking water source in the upgradient areas. As a result, additional actions to address site soils with concentrations above potential cleanup levels are also not required under Alternative 13M.

Compliance with Potential Chemical-Specific Soil ARARs for the Protection of Terrestrial Ecological Receptors

The identification and evaluation of potential cleanup levels for soils for the protection of ecological receptors is ongoing. Preliminary EISCs were calculated for site AOIs and are presented in Appendix I for preliminary screening purposes only. Soil concentrations between 0 and 6 feet in the areas downslope of Honeymoon Heights and the LWA-east are elevated with respect to the preliminary EISCs for one or more wildlife receptors. The preliminary EISCs developed for the protection of plants and soil invertebrates are exceeded for one or more PCOCs in all of the site soil AOIs.[46]

Alternatives 11 and 13M would implement equivalent actions to mitigate potential exposure pathways to terrestrial ecological receptors and comply with potential chemical-specific soil ARARs in the lagoon area, maintenance yard, and former SRA. Portions of the LWA-east and area of windblown tailings with soil concentrations above the preliminary EISCs would be covered or removed during implementation of other remediation components under Alternative 13M. Alternative 13M would implement monitored natural recovery for those remaining portions of the Site where soil concentrations would remain above potential EISCs for the protection of terrestrial plants, soil invertebrates and/or some wildlife, including the wilderness boundary area, the area downslope of Honeymoon Heights, portions of the LWA, and portions of the area of windblown tailings. Specific remedial actions were not identified under Alternative 11 in the Final Draft Proposed Plan for the protection of ecological receptors in these other soil AOIs, and therefore a direct comparison between alternatives cannot be made for these areas.

4.2.1.4 *Compliance with Potential Chemical-Specific Sediment ARARs*

Alternatives 11 and 13M would meet potential chemical-specific sediment ARARs under current conditions. Groundwater and seep collection and addressing ferricrete through removal or relocation of Railroad Creek under Alternatives 11 and 13M are expected to further improve the aquatic habitat in Railroad Creek.

---

[46] Plants and soil invertebrates are not considered receptors of concern for the Holden Village. Due to safety concerns, no soil samples have been collected to date from within the former mill building.

4.2.2 *Compliance with Potential Action- and Location-Specific ARARs and TBCs*

Potential action- and location-specific ARARs must be considered in remedy selection under CERCLA as discussed in Section 2.2. There are no apparent significant differences between Alternatives 11 and 13M for most of the potential action- and location-specific ARARs. Monitoring during and after implementation would be used to assess compliance, as required under both CERCLA and MTCA. An evaluation of Alternatives 11 and 13M with respect to several of the key potential action- and location-specific ARARs and TBCs is presented in the following subsections.

4.2.2.1 *Washington MTCA [RCW 70.105D, Chapter 173-340 WAC]*

The following requirements under MTCA potentially affect implementation of the RD/RA at the Site:

- **Natural Attenuation (WAC 173-340-370[7])** – Both Alternatives 11 and 13M would rely on natural attenuation to some extent to reduce concentrations of PCOCs released from the Site over time and meet ARARs in Site surface water (e.g., surface water ARARs would be set equal to background concentrations for several constituents) immediately downgradient of the Site. Alternative 13M would rely on natural attenuation to a greater extent for groundwater downgradient of tailings piles 2 and 3; however, both Alternatives 11 and 13M would meet the expectations under MTCA for natural attenuation to be considered an active remedial measure for the Site.

- **Reasonable Restoration Timeframe (WAC 173-340-360[2][b][ii])** – Alternatives 11 and 13M would provide active measures to collect and treat identified groundwater sources that exceed potential ARARs where groundwater enters Railroad Creek. Both alternatives are expected to result in significant reductions in PCOC concentrations in Railroad Creek immediately after implementation and achieve potential surface water ARARs within similarly reasonable time frames. An evaluation of restoration time frames is provided in Section 5.5.

- **Institutional Controls (WAC 173-340-440) –** Both Alternatives 11 and 13M would implement institutional controls to address residual risk at the Site.

- **Compliance Monitoring (WAC 173-340-410, WAC 173-340-720[9], 173-340-730[7], and WAC 173-340-740[6]) –** Alternatives 11 and 13M will provide for compliance monitoring for groundwater, surface water, and soil. Monitoring plans will be developed during RD to address these requirements. A discussion of potential compliance monitoring under Alternative 13M is provided in Section 5.3.

4.2.2.2 *Washington State Standards for Solid Waste Handling (RCW 70.95; WAC 173-350-400[3][e][i][A] through [H], -400[7][a], and -710[7][a])*

The evaluation of Alternatives 11 and 13M with respect to the closure system performance standards included under WAC 173-350-400(3)(e)(i)(A) through (H) is provided below.

Analysis of Alternative 11 with Respect to the Washington State Standards for Solid Waste Handling

Alternative 11 includes the consolidation of the Honeymoon Heights waste rock piles and portions of the east and west waste rock piles on to the tailings piles, and then placement of a cover including a geomembrane and two feet of soil over the tailings and remainder of the east and west waste rock piles (i.e., the presumptive closure cover under WAC 173-350-400(3)(e)(ii)).

The Alternative 11 cover systems for the tailings and east and west waste rock piles are expected to prevent exposure of waste; minimize infiltration; prevent erosion from wind and water; be capable of sustaining native vegetation; address anticipated settlement with a goal of no less than two to five percent slope; and provide for the management of run-on and run-off, preventing erosion or otherwise damaging the closure cover (WAC 173-350-400[3][e][i][A] through [E] and [G]). However, as described below, the cover systems may not provide sufficient stability and mechanical strength and address potential freeze-thaw and desiccation, or minimize the need for post-closure maintenance (WAC 173-350-400[3][e][i][F] and [H]).

The stability analyses presented in Appendix C show that to achieve adequate seismic factors of safety and tolerable seismic deformations, the regraded tailings piles under Alternative 11 would require a rockfill buttress and shear key at the toe of the slopes. A large rockfill buttress was found to increase the seismic factors of safety and reduce deformation, but not enough for tailings piles 2 and 3 and the presence of the barrier wall along the toe of tailings pile 2 would exacerbate stability issues by raising water levels within the tailings. The presumptive covers included under Alternative 11 for both the tailings and east and west waste rock piles would require benching and a geogrid to maintain the proposed 2:1 slopes. However, under the MDE seismic loading, the tailings and waste rock would still undergo deformation and the cover would be damaged, requiring significant effort and specialized construction crews to repair the geomembrane component of the cover.

Significant post closure maintenance would be required under Alternative 11 to prevent the establishment of deeper rooted plants and burrowing animals that would potentially damage the geomembranes; prevent the establishment of invasive, non-native plant species; and to maintain the extensive drainage network free of ice and other obstructions. Long-term collection and treatment of groundwater and seeps would also be required under this alternative.

In addition, although the Alternative 11 cover systems would likely sustain native, shallow-rooted plants, preventing the establishment of deeper rooted plants would result in a final vegetative cover that is significantly different than the surrounding native eastside mixed conifer and eastside wetland riparian habitats.

Analysis of Alternative 13M with Respect to the Washington State Standards for Solid Waste Handling

Alternative 13M includes a soil cover on the tailings and east and west waste rock piles. The soil covers under Alternative 13M would prevent exposure of waste; minimize infiltration; prevent erosion from wind and water; be capable of sustaining native vegetation; address anticipated settlement with a goal of no less than two to five percent slope; provide sufficient stability and mechanical strength and address potential freeze-thaw and desiccation; provide for the management of run-on and run-off, preventing erosion or otherwise damaging the closure cover; and minimize the need for post-closure maintenance (WAC 173-350-400[3][e][i][A] through [H]).

Post closure maintenance would be required in the short-term to maintain planted vegetation and prevent the establishment of invasive, non-native plant species. Long-term collection and treatment of groundwater and seeps associated with the waste rock and tailings piles would also be required under this alternative.

Due to the shallow bedrock, steep topography, and presence of near-surface underground stopes beneath the potential access road alignment and portions of the 300-, 550-, and 700-level waste rock piles, covering or relocation of the Honeymoon Heights waste rock piles, as included under Alternative 11, would not be possible without significant safety risks and potential for long-term or permanent environmental impairment.

Therefore, covering or relocation of the Honeymoon Heights waste rock piles it is not considered relevant or appropriate under Alternative 13M.

The results of the draft TEE (Appendix G) show that under current conditions, PCOC concentrations in Honeymoon Heights are unlikely to pose a risk to wildlife, and the collection and treatment of Honeymoon Heights seeps SP-12 and SP-23 would mitigate the transport of PCOCs to Railroad Creek and protect aquatic life. Therefore, the Honeymoon Heights actions under Alternative 13M would be protective of human health and the environment, which is the overriding objective of WAC 173-350-400(3)(e)(i)(A) through (H).

Based on this analysis, the Alternative 13M closure configurations are more compatible with site conditions than the presumptive closure cover included under WAC 173-340-400(3)(e)(ii).

4.2.2.3 *Clean Water Act Section 402, National Pollutant Discharge Elimination System Regulations. [33 USC 1342]*

Due to the remote nature of the Site, lack of available power, and elevated background concentrations of some PCOCs in surface water that are above or nearly equal to potential ARARs, technology-based limitations may need to be established on a case-by-case basis for this Site. This would include consideration of the proposed low energy treatment systems under Alternatives 11 and 13M demonstrating BAT as a substantive requirement under potential federal NPDES ARARs and demonstrating AKART under potential Washington State ARARs.

The low-energy treatment systems evaluated under Alternatives 11 and 13M will significantly reduce PCOC concentrations in site seeps, groundwater, and the 1500-level portal discharge. The treatment system performance and compliance with potential surface water ARARs will continue to be evaluated based on the results of the bench and pilot testing to be completed in 2009 and 2010 and during remedial design.

The proposed narrative criteria, which protect the specific designated uses of all fresh waters (WAC 173-201A-600 and WAC 173-201A-602) in the State of Washington would be met by Alternatives 11 and 13M as the low-energy treatment systems would improve water quality, designated water uses, and aesthetic values, and would protect human health. In addition, the proposed treatment systems would meet anti-degradation policy by restoring Railroad Creek's surface water quality and apply AKART. Monitoring requirements would be established based upon the proposed system and effluent discharge. Development of monitoring requirements could commence during the RD.

Both alternatives would collect and treat storm water runoff using similar methods. However, due to the massive tailings regrading required under Alternative 11, Alternative 11 would likely require the management of more impacted storm water during remedy implementation than Alternative 13M.

4.2.2.4 *Land and Resource Management Plan for Wenatchee National Forest (Forest Service 1990)*

As described in Section 2.2.4, portions of the 1990 LRMP and 1994 NWFP are TBC. Specific provisions that have been identified by the Agencies for further evaluation include standards and guidelines relating to activities within, or that affect Riparian Management Areas along Railroad and Copper Creeks, including 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 have been identified by the Agencies for tailings and waste rock piles located within Riparian Reserves at the Site include provisions 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.

Alternatives 11 and 13M are expected to meet the standards and guidelines, including RF-2 through RF-7, that pertain to the construction and use of temporary and/or permanent roads within the Riparian Reserves during remedy implementation and for those remedial actions taking place within the Riparian Reserves, such as the construction of groundwater collection and treatment systems and Railroad Creek relocation. Additionally, tailings piles 1, 2, and 3 are located within the Riparian Reserves for Railroad and Copper Creeks. The tailings pile investigations completed to date to assess the chemical composition, geochemical conditions, and groundwater quality associated with the tailings were completed using best conventional methods and are expected to comply with MM-3 (a). The tailings pile closure actions included under Alternatives 11 and 13M to improve slope stability, reduce surface water runon, improve surface water runoff, and provide groundwater collection and treatment represent best conventional techniques to provide mass stability, prevent the release of acid or toxic materials, insure chemical and physical stability, and improve water quality in Railroad Creek; thereby meeting the provisions under MM-3 (b) and (c).

The Honeymoon Heights waste rock piles and east and west waste rock piles are not located within designated Riparian Reserves; therefore, 1990 LRMP and 1994 NWFP would not be considered a TBC for these areas.

4.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

As described in USEPA Guidance (EPA, 1988), the following factors are considered in the assessment of long-term effectiveness and permanence:

- Magnitude of residual risk based on characteristics of untreated materials and concentrated wastes remaining after completion of remedial activities. Volume, toxicity, mobility, and potential for bioaccumulation of remaining hazardous materials are considered during the quantification of residual risks.
- The expected adequacy and reliability of engineering controls, including the suitability and continual effectiveness of controls used to manage the remaining materials; the need for replacement of technical components or facilities; and requirements for long-term management, monitoring, and O&M. The uncertainties of long-term effectiveness are addressed under this criterion, when appropriate.

4.3.1 Magnitude of Residual Risk

The magnitude of residual risks to human health and aquatic and terrestrial ecological receptors is discussed in the following subsections.

4.3.1.1 Magnitude of Residual Risk to Human Health

Alternatives 11 and 13M are expected to be fully protective of human health following implementation; therefore, the magnitude of residual risks to human health is anticipated to be similar under both alternatives.

Results of the baseline HHRA presented in the 1999 DRI and the supplemental human health risk evaluations conducted for the tailings and waste rock in 2009 (Appendix F) show that PCOC concentrations associated with site soils, waste rock, and tailings are protective of human health under current and anticipated future recreational land use and future construction and maintenance worker activities. Under Alternatives 11 and 13M, soil with concentrations above the potential

MTCA direct contact values and groundwater with concentrations above potential drinking water ARARs will be managed in place in some areas of the Site. Institutional controls, including land use restrictions, would be implemented in these areas to mitigate potential future exposures to human receptors and protect human health. Under both alternatives, the overall area of groundwater having PCOC concentrations above potential drinking water standards is expected to be similar.

Alternatives 11 and 13M would also reduce potential physical hazards to Holden Village residents and visitors through slope stability measures for the tailings and waste rock piles, the installation and maintenance of access restrictions in the underground mine portals, and removal of the steel superstructure associated with the former mill building.

4.3.1.2 Magnitude of Residual Risk to Aquatic Receptors

Alternatives 11 and 13M would fully address potential risks to aquatic receptors; therefore the magnitude of residual risks to aquatic receptors would be equivalently low under both alternatives. Both alternatives include the collection and treatment of groundwater and seeps discharging to Railroad Creek adjacent to the Site and having PCOC concentrations above potential surface water ARARs established for the protection of aquatic life. Groundwater discharging to Railroad Creek downgradient of the Site is expected to meet potential surface water ARARs at the discharge location(s) through natural attenuation. The seep and groundwater collection and treatment actions under Alternatives 11 and 13M would immediately reduce PCOC concentrations in Railroad Creek and concentrations are expected to continue to decline over time as a result of source control actions and through natural attenuation mechanisms.

Site sediment would be protective of aquatic life under both Alternatives 11 and 13M. Groundwater and seep collection and addressing ferricrete through removal or relocation of Railroad Creek under Alternatives 11 and 13M are expected to further improve the aquatic habitat in Railroad Creek. Both Alternatives 11 and 13M include measures to stabilize the tailings pile side slopes and mitigate the residual risk of tailings transport to Railroad Creek under static or seismic conditions. However, as described in Section 4.6.1, there would be a greater risk of slope failure and potential release of tailings to Railroad Creek during the tailings piles 2 and 3 regrading actions under Alternative 11, and further evaluation of the final slope configurations for tailings piles 2 and 3 is needed to ensure adequate long-term stability can be attained under Alternative 11.

4.3.1.3 *Magnitude of Residual Risk to Terrestrial Ecological Receptors*

Alternatives 11 and 13M include removal and/or covering of soils in the lagoon area, maintenance yard, and former SRA. These actions would mitigate potential exposure pathways to terrestrial ecological receptors and the residual risks in these areas would be low under both alternatives.

Alternatives 11 and 13M would both mitigate potential exposure pathways to shallow-rooted plants and soil invertebrates in the tailings and east and west waste rock piles. Alternative 11 would also mitigate potential risks to deeper-rooted plants by preventing their establishment through active maintenance. Although a low potential risk to deeper rooted plants would remain on the tailings and waste rock under Alternative 13M, data and recent observations of the piles show that deeper rooted plants are re-establishing, and a plant community representative of the surrounding habitats is expected to result over time as a result of natural recovery. Under Alternative 11, the establishment of deep rooted plants would not be allowed in order to protect the integrity of the geomembrane cover.

The incidental removal and/or covering of soils in portions of the lower west area and area of windblown tailings during implementation of other Alternative 13M remedy components would reduce the overall risks to terrestrial ecological receptors in these two areas. However, the results of the draft TEE indicate that a low potential risk would remain for terrestrial ecological receptors in the ballfield/wilderness boundary area, and portions of the LWA and area of windblown tailings not removed or covered by other actions. Alternative 13M would implement monitored natural recovery for these AOIs, because active remediation is not possible without potential long-term or permanent impairment of the native habitats. Specific remedial actions were not identified for these AOIs under Alternative 11; therefore a direct comparison between alternatives is not possible.

Please refer to Section 4.1.3 for a more detailed evaluation of Alternatives 11 and 13M with respect to the protection of terrestrial ecological receptors.

4.3.2 *Adequacy and Reliability of Controls*

The adequacy and reliability of the proposed water treatment systems, disposal of treatment system residuals, groundwater collection and conveyance systems, and capping systems is discussed in the following subsections. Based on these evaluations, the actions included under

Alternative 13M would protect human health and the environment with a higher degree of reliability than the actions included under Alternative 11.

4.3.2.1 *Adequacy and Reliability of Water Treatment Systems and Treatment Residual Disposal*

The low-energy treatment system technologies proposed under Alternatives 11 and 13M are well demonstrated and are expected to be adequate and reliable in permanently removing PCOC from collected site waters. Variable flow rates to the treatment systems are expected under both alternatives due to seasonal variations in seep flows and groundwater elevations across the Site. The potentially large fluctuations in flow and metals loading would increase the difficulty in optimizing the chemical dosing rates for the treatment systems. However, these difficulties would be more pronounced for Alternative 11, which relies on pumping of all water collected adjacent to tailings piles 2 and 3. Flow rates in excess of the treatment capacity or the pumping capacity for Alternative 11 would need to be discharged to Railroad Creek without treatment. As discussed in the Agencies' SFS, this flow rate would be determined during the detailed design.

Similar treatment sludge generation rates and characteristics are expected under both Alternatives 11 and 13M, although Alternative 11 is anticipated to generate some additional sludge through the collection and treatment of groundwater associated with tailings piles 2 and 3. The ongoing bench and pilot scale testing will provide additional data related to the expected sludge characteristics. However, the generated sludge is anticipated to be a solid, non-hazardous waste under Chapter 173-350 WAC, and the design, construction and closure of the sludge disposal area in conformance with the requirements under WAC 173-350-400 is expected to be reliable and adequate in mitigating the release of PCOCs from the treatment sludge over time.

4.3.2.2 *Adequacy and Reliability of Groundwater Collection Systems*

The seep and groundwater collection technologies included under Alternatives 11 and 13M are expected to be reliable and effective over the long-term; however, some of the Alternative 13M technologies are expected to be more reliable than the Alternative 11 technologies.

Both alternatives would use the same technologies (i.e., a combination of discrete collection basins and barrier walls/open collection trenches) to collect the 1500-level portal drainage, Honeymoon Heights seeps, and groundwater and seeps associated with the LWA. These technologies are expected to be reliable and effective over the long-term. Alternative 13M would make minimal use of pipelines for water transport in the east area, where the occurrence of elevated iron concentrations increases the potential for iron precipitation and blockage.

In contrast, there are significant concerns related to the long-term effectiveness and permanence of the water collection and conveyance system included under Alternative 11 adjacent to the three tailings piles. All water collected under Alternative 11 would be transported to the treatment system in pipelines. A large portion of this water would also require pumping from the southeastern corner of tailings pile 3 to the treatment system location. The pipelines and pump systems would need to be closely monitored and maintained year-round to prevent releases of untreated water. Any excess flow beyond the pumping capacity, and all flows at times of power interruption or pump failure, would be directly discharged to Railroad Creek.

4.3.2.3 *Adequacy and Reliability of Cover Systems*

The surface regrading and cover systems planned under Alternatives 11 and 13M are expected to be adequate and reliable in reducing infiltration and protecting terrestrial ecological receptors over the long term. However, the Alternative 13M soil cover would require significantly less maintenance compared to the cover system planned under Alternative 11, and the Alternative 13M cover could be repaired relatively quickly with conventional equipment, such as shovels, excavators, or bulldozers, in the event of damage resulting from a seismic event. Significant post closure maintenance would be required under Alternative 11 to prevent the establishment of deep-rooted plants and burrowing animals that would potentially damage the geomembrane; to prevent the establishment of invasive, non-native plant species; and to maintain the extensive drainage network free of ice and other obstructions. In the event of damage to the Alternative 11 cover, significant effort and specialized construction crews would be required to repair the geomembrane.

4.4 *REDUCTION OF TOXICITY, MOBILITY AND VOLUME THROUGH TREATMENT*

The NCP in 40 CFR 300.430(e)(9)(iii)(D) requires that: "The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume shall be assessed, including how treatment is used to address the principal threats posed by the site." Technologies that meet the statutory preference for treatment-based alternatives include actions that result in one or more of the following:

- Destruction of contaminants,
- Reduction of the total mass of contaminants,
- Irreversible reduction in contaminant mobility, and
- Reduction of total volume of contaminated materials.

The USEPA has made the following statements regarding the applicability of treatment technologies at mining-related CERCLA sites through OSWER Directive No. 9355.0-26 (USEPA 1989c):

- Engineering controls such as containment may be more appropriate than treatment at large sites characterized by high volume/low toxicity wastes such as mine and mill wastes.
- Treatment technologies are generally more appropriate for addressing liquid, highly concentrated, and toxic compounds.
- In some instances, a combination of treatment and containment would be recognized as the most appropriate remedial approach.

Alternatives 11 and 13M are similar in their reduction of toxicity, mobility and volume of PCOCs released from the Site, because both alternatives include the collection and treatment of groundwater and seeps discharging to Railroad Creek adjacent to the Site and having PCOC concentrations above potential surface water ARARs. Alternative 11 would collect and treat additional groundwater associated with tailings piles 2 and 3; however, it is anticipated that Alternative 13M would meet potential surface water ARARs where this groundwater discharges to Railroad Creek through natural attenuation processes.

The alkaline precipitation treatment processes included for the Alternative 11 and 13M water treatment systems would reduce the concentrations of PCOCs in collected waters before release to surface water. Therefore, these systems would reduce the toxicity of the collected waters to aquatic organisms and the mass and volume of PCOCs released to the environment. The metals removed through water treatment would be contained in the alkaline sludge generated in the water treatment processes and properly disposed on site; thereby reducing the mobility of these constituents. The mass and volume of PCOCs released to groundwater and surface water would also be reduced from site sources over time through source control actions and the natural geochemical processes described in the DFFS.

Stabilization processes would be implemented under Alternatives 11 and 13M if solid media determined to be characteristic hazardous wastes is identified during remedy design or implementation. These stabilization processes would produce a stable product and reduce constituent mobility to environmental receptors.

4.5 SHORT-TERM EFFECTIVENESS

The NCP, in 40 CFR 300.430(e)(9)(iii)(E) requires consideration of the following factors to assess the potential short-term impacts of alternatives:

- Short-term risks that might be posed to the community during implementation of an alternative;
- Potential impacts on workers during remedial action 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.

As described in the following subsections, the implementation of Alternatives 11 and 13M would pose short-term risks to the local community, workers, and environment. Although many of these risks can be managed or mitigated during remedy implementation, the short term risks posed by Alternative 11 are significantly greater than the risks posed by Alternative 13M because implementation of Alternative 11 includes more handling of contaminated materials, more heavy construction activity, and a longer construction duration than Alternative 13M.

4.5.1 Potential for Short-Term Impacts to the Local Community and Workers

The implementation of appropriate health and safety measures and close coordination with the Holden Village during construction would reduce safety risks to workers, Holden Village residents, and visitors under Alternatives 11 and 13M. For all the alternatives under consideration, a permanent and/or temporary stream crossing would be installed over Railroad Creek at the downstream edge of tailings pile 3 to allow vehicles and equipment to bypass the Holden Village during remedy construction. Access to the top of the tailings piles would also be gained from the new stream crossing. However, under both alternatives, the increased heavy equipment and truck traffic on the road to the east of the Holden Village would result in short-term impacts to the local community, including the routine Holden Village bus and supply vehicle traffic, disruption to pedestrian use in the area, and increased noise levels.

The duration and extent of construction activities and long-term O&M requirements would vary between the alternatives. As a result, safety risks and impacts to workers and Holden Village residents and visitors would also be different under each alternative. The additional construction activities required to implement Alternative 11 would substantially increase the safety risks and construction-related impacts associated with this alternative compared to Alternative 13M. The estimated peak number of construction workers and equipment estimated for Alternative 13M and Alternative 11 would likely be similar, with comparable construction-related impacts during those times. However, the Alternative 13M construction activities are expected to be completed in two full construction seasons, with final seeding and planting occurring in year three, while Alternative 11 would likely require more than three full construction seasons to complete, thereby extending the impacts on the workers and the Village for an additional year.

Direct impacts to Holden Village facilities are anticipated to be similar for both alternatives during construction. However, as described above, the duration of these impacts would be extended for an additional construction season under Alternative 11. All of the alternatives would result in periodic disruptions to use of the maintenance buildings and vehicle storage area, the riverside sauna, hydroelectric plant, road to the Copper Creek water intake, pedestrian bridge, and the road between Holden and Lucerne. However, it should be possible to limit disruptions to these facilities through close coordination between the construction contractor and the Holden Village.

During construction of the new Railroad Creek channel, Alternative 13M would result in construction-related noise and dust-generation potential near the Holden Village. Alternative 11 does not include significant construction activities on the north side of Railroad Creek in the immediate vicinity of the Holden Village.

Relocation of the Honeymoon Heights waste rock piles under Alternative 11 would present significant safety risks during access road construction and remedy implementation due to the steep topography and the potential for a collapse of near-surface underground stopes located beneath this area. Alternative 13M does not include Honeymoon Heights relocation and would therefore avoid these risks.

Both Alternatives 11 and 13M would include the evaluation and construction of hydrostatic bulkheads in the 1500-level main and ventilator portals (if determined to be feasible) and access restrictions and possible low-head plugs into open Honeymoon Heights portals. These actions would require work within the underground mine workings and associated risks to workers. For this work, MSHA standard safety protocols would be implemented to reduce potential safety risks to workers.

4.5.2 *Potential for Short-Term Impacts to the Environment*

Short-term impacts to the environment resulting from implementation of Alternatives 11 and 13M may include:

- Risk of tailings or PCOC releases to Railroad Creek or Copper Creek during regrading;
- Risk of bentonite or cement releases to Railroad Creek or Copper Creek during barrier wall construction;
- Risk of fuel and lime spills;
- Risk of sediment release to Railroad and Copper Creeks during construction of groundwater and seep collection systems, stream crossings for vehicles, pipeline crossings, and ferricrete removal;
- Risk of sediment release to Railroad and Copper Creeks during realignment of Railroad Creek and Copper Creek improvements;
- Risk of impacts to the riparian corridor along Railroad Creek during construction of barrier walls and the Railroad Creek realignment;
- Risks associated with increased PCOC concentrations in the portal drainage following remedy implementation; and
- Risks of impacts to terrestrial habitats due to rock quarry development and construction activities at Honeymoon Heights, LWA, ballfield/wilderness boundary area, and/or the area of windblown tailings.

4.5.2.1 *Potential for Tailings or PCOC Releases to Railroad or Copper Creeks during Regrading*

The relocation of tailings under Alternatives 11 and 13M, particularly tailings situated near Railroad and Copper Creeks, raises the risk of an accidental release of tailings or PCOCs to the creeks during remedy implementation. Based on the volume of tailings to be relocated and the stability of the resulting side slopes, Alternative 11 has a higher risk of tailings or PCOC releases to the creeks than does Alternative 13M.

It is estimated that approximately 960,000 cy of tailings would require relocation under Alternative 11 compared to 390,000 cy under Alternative 13M, because Alternative 11 requires creation of a 45-foot bench at the toe of the tailings piles, whereas for Alternative 13M, no bench is required and the current toe would remain in place. Implementation of Alternative 11 would also result in the removal of the starter dams, all the strong cemented Zone 1A tailings, and most of the relatively strong Zone 1 tailings that have maintained the steep tailings pile side slopes since the cessation of mining operations. The final exposed slopes in the Zone 2 tailings would have higher moisture contents, with weaker tailings material than is exposed at present. Additionally, the barrier wall and groundwater collection system located at the toes of tailings piles 2 and 3 under Alternative 11 would require construction after the tailings pile side slopes have been regraded but before the rockfill buttress is placed, resulting in potential slope stability issues during construction. These conditions could lead to local instabilities and sloughing during construction of Alternative 11.

Under Alternative 13M, significantly less tailings would be removed from the side slopes, the current toe would remain in place, and the overbank deposits would not be exposed during slope regrading; thereby increasing the overall stability during construction. Further, Alternative 13M does not include barrier walls at the toes of tailings piles 2 and 3.

Storm water and sediment management during tailings pile regrading activities will be accomplished in a similar way under both Alternatives 11 and 13M, but with larger volumes of unoxidized tailings exposed during regrading and consolidation and greater potential for material erosion and potentially contaminated runoff under Alternative 11. Under both alternatives, space would be available in the area immediately east of tailings pile 3 for construction of temporary settling ponds or other measures to control runoff during the construction period.

4.5.2.2 *Risk of Bentonite or Cement Releases to Railroad Creek or Copper Creek during Barrier Wall Construction*

There is a significantly greater potential for the release of bentonite or cement to Railroad Creek or Copper Creek during construction of the fully-penetrating barrier walls under Alternative 11 compared to Alternative 13M. Alternative 11 includes the construction of approximately 7,960 linear feet (lf) (570,000 square feet [sf]) of barrier wall along the Site compared to approximately 3,470 lf (204,000 sf) under Alternative 13M. The potential for release of slurry to surface water can be reduced through careful construction practices, including location of dry materials storage and mixing facilities away from the creek, good housekeeping to minimize spillage during slurry handling, and advanced preparation of a spill management contingency plan.

4.5.2.3 *Risk of Fuel and Lime Spills*

During construction, there is a risk of fuel spills both on and off the Site. In an assumed worst case, an off-site spill could release the contents of a tanker truck (typically about 2,000 gallons) into Lake Chelan. The risk of this is proportional to the total quantity of fuel that would be used during construction. The increased construction requirements and durations for Alternative 11 would result in greater total fuel usage and corresponding fuel deliveries. Similarly, due to the pumping requirements for the water treatment system, Alternative 11 would require additional power for short- and long-term operations.

After treatment plant construction, there is some potential risk of spilling fuel or hydrated lime during transport to the Site or during transfer from delivery trucks into storage facilities. The risk of potential hydrated lime spills during treatment system operation is similar under Alternatives 11 and 13M, because the water treatment systems would receive similar total metals and acidity loading and are anticipated to use equivalent quantities of lime.

4.5.2.4 *Risk of Sediment Release to Railroad and Copper Creeks during In-Stream Construction Activities and Railroad Creek Realignment*

Alternatives 11 and 13M present a risk of an accidental release of sediment to Railroad and/or Copper Creeks because both alternatives include construction activities in or adjacent to the creeks (e.g., groundwater and seep collection systems, stream crossings for vehicles, pipeline crossings and stream relocation). As described in section 4.5.2.2, careful construction practices can reduce the risk of sediment releases during construction adjacent to Railroad or Copper Creeks. Nonetheless, the potential risk of sediment release is proportional to the amount of construction work performed in or adjacent to the streams.

Both alternatives include the excavation of groundwater and seep collection trenches adjacent to portions of Railroad and Copper Creeks; however, the risk of a sediment release to the creeks is less under Alternative 13M because most of the groundwater collection system adjacent to tailings piles 1 and 2 would be constructed within the former Railroad Creek channel and not immediately adjacent to the active portion of the stream. However, there would be an increased risk of sediment release under Alternative 13M during realignment of Railroad Creek and the planned improvements to Copper Creek. There is also a potential for short-term impacts to water temperature under Alternative 13M, while the new riparian vegetation is maturing.

Both Alternatives 11 and 13M would require the construction of one or more stream crossings for construction vehicles. Alternative 11 includes construction of two pipeline crossings, one across Copper Creek near the confluent with Railroad Creek, and one across Railroad Creek near the east end of tailings pile 3. Alternative 13M includes one pipeline crossing under Copper Creek.

The use of heavy equipment within Railroad Creek to remove ferricrete from the streambed under Alternative 11 would result in the release of sediment to downstream areas.

4.5.2.5 *Potential for Impacts to the Riparian Corridor*

Under Alternatives 11 and 13M, existing riparian vegetation would need to be cleared for construction of the barrier walls and groundwater collection systems and the realignment of Railroad Creek (Alternative 13M only). The short-term impact to the riparian corridor is proportional to the total area of cleared vegetation and compacted soils; therefore, Alternative 13M would produce a higher potential for impacts to the riparian corridor than Alternative 11.

Under Alternatives 11 and 13M, existing riparian vegetation would need to be cleared for construction of the barrier walls and groundwater collection systems. For Alternative 11, clearing would be required in the LWA, up part of the Copper Creek draw, and at the origin and terminus points where the barrier walls would tie into the mountain side. The approximate area of forest requiring clearing would be 4.2 acres. Additional areas would also need to be cleared for installation of a maintenance access road at the base of the tailings piles and collection ditches. Portions of these areas include old growth habitats with large trees. For Alternative 13M, the approximate forested area that would require clearing is 2.9 acres for the west barrier wall.

Under Alternative 13M, areas between the existing Railroad Creek channel and the Holden Village would be disturbed during construction of the new Railroad Creek alignment. Potential short-term impacts to the riparian corridor from the Railroad Creek realignment are expected to include the loss of native shrubs, brush, and trees during the construction of the planned channel, access roads, and materials storage areas, including the loss of many trees greater than 20 inches diameter at breast height.

Areas cleared for construction under either alternative would be subjected to the following impacts:

- Destruction of native habitat;
- Erosion/loss of native soils;
- Loss of native soil invertebrate community;
- Loss of native biota; and
- Likely increased expansion of invasive exotic species.

In addition to the removal of existing native vegetation, the compaction of soils resulting from vehicles, equipment, and/or other materials required to support the construction activities may further hinder the long-term re-establishment of native vegetation in the cleared areas. These impacts can be minimized by the proper location of access and staging of equipment, sequencing of construction activities to minimize the disturbed areas, and development of appropriate planting plans for the post-construction period. Impacts may also be reduced during final design by potentially reducing the realigned channel footprint and developing construction plans and specifications that require the contractor to work within narrow construction limits.

To the extent possible, the final design of the creek channel will include the use of salvaged topsoil from construction activities for replanting the adjacent banks, and developing planting plans that make use of native plants that are consistent with the area and the amount of moisture available. By using salvaged topsoil and constructing the creek realignment quickly, the herbaceous seed bank can be maintained and put to use to increase the recovery rate. This approach will continue to be evaluated and developed in subsequent design steps.

4.5.2.6 *Potential for Increased PCOC Concentrations in the Portal Drainage Following Remedy Implementation*

Alternatives 11 and 13M include the installation of hydrostatic bulkheads within the 1500 level main and ventilator mine portals, if determined to be feasible during remedial design. While bulkheads are the preferred method of portal drainage flow equalization and control, documentation in the DFFS indicates that bulkheading may cause short-term degradation of water quality, due to the effect of flooding underground areas where metal salts and/or exposed sulfide-bearing rock is not currently in contact with water. As documented in the DFFS, this effect has been observed at other mines that are allowed to flood. The actual degree of short-term water quality degradation is difficult to predict, and will depend on the height of water backed up within the underground mine workings. However, a basis for estimating the resulting water quality degradation was provided in the DFFS and has been taken into account in analyses of the proposed water treatment systems under Alternatives 11 and 13M (Appendix H).

This issue would affect both alternatives equally. However, Alternative 11 has the added risk of a short- and long-term increase in surface water runoff into the underground mine resulting from a potential collapse of crown pillars during the relocation of the Honeymoon Heights waste rock piles (Appendix B); thereby increasing the volume and PCOC loading to the treatment system associated with the 1500-level portal drainage.

4.5.2.7 *Potential for Impacts to Terrestrial Habitat due to Rock Quarry Development*

Rock quarrying to support the implementation of Alternatives 11 and 13M will require some clearing of native vegetation to develop the rock quarry and related access roads, thereby impacting terrestrial habitat. The impact to the terrestrial habitat is proportional to the volume of rock needed to implement the remedial alternative. Preliminary calculations estimate approximately 160,000 cy and 85,000 cy of rock will need to be obtained from a quarry for implementation of Alternatives 11 and 13M, respectively. As such, Alternative 11 would have the greatest impact to terrestrial habitat from rock quarrying activities. As described above in Section 4.5.2.5, areas cleared for quarry development would be subjected to the destruction of native habitat; erosion/loss of native soils and seed bank; loss of native soil invertebrate community; loss of native biota; and likely increased expansion of invasive exotic species.

Potential rock sources within the Railroad Creek valley will be evaluated during remedial design for possible quarry development. Locations that may be evaluated include the former Forest Service quarry at Lightning Ridge, located near Lake Chelan, and other areas with apparent bedrock outcroppings in the vicinity of 10-Mile Creek. Potential impacts to the terrestrial habitat resulting from quarry development may be reduced if use of the former Lightning Ridge quarry site is feasible. However, regardless of the selected location, some clearing of native vegetation will be required. These impacts can be minimized by the proper location of access and staging of equipment, sequencing of construction activities to minimize the disturbed areas, and development of appropriate planting plans for the post-construction period.

4.5.2.8 *Potential for Impacts to Terrestrial Habitats in Honeymoon Heights, LWA, Ballfield/Wilderness Boundary Area, and Area of Windblown Tailings*

The potential for short-term impacts to terrestrial habitats in Honeymoon Heights, the LWA, the ballfield/wilderness boundary area and area of windblown tailings is directly proportional to the amount of clearing required for remedy implementation. It is estimated that approximately 5 acres of eastside mixed conifer forest and/or eastside riparian wetland habitat would need to be cleared to access and remove the Honeymoon Heights waste rock under Alternative 11 (not including the footprints of the waste rock piles themselves) and additional areas would need to be cleared if active measures are taken to remove or cover the areas immediately downslope of Honeymoon Heights waste rock. No clearing would be required for implementation of Alternative 13M in this area.

Although specific remedial actions were not identified for the LWA, ballfield/wilderness boundary area, and area of windblown tailings under Alternative 11, actions involving excavation, covering and/or amending the soils in these areas would result clearing of forested areas and impact to terrestrial habitat as follows:

- The area of windblown tailings – A portion of the estimated 77 acres of forested habitat would require clearing under Alternative 13M for Railroad Creek realignment. Excavation, covering, or soil amendments would require the removal of native topsoil and/or vegetation over the entire/remaining area.
- The ballfield/wilderness boundary area – Excavation, covering, or soil amendments would require the removal of native topsoil and/or vegetation over the entire approximately 6.7 acres of forested and open habitats in this AOI.
- The LWA – Ongoing human activities and the installation of groundwater barrier walls, collection systems, and the west water treatment system would result in the removal of portions of the approximate 14.6 acres of forested and open habitats in this AOI. Excavation, covering, or soil amendments would require the removal of native topsoil and/or vegetation over the entire/remaining area.

With the exception of potential clearing required to implement other remedy components as described above, Alternative 13M would avoid disturbance and clearing of the existing native habitats in all of these AOIs. As described above in Section 4.5.2.5, areas cleared for removal, covering, or amendment would be subjected to the destruction of native habitat; erosion/loss of native soils and possibly the seed bank; loss of native soil invertebrate community; loss of native biota; and likely increased expansion of invasive exotic species. Additionally, as described in Section 4.1.3.2, due to the steep topography and shallow bedrock depths in Honeymoon Heights, Alternative 11 would likely expose bedrock beneath the Honeymoon Heights waste rock piles and in portions of the other areas cleared to access Honeymoon Heights, which would slow or prevent the re-establishment of native vegetation in portions of this AOI.

4.5.3 Time until Protection is Achieved

The time until protection is achieved for human health, aquatic receptors, and terrestrial ecological receptors is evaluated in the following subsections for Alternatives 11 and 13M. Alternatives 11 and 13M are expected to be fully protective of human health following implementation. Both alternatives would also decrease PCOC concentrations in Railroad Creek immediately after implementation and would be protective of aquatic life within similar timeframes.

4.5.3.1 Time until Protection is Achieved for Human Health and Aquatic Receptors

Alternatives 11 and 13M are expected to be fully protective of human health following implementation, and are expected to be protective of aquatic life within a similar timeframe.

Sediment quality at the Site is protective of aquatic life under current conditions. Both Alternatives 11 and 13M would also address existing and future ferricrete formation in Railroad Creek adjacent to the Site and would decrease PCOC concentrations in Railroad Creek immediately after implementation by addressing groundwater that would otherwise enter the creek with PCOC concentrations above potential surface water ARARs. The source control actions implemented under both alternatives and natural attenuation processes are expected to reduce the loading of PCOCs to site groundwater and surface water and further improve the water and sediment quality in Railroad Creek over time.

Because the implementation of Alternative 11 will require an additional construction season, Alternative 13M will achieve protection of human health and aquatic receptors slightly faster than Alternative 11.

4.5.3.2 *Time until Protection is Achieved for Terrestrial Ecological Receptors*

The source control actions implemented under both Alternatives 11 and 13M (removal and or covering) in the former SRA, lagoon, maintenance yard, former mill building, east and west waste rock piles, and tailings piles would be completed within a similar timeframe and are expected to be fully protective of shallow-rooted plants, soil invertebrates, and terrestrial wildlife immediately after implementation. Deeper rooted plants would continue to be exposed to PCOC concentrations above potential risk-based values in the former mill building, east and west waste rock piles, and tailings piles under Alternative 13M into the long-term. However, available data and recent observations of the piles show that deeper rooted plants are re-establishing, and a plant community representative of the surrounding habitats is expected to result over time as a result of natural recovery. Under Alternative 11, the establishment of deeper-rooted plants would not be allowed in order to protect the integrity of the geomembrane cover.

The removal and/or covering of soils in portions of the LWA and area of windblown tailings during the implementation of other remedy components in these AOIs would immediately reduce the overall risks to terrestrial ecological receptors in these areas. Alternative 13M would implement monitored natural recovery for those remaining portions of the Site where soil concentrations remain above potential risk-based values established for the protection of terrestrial plants, soil invertebrates and some wildlife. However, as discussed elsewhere, re-establishment of mid-seral forested habitats of large trees would take many decades if soil removal, covering and/or amendments were to be performed in these areas.

4.6 *IMPLEMENTABILITY*

The NCP, in 40 CFR 300.430(e)(9)(iii)(F), requires that the ease or difficulty of implementing the alternatives shall be assessed by considering the following factors, as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions).
- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources.
- Availability of prospective technologies.

The implementability of Alternatives 11 and 13M is evaluated in the following subsections. Alternative 13M is expected to be more implementable than Alternative 11, due to constructability problems associated with the tailings pile regrading actions, construction issues and safety risks associated with relocation of the Honeymoon Heights waste rock piles, and the greater overall construction requirements and durations under Alternative 11.

4.6.1 *Implementability of Tailings Pile Slope Stability Actions*

The regrading actions proposed for the tailings piles under both Alternatives 11 and 13M could be completed using conventional technologies and construction methods and a locally available work force. However, the tailings regrading and cover actions proposed under Alternative 11 would provide more constructability challenges and risks than Alternative 13M, because of the relatively large volume of wetter, finer, and weaker tailings that would be excavated, relocated, placed, and compacted and due to the large volumes of rock required for buttress construction.

Under both Alternatives 11 and 13M, the three tailings pile side slopes would be regraded to 2H:1V for stability[47] and a buttress and shear key would be constructed at the toe (Appendix C). Alternative 11 would also include the excavation of additional tailings to provide a 45-foot bench at the base of the slope to allow construction of a barrier wall and groundwater collection system at the south bank of Railroad Creek. It is

---

[47] Additional field work and geotechnical analyses are planned for 2009 to further evaluate the stability of steeper tailings pile side slopes under Alternative 13M. The additional data and geotechnical analysis results will be provided to the Agencies when they become available.

estimated that approximately 960,000 cy of tailings would require relocation under Alternative 11 compared to 390,000 cy under Alternative 13M.

Based on the geotechnical analyses described in Appendix C, the significant tailings regrading required under Alternative 11 would remove all the strong cemented Zone 1A tailings and most of the relatively strong Zone 1 tailings that have maintained the steep tailings pile side slopes since the cessation of mining operations. The final exposed slope in the Zone 2 tailings would have a higher moisture content, and less strength than the currently exposed materials. In addition, the starter dams that contribute to the current slope stability would be removed. These actions could lead to local instabilities and sloughing during construction.

Alternative 11 would also require heavy equipment to operate in wetter, finer, and weaker Zone 2 tailings, resulting in a higher potential for equipment getting stuck and bogged down in the tailings that are being removed and having trafficability problems in tailings as they are being placed. Compaction of the tailings would also be progressively more difficult under Alternative 11, with the moisture content increasing above optimum levels. In contrast, approximately 60-percent less tailings would be removed from the side slopes under Alternative 13M, therefore less of the Zone 2 tailings would be exposed. The current toe would remain in place, and the overbank deposits would not be exposed during slope regrading; thereby increasing the overall stability during construction (Appendix C).

The barrier wall and groundwater collection system located at the toes of tailings piles 2 and 3 under Alternative 11 would need to be constructed after the tailings pile side slopes have been regraded but before the rockfill buttress is placed, resulting in potential slope stability issues during construction. Alternative 13M does not include barrier walls adjacent to tailings piles 2 and 3.

The buttresses constructed at the base of the tailings piles under Alternatives 11 and 13M would require the import of rock from a rock quarry developed within the Railroad Creek valley. However, under Alternative 13M, the buttresses would be much smaller and could be constructed using a combination of compacted tailings and rock; thereby reducing the overall rock requirements compared to the significantly larger rock buttress required under Alternative 11. Even with a 2H:1V slope and a large rockfill buttress, adequate factors of safety were not achieved under Alternative 11 for the tailings piles 2 and 3 side slopes under seismic conditions (Appendix C). Further evaluation of these actions would be required to ensure adequate stability can be attained.

4.6.2 *Implementability of East and West Waste Rock Pile Slope Stability Actions*

As described in Appendix C, the east and west waste rock pile slope stability actions under Alternatives 11 and 13M could be completed using conventional technologies and construction methods and a locally available work force. The actions are similarly implementable under both alternatives with the exception that excess waste rock generated under Alternative 13M from the west waste rock pile would be placed within the former mill building area and excess rock from the east pile would be pushed onto tailings pile 1. The use of these locations for the excess rock would reduce estimated haul distances and construction time frames, thereby increasing the implementability of Alternative 13M compared to Alternative 11, which would put all excess waste rock onto an unspecified location on the tailings piles.

4.6.3 *Implementability of the Tailings and Waste Rock Pile Cover Actions*

Based on the geotechnical analyses provided in Appendix C, the tailings and waste rock pile soil cover under Alternative 13M would be significantly more implementable than the cover system proposed under Alternative 11. Conventional equipment and locally-available materials and labor could be used both to construct and repair the Alternative 13M soil covers and drainage features, and the work could be completed during typical Pacific Northwest weather conditions.

In contrast, special materials, equipment, and skilled labor would need to be procured and mobilized from across the United States for installation, maintenance, and repair of the Alternative 11 cover, and the work could only be completed within specific temperature ranges and low-wind weather conditions. The results of the stability analyses indicate that anchored geogrid reinforcement and benching would be necessary to achieve adequate factors of safety for static and seismic conditions for the Alternative 11 covers. The benching would involve additional regrading and construction of an under-drain collection system at the start of the bench and an anchor trench at its terminus. To provide the minimum factors of safety, the maximum vertical heights of the piles would need to be reduced, through benching, to 78- and 38-foot sections for the 475- and 2,475-year earthquake return periods, respectively (Appendix C).[48]

Construction of the Alternative 11 geomembrane cover would require special materials and skilled labor that are not available locally. Because of the remote location of the Site, transporting these specialized materials and skilled labor to the Site is a major implementation and safety issue. Further, the volume of soil needed to construct the Alternate 11 cover is significantly more than the volume needed for the Alternative 13M cover. A source of cover soil would need to be developed locally and transporting the soil from the local source to the tailings and waste rock piles adds considerable traffic to the limited local roadways; thereby increasing implementation and safety concerns.

Significantly more post closure maintenance would be required under Alternative 11 compared to Alternative 13M in order to prevent the establishment of deeper rooted plants and burrowing animals that would potentially damage the geomembrane; prevent the establishment of invasive, non-native plant species; and to maintain the extensive drainage network free of ice and other obstructions.

4.6.4 *Implementability of Honeymoon Heights Relocation*

The construction and use of access roads on the steep terrain in Honeymoon Heights presents serious safety and environmental risks under Alternative 11, with the highest risks associated with access and removal of the uppermost piles located at the 300-, 550-, and 700-levels. As a result, the Alternative 11 actions for Honeymoon Heights are significantly less implementable than Alternative 13M (monitored natural recovery).

As described in Appendix B, relocation of the Honeymoon Heights waste rock piles would require re-establishment and expansion of the former primitive access road up to the 550-level mine portal and construction of a new road up to the 300-level mine portal. Due to the steep topography and shallow bedrock depths in the area of Honeymoon Heights, access road construction would likely require drilling, blasting, and the placement of fill materials. The results of the Draft Honeymoon Heights

---

48 Alternatively, if the tailings and waste rock pile side slopes were flattened to 3H:1V, the minimum static factor of safety would be satisfied for most conditions without the use of veneer reinforcement or benching; however, to satisfy the minimum seismic factor of safety for the 2,475-year earthquake, geogrid reinforcement and benching would still be required.

Near-Surface Stope Mapping provided in Appendix B confirm the presence of near-surface stopes that are coincident with portions of the access road and the three upper waste rock piles (300-, 550- and 700-levels). Based on the relatively shallow nature of the crown pillars that separate the stopes from the ground surface (reported to be on the order of 50-feet thick), any above-ground related efforts are considered a risk for potential crown pillar collapse. There are no realistic measures to mitigate the potential risk of collapse other than avoidance of the upper three waste rock piles. A collapse of any of the near surface stopes would present obvious safety risks, and would also allow the inflow of additional surface water to the underground mine workings, thereby increasing the metals loading and treatment requirements for the 1500-level main portal.

4.6.5 Implementability of Railroad Creek Realignment and Copper Creek Improvements

The analyses presented in Appendices C and D confirm the technical feasibility of realigning Railroad Creek to the north of its present location and extending and stabilizing Copper Creek under Alternative 13M. The unique conditions associated with these actions, including rock blasting, diversion of the existing creek during construction of the creek tie-in, remote location, numerous cobbles and boulders encountered during excavation, a high groundwater table, limited access, steep slopes and difficult terrain present construction challenges, but could be managed with proper planning and equipment.

It is anticipated that the Railroad Creek realignment could be completed within two construction seasons. The majority of the work associated with these actions could be completed with conventional equipment and construction techniques. However, the rock blasting, retaining wall construction, and habitat construction would require some specialized equipment and contractors. Construction sequencing, especially in the tight section adjacent to tailings pile 2 would need to be carefully addressed to minimize the total number of construction seasons required to complete these actions. The following issues that affect the implementation of the Railroad and Copper Creek actions have been identified for further analysis and review during design (Appendix D):

- Specific material requirements: selection of liner materials, sourcing and transport of rounded river rock of specific gradation, and large rock of suitable size/mass.
- Specific plant types and species for replanting: because of the quantity and diversity of plants required, and the challenge of revegetation at

the Site, it is likely that a 2-year lead time will be needed to find and secure one or more plant sources.

- Selection of a construction contractor with habitat construction experience (e.g., working with reduced footprint and material handling for salvage rather than disposal).

These implementation challenges are unique to Alternative 13M; however, the challenges associated with Railroad Creek realignment and Copper Creek improvements are of a smaller scale and more easily resolved than the challenges associated with the tailings pile slope stability actions required under Alternative 11 (Sections 4.6.1). This comparison is important because the relocation of Railroad Creek under Alternative 13M eliminates the need for some of the more difficult tailings pile slope stability actions required under Alternative 11.

4.6.6 Implementability of Barrier Wall and Collection System Installation

The analyses presented in Appendix C show that construction of the Alternative 11 and 13M barrier walls are feasible, with the exception of the portions of the Alternative 11 alignments that extend substantially to the south up the Copper Creek drainage. Due to the extremely steep topography and proximity to the tailings pile side slopes and Copper Creek, these portions are not feasible.

The unique conditions associated with barrier wall construction at this Site including massive tailings regrading (Alternative 11 only), remote location, numerous cobbles and boulders, proximity of large surcharge loads (primarily Alternative 11), high water table, limited access, steep slopes, and difficult terrain, can be managed with proper planning and equipment. However, the portion of the Alternative 11 barrier wall alignment adjacent to tailings piles 2 and 3 will be much more difficult to successfully implement than the collection system proposed under Alternative 13M adjacent to tailings pile 2. Slope stability issues associated with tailings piles 2 and 3, the depth to bedrock (over 100 feet bgs) at the northeast toe of tailings pile 3, the challenging lithology, and the transition up the steep hillside on the east side of tailings pile 3 raises feasibility questions with respect to this portion of the Alternative 11 wall.

Barrier wall construction at the Site will require a specialized contractor. Considering the challenging site conditions, there are likely only three to four qualified contractors in the United States that could perform this work, and utilizing one of these contractors will be important to the successful implementation of these actions. The equipment types likely required for construction include, a long-reach excavator, a crane with clamshell and rock chisel, a support excavator, bulldozer, forklift, haul trucks, and soil-bentonite/cement bentonite mixing plants and associated pumps and piping (Appendix C).

The duration of barrier wall construction, and associated increases in the difficulty in implementing this action, are directly related to the length and depth of the barrier. Based on the estimated production rates in Appendix C, installation of the approximately 7,960 lf (570,000 sf) barrier wall under Alternative 11 would require approximately 400 working days, whereas the approximate 3,470 lf (204,000 sf) barrier wall under Alternative 13M would require approximately 130 working days. As such, relative to Alternative 13M, Alternative 11 will require at least one additional construction season and an approximate 60-percent increase in the mobilization and transportation of specialized equipment, skilled labor and materials to this remote site for performance of this action.

4.6.7 *Implementability of Water Conveyance and Treatment Systems*

The low-energy treatment systems proposed under Alternatives 11 and 13M are implementable and could be constructed with conventional equipment and construction techniques. The settling pond and other treatment system components under Alternative 11 may be smaller in size compared to Alternative 13M, as a result of lower estimated groundwater collection rates under Alternative 11. However, it is anticipated that similar quantities of sludge would be generated under Alternative 11 compared to Alternative 13M, and that sludge removal may be more difficult under Alternative 11 due to the use of lined settling ponds versus unlined ponds.

The most significant long-term operation and maintenance issues associated with the water conveyance and treatment systems include: (1) supplying adequate power to operate the systems, (2) O&M effort, particularly in cold weather, and (3) managing potential iron fouling. The power requirements for operation of the treatment systems under both alternatives are similar; however, the conveyance system for Alternative 11 would have higher power requirements than the conveyance system for Alternative 13M. Under Alternative 13M, both the west area and east area water conveyance systems allow for conveyance, mixing, and aeration by gravity flow. As a result, the low energy requirements for Alternative 13M could be readily provided by a small generator(s) and/or seasonally available excess power from the Holden Village's hydroelectric plant. In comparison, a significant portion the water collected under Alternative 11 would need to be pumped to a treatment system located on the north side of Railroad Creek. This would result in higher power requirements for the Alternative 11 conveyance system and lower implementability compared to Alternative 13M.

It is estimated that the Alternative 13M collection, conveyance, and treatment systems would require at least one full-time operator. The O&M requirements for Alternative 11 would likely be greater than for Alternative 13M, due to the longer water conveyance system and pumping/power requirements. Under Alternative 13M, the west area treatment system and operator facilities would be located near the existing Holden Village maintenance garage and within walking distance from the Holden Village. The location of these facilities near the Village allows reliable access year-round, including during the winter months. The east area treatment systems under Alternatives 11 and 13M, located almost a mile away from the Village, would be less accessible and more difficult to operate, particularly during cold weather. However, the low-energy chemical addition and treatment system proposed under Alternative 13M could be designed to require less frequent operator attention than the more power-intensive pumping and treatment system under Alternative 11.

An additional assessment of groundwater levels and construction techniques would be required during design to evaluate the use of unlined settling ponds under Alternative 13M. Considerations include the effects of groundwater inflow on settling pond residence times and treatment system efficiencies.

4.6.8 Implementability of Hydrostatic Bulkheads in the 1500-Level Underground Mine Portals

The installation of hydrostatic bulkheads in the 1500-level main and ventilator portals is the preferred method of flow equalization and control for the 1500-level main portal drainage under both Alternatives 11 and 13M. The feasibility and anticipated effectiveness of bulkhead construction will be further evaluated during the 2009 and 2010 field seasons. If bulkhead installation is determined to be infeasible, other methods of flow control, outside the mine, will need to be evaluated.

The implementability of this action would be the same under both alternatives. The installation of hydrostatic bulkheads would require specialized contractors, equipment, and construction methods. Underground work presents unique safety risks; however, these risks can be managed through proper planning and health and safety practices.

4.7 COST

The NCP in 40 CFR 300.430 (e)(9)(iii)(G) specifies that the following types of costs shall be assessed for the candidate remedial alternatives:

- Capital costs, including both direct and indirect costs;
- Annual O&M costs; and
- Net present value of capital and O&M costs.

The total cost of Alternative 13M is anticipated to be at least 40 percent lower than Alternative 11. The lower total cost for Alternative 13M is expected because it uses:

- A barrier wall only in areas where groundwater having metals concentrations that exceed potential surface water ARARs would discharge to Railroad Creek;
- Source control actions combined with natural attenuation to address groundwater having metals concentrations that are expected to meet potential surface water ARARs at a CPOC(s) where the groundwater enters Railroad Creek downgradient (east) of the Site;
- Realignment of Railroad Creek to reduce the required regrading and buttressing of the tailings piles;
- An efficient plan for regrading and relocating the east and west waste rock piles that includes placement of rock on the former mill building foundations;
- A protective soil cover for the tailings and east and west waste rock piles;
- Low-energy and low-maintenance water collection and treatment systems; and
- Natural recovery rather than active remediation in areas, such as the Honeymoon Heights waste rock piles, where the long-term risks to the environment are low, but the construction safety risk and/or the risk of long-term or permanent impairment of the native habitat caused by active remediation is high.

4.8 AGENCY ACCEPTANCE

Forest Service, USEPA and State acceptance of the preferred remedy will be evaluated and submitted as part of the ROD. The State of Washington is concurrently addressing the Site through its independent cleanup authority under MTCA. Based on the analyses presented in Sections 4 and 5 of this report, Alternative 13M meets the State's expectations for cleanup action alternatives specified under WAC 173-340-360 and -370 and can be considered a permanent cleanup action under MTCA.

4.9 COMMUNITY ACCEPTANCE

The Agencies will evaluate community acceptance primarily based on comments received from the public on the Proposed Plan. The Holden Village community will be the most affected by implementation of the selected remedy, although the communities of Stehekin and Chelan will also be affected, as they benefit from the tourism generated by Holden Village visitors. The implementation of appropriate health and safety measures and close coordination with the Holden Village and other local communities during construction would reduce potential safety risks to residents and visitors under Alternatives 11 and 13M.

The assessment of potential impacts to the Holden Village community during and after remedy implementation is ongoing and will continue through remedial design. Some of the factors being considered include the following:

Remedial Alternative Construction Timeframes - Comparable construction-related impacts to the local communities would be expected during the active construction seasons. However, construction of Alternative 13M is expected to be completed within two full construction seasons, with final seeding and planting occurring in year three, while Alternative 11 would likely require more than three full construction seasons to complete, thereby extending the impacts on the Holden Village for an additional year or more.

The Potential Need for Future Actions and Construction Disturbance – Compliance monitoring is proposed under Alternative 13M to confirm the effectiveness of Alternative 13M actions in achieving ARARs downgradient (east) of tailings pile 3. In the event the monitoring results do not demonstrate that potential ARARs are met at the point(s) of compliance, then contingent actions will be evaluated. The remobilization and implementation of potential contingent actions would impact Holden Village operations. However, the magnitude of construction is anticipated to be significantly less than during implementation of either Alternatives 11 or 13M.

Potential Impacts to Holden Village Facilities During and After Construction – Similar direct impacts to Holden Village facilities are anticipated under both Alternatives 11 and 13M. Both alternatives would result in periodic disruptions to the use of the maintenance buildings and vehicle storage area, the riverside sauna, hydroelectric plant, road to the Copper Creek water intake, pedestrian bridge, and the road between Holden and Lucerne. However, it should be possible to limit disruptions to these facilities through close coordination with the construction contractor. It is possible that the baseball field and/or the Winston Homesite area would be used by the contractor for a temporary construction camp. Under both alternatives, it may be necessary to permanently relocate the Holden Village portal museum.

The Proposed Location of the Realigned Railroad Creek Channel - Construction of the new Railroad Creek channel would result in construction-related noise and dust-generation near the Holden Village. These issues can be mitigated by construction sequencing, proper routing of construction traffic, providing water trucks to minimized dust generation from access roads, and requiring noise suppression devices for equipment. There would also be long-term safety considerations associated with increased exposure to a fast-moving stream (closer to the village school) and loss of riparian habitat that screens the view of the tailings piles from the Village. However, there would also be aesthetic and habitat quality benefits related to the newly constructed stream channel. Alternative 11 does not include significant construction activities on the north side of Railroad Creek in the immediate vicinity of the Holden Village.

Aesthetic Considerations Associated with the Tailings and Waste Rock Piles – Under Alternative 11, the relocation of regraded tailings to tailings piles 1 and 3 would increase the heights of the two piles by approximately 40 feet each, or about 60- and 80-percent higher, respectively. In contrast, the tailings regrading under Alternative 13M would increase the heights of tailings piles 1 and 3 by about 5 and 10 feet, or 10 and 15 percent, respectively.

Long-term Operation and Maintenance Requirements - It is estimated that the Alternative 13M remedy components would require at least one full-time operator. The O&M requirements for Alternative 11 would likely be greater than for Alternative 13M, due to additional tailings and waste rock cover maintenance, the longer water conveyance system, and pumping/power requirements.

Considerations Related to Soil Excavation, Covering, and/or Amendment in the Area of Windblown Tailings, Ballfield/Wilderness Boundary Area, LWA, or Areas Downslope of Honeymoon Heights – Removal, covering, and/or amending soils in these AOIs would require the significant clearing of vegetation and/or soils and would increase the construction durations associated with Alternative 11, if included by the Agencies; thereby resulting in additional disruption to the local community and aesthetic impacts on areas in close proximity to the Holden Village.

5.0 EVALUATION OF ALTERNATIVES 11 AND 13M UNDER MTCA

This section presents an evaluation of Alternatives 11 and 13M with respect to the following minimum requirements specified under MTCA for cleanup actions conducted in Washington State (WAC 173-340-360):

- Protect human health and the environment;
- Comply with cleanup standards specified in WAC 173-340-700 through 760;
- Comply with applicable state and federal laws;
- Provide for compliance monitoring as specified under WAC 173-340-410 and 173-340-720 through -760;
- Use permanent solutions to the maximum extent practicable, which requires the use of a disproportionate cost analysis to compare the costs and benefits of candidate remedial alternatives;
- Provide for a reasonable restoration time frame as described in WAC 173-340-360(4); and
- Consider public concerns.

Ecology recognizes that some of the requirements listed above contain flexibility and will require the use of professional judgment in determining how to apply them at particular sites. The first four requirements listed above are considered to be "threshold" requirements that the selected final remedy must meet. The remaining three requirements are considered along with the threshold requirements in the comparative analysis of remedial alternatives. There is considerable overlap between the seven MTCA criteria and nine CERCLA criteria, and to minimize repetition, some of the subsections below reference back to previous discussions in Section 4.

In addition to the seven minimum requirements listed above for remedy selection, the Agencies identified several additional provisions under MTCA for evaluation. These include MTCA provisions for permanent and non-permanent groundwater cleanup actions; cleanup actions for soils at current or potential future residential areas and for soils at schools and child care centers; institutional controls; releases and migration; dilution and dispersion; and remediation levels. While some of these additional provisions were not identified as ARARs for the Site, they are also briefly discussed in this section.

5.1 PROTECT HUMAN HEALTH AND THE ENVIRONMENT

As demonstrated in Section 4.1, both Alternatives 11 and 13M are expected to be fully protective of human health following implementation. Both alternatives would also decrease PCOC concentrations in Railroad Creek immediately after implementation and would be protective of aquatic life within similar timeframes. Please refer to Section 4.1 for additional assessment of the protection of human health and the environment provided by Alternatives 11 and 13M.

5.2 COMPLIANCE WITH CLEANUP STANDARDS AND APPLICABLE STATE AND FEDERAL LAWS

Under WAC 173-340-360(2)(a)(ii) and (iii), MTCA requires that cleanup actions comply with cleanup standards (WAC 173-340-700 through -760) and applicable state and federal laws (WAC 173-340-710). Compliance with MTCA cleanup standards and applicable state and federal laws is addressed in Section 4.2 of this report. The evaluation of Alternatives 11 and 13M with respect potential ARARs is summarized below.

5.2.1 Compliance with Potential Chemical-Specific ARARs

Section 4.2.1 provides a detailed assessment of each alternative's compliance with the potential chemical-specific ARARs. Both Alternatives 11 and 13M are expected to comply with potential chemical-specific ARARs for surface water and groundwater at the Site. Both Alternatives are also expected to meet the potential Soil ARARs developed for the protection of human health. The development and evaluation of potential chemical-specific soil ARARs for the protection of terrestrial ecological receptors is ongoing for both Alternatives 11 and 13M.

5.2.2 Compliance with Potential Action- and Location-specific ARARs

Both Alternatives 11 and 13M would be conducted in a manner that would provide substantive compliance with the potential action- and location-specific ARARs, except that Alternative 11 may not meet some of the specific provisions of WAC 173-350-400 for the tailings and east and west waste rock piles, including the provision to provide sufficient stability and mechanical strength (WAC 173-350-400[3][e][i][F]) and minimize the need for post-closure maintenance (WAC 173-350-400[3][e][i][H]).

An evaluation of Alternatives 11 and 13M with respect to compliance with potential action- and location-specific ARARs is presented in Section 4.2.2.

5.3 PROVIDE FOR COMPLIANCE MONITORING

Compliance monitoring is required under both CERCLA and MTCA. Under MTCA, compliance monitoring is a threshold requirement (WAC 173-340-360(2)(a)(iv) and WAC 173-340-410) and includes the following three monitoring types:

- Protection monitoring to confirm that human health and the environment are adequately protected during construction and the O&M period of the cleanup action;
- Performance monitoring to confirm whether the cleanup action has attained cleanup standards and remediation levels or other performance standards; and
- Confirmation monitoring to confirm the long-term effectiveness of the cleanup action once cleanup standards and remediation levels or other performance standards have been attained.

Compliance monitoring is not an evaluation criterion under CERCLA, but is generally required as part of O&M.

Both Alternatives 11 and 13M would include the three types of compliance monitoring listed above. The following subsections outline a general approach for protection and performance monitoring under Alternative 13M. Confirmation monitoring would also be performed under both alternatives once cleanup standards have been met; however confirmation monitoring is not discussed in this report.

The general monitoring approach discussed in this section considers the Alternative 13M remedy components, the results of the 2008 field investigations, and the Agencies' conceptual monitoring program described in the SFS. Details regarding the number and locations of monitoring points, sample collection methods, the frequency of measurements and analyses, and the data analysis and evaluation procedures will be identified for the selected remedy during remedial design in a compliance monitoring plan that is prepared in accordance with the requirements of WAC 173-340-410(3).

5.3.1 *Groundwater and Surface Water Monitoring*

The objective of the proposed Alternative 13M surface water and groundwater monitoring would be to:

- Assess PCOC concentrations at the identified points of compliance;
- Assess trends in groundwater and surface water PCOC concentrations, and demonstrate that groundwater and surface water will attain cleanup levels; and
- Demonstrate that Alternative 13M is protective of human health and the environment under WAC 173-340-360(2)(a)(i) and 40 CFR 300.430(e)(9)(iii)(A), and that the remedy components meet design objectives (i.e., groundwater barrier walls, collection, conveyance and treatment systems).

5.3.1.1 *Groundwater Monitoring*

Under Alternative 13M, the groundwater CPOC would be located "within the surface water as close as technically possible to the point or points where groundwater flows into the surface water" (WAC 173-340-720[8][d][i]). The monitoring approach described in this section identifies the general locations where compliance monitoring would be performed, but does not address the techniques that would be used to collect samples where groundwater flows into surface water. Where appropriate, monitoring would likely include both water level measurements and the collection and analysis of surface water samples at the CPOC(s).

Additional investigations downstream of the proposed terminus of the Alternative 13M realigned creek channel are ongoing to determine where groundwater enters the creek east of the Site. Compliance monitoring points will be selected for Alternative 13M based on the results of these investigations. Potential groundwater compliance monitoring locations may include:

- In surface water at the south bank of Railroad Creek, downgradient of the SP-23 and SP-12 collection basins;
- In surface water at one or more locations along the south bank of Railroad Creek adjacent to the LWA and tailings pile 1 (upstream of the realigned creek channel);
- In groundwater at one or more locations upgradient and downgradient of the LWA/tailings pile 1 barrier wall to assess the effectiveness of the containment and collection system;

- In surface water at one or more locations along the south bank of the realigned stream channel;
- In surface water at one or more locations at the north bank of Railroad Creek, downgradient of the terminus of the realigned creek channel;
- In groundwater at one or more downstream monitoring well locations (east of the Site) to document trends and changes in groundwater quality over time; and
- In groundwater at one or more monitoring well locations downgradient of the east treatment system, if unlined settling ponds are used, to monitor groundwater quality and the effects of potential leakage from the ponds.

5.3.1.2 *Surface Water Monitoring*

Potential surface water compliance monitoring locations may include:

- A background surface water station within Railroad Creek (e.g., RC-6);
- One or more locations in Railroad Creek adjacent to and/or downstream of the Site to assess water quality for the fully mixed condition; and
- Water treatment system discharge location(s) at the edge of a mixing zone.

5.3.2 *Monitoring of the Railroad Creek Realignment*

Compliance monitoring of the Alternative 13M Railroad Creek realignment would likely focus on potential sediment releases during construction and enforcement of geographic or temporal disturbance limits, as well as long-term compliance with surface water quality standards (discussed above in Section 5.3.1). Examples of compliance monitoring specific to the Railroad Creek realignment include:

- Substantive monitoring requirements equivalent to those included in a construction storm water permit with a storm water pollution prevention plan;
- Monitoring turbidity/suspended sediment standards over the first few years; and
- Monitoring for compliance with the terms and conditions with respect to the Endangered Species Act, as needed.

Additional monitoring may also be conducted to document:

- Consistency with the Wenatchee National Forest Plan (USFS, 1990) and the Aquatic Conservation Strategy of the NWFP;
- Monitoring with respect to instream and riparian habitat quality, including fish passage, the cover and diversity of non-noxious riparian vegetation , floodplain interaction, and pool quality; and
- Monitoring of habitat recovery typically required in a 404 permit for placement of fill within waters of the United States. This monitoring would likely overlap with some of the monitoring for NWFP described above.

5.3.3 Tailings and Waste Rock Pile Monitoring

Potential compliance monitoring for the tailings and waste rock piles may include:

- Periodic visual monitoring of tailings and waste rock pile side slopes to assess stability;
- Periodic visual monitoring to assess the integrity of the tailings and waste rock pile soil covers and the cover and diversity of non-noxious vegetation; and
- Monitoring to assess the progress of re-vegetation efforts and the protectiveness of the cover with respect to terrestrial ecological receptors, including plants, soil invertebrates, and wildlife (see Section 5.3.4).

5.3.4 Monitoring of Protection of Ecological Receptors

Compliance monitoring for AOIs where monitored natural recovery is proposed to address residual PCOC concentrations in soils above risk-based values (e.g., the ballfield/wilderness boundary area, area of windblown tailings, areas downslope of Honeymoon Heights, and LWA) would be conducted to characterize the status and trend of the structure and function (services) of the habitats (where soil values for the protection of plants and soil invertebrates are exceeded) and/or food chain exposures to wildlife (where soil values for the protection of wildlife receptors are exceeded). The objectives of the terrestrial ecological monitoring would include:

- Assess the recovery of desired habitat and/or biota at the AOI; and/or
- Assess if the remedial action(s) reduce and/or eliminate the transfer of PCOCs through the food chain to wildlife at the AOI.

Biological monitoring in Railroad Creek (e.g., monitoring of fish and benthic macroinvertebrate populations) may also be performed to evaluate the protection of aquatic life. The objectives of the aquatic monitoring would include:

- Assess trends in fish and/or benthic macroinvertebrate populations; and
- Demonstrate that Alternative 13M is protective of the aquatic environment.

5.4 USE PERMANENT SOLUTIONS TO THE MAXIMUM EXTENT PRACTICABLE

The MTCA (WAC 173-340-360[2][b][i]) provides that the final remedy use permanent solutions to the maximum extent practicable. A disproportionate cost analysis is used to make this assessment, and includes the evaluation of predicted costs and benefits. The costs and benefits evaluated include overall protection of human health and the environment, permanence, cost, effectiveness over the long term, management of short-term risks, technical and administrative implementability, and consideration of public concerns. The cost estimates for Alternatives 11 and 13M are under development; therefore, a qualitative assessment of this criterion is provided herein.

Alternatives 11 and 13M would both use permanent solutions to the maximum extent practicable and are expected to provide a high-level of overall protection to human health, aquatic life, and terrestrial ecological receptors following remedy implementation (see Sections 4.1, 4.3, and 4.4). Short-term risks to human health and the environment, including the local community, during remedy implementation would be less under Alternative 13M compared to Alternative 11 (see Section 4.5), and Alternative 13M is more technically implementable than Alternative 11 (see Section 4.6). Alternative 13M would also address the local communities' concerns regarding the duration of remedy construction by including actions that could be constructed within two construction seasons compared to Alternative 11 that would require more than 3 seasons of heavy construction (see Section 4.9). The costs associated with Alternative 13M are also expected to be significantly less than for Alternative 11 (see Section 4.7).

Both Alternatives 11 and 13M would use proven and reliable methods of water collection and treatment to address the 1500-level portal drainage and groundwater and seeps discharging to Railroad Creek with PCOC concentrations above potential surface water ARARs. The water collection and treatment actions under both alternatives would immediately reduce PCOC concentrations in Railroad Creek. The proposed source control actions under both alternatives are expected to further improve groundwater and surface water quality over time, and Alternatives 11 and 13M would be protective of aquatic life within similar timeframes. Additionally, the new Railroad Creek realignment under Alternative 13M would provide clean substrate and address the existing ferricrete formation in Railroad Creek immediately after implementation and would mitigate potential future ferricrete formation adjacent to the Site. The realigned channel would also be designed to provide enhanced aquatic and riparian habit compared to current conditions. Based on this analysis, the actions included under Alternative 13M constitute permanent solutions to the maximum extent practicable for site surface water, and the additional costs and short-term risks associated with the Alternative 11 actions are disproportionate to the potential environmental benefits.

Both Alternatives 11 and 13M include the removal and/or containment of hazardous substances in the former SRA, lagoon, underground mine, former mill building, east and west waste rock piles, maintenance yard, Honeymoon Heights, and LWA through capping and/or downgradient groundwater collection and treatment using collection basins and a fully-penetrating barrier wall and groundwater collection system. However, Alternatives 11 and 13M differ with respect to the actions taken to address groundwater associated with tailings piles 2 and 3. The constructability issues and uncertainties related to the short- and long-term stability of tailings piles 2 and 3 significantly reduce the technical implementability and increase the costs and short-term risks associated with the Alternative 11 actions, including construction of an engineered cap with a low-permeability membrane and the installation of a barrier wall and groundwater collection system at the base of the two piles. Furthermore, based on the existing data, these actions are not needed to achieve potential drinking water ARARs in groundwater east of tailings pile 3 or surface water ARARs at the downstream CPOC(s). As a result, the actions included under Alternative 11 for tailings piles 2 and 3 are not practicable or reasonable, and the costs associated with these actions are disproportionate to the potential human health or environmental benefits.

Both Alternatives 11 and 13M are expected to be fully protective of human health following implementation. Based on the results of the draft TEE (Appendix G), the source control actions implemented under Alternatives 11 and 13M in the former SRA, lagoon, maintenance yard, former mill building, east and west waste rock piles, and tailings piles are also expected to be fully protective of shallow-rooted plants, soil invertebrates, and terrestrial wildlife immediately after implementation. Although deeper rooted plants would continue to be exposed to PCOC concentrations above potential EISCs on the tailings and waste rock piles under Alternative 13M, data and recent observations of the piles show that deeper rooted plants are re-establishing, and a plant community representative of the surrounding habitats is expected to result over time as a result of natural recovery.

Alternative 11 would remove materials in the former mill building with PCOC concentrations above potential soil levels established for the protection of terrestrial ecological receptors; however, it is unclear what additional actions would be conducted to promote revegetation of the area (consisting of a large concrete foundation) following remedy implementation. Under Alternative 11, extensive active maintenance would be required in perpetuity to prevent deep-rooted plants from establishing and puncturing the low-permeability membrane cover on the tailings and east and west waste rock piles. If the cover were to be punctured, the potential exposure pathway to the deeper-rooted plants would be re-established. Therefore, because Alternative 13M would protect human health and allow the eventual establishment of native vegetation that more closely resembles the surrounding habitat, the additional costs and short-term risks associated with the cover actions proposed under Alternative 11 are disproportionate to the potential human health or environmental benefits.

The actions included under Alternative 13M would reduce the potential exposures to terrestrial ecological receptors in the LWA-east and area of windblown tailings immediately after implementation; however, PCOC concentrations above potential risk-based values for the protection of plants, soil invertebrates, and some wildlife would remain in portions of these areas, and in the ballfield/wilderness boundary area, LWA-west and Honeymoon Heights over the long-term. Monitored natural recovery would be implemented under Alternative 13M in these remaining areas.

The removal, covering, or mixing of possible amendments into soils in these AOIs would require the significant clearing of mature native vegetation and high-quality habitat that would require 50 years or more to re-establish. Further, the cleared areas would be subjected to erosion/loss of native top soil and potential seed bank; loss of native soil invertebrate communities; loss of native biota; and likely increased expansion of invasive exotic species. Due to the steep topography and shallow bedrock depths in the area of Honeymoon Heights, the removal of waste rock or soil in that area would likely expose bedrock and result in permanent impairment to the native habitats. It is estimated that the clearing of more than 5 acres would be required just to access the Honeymoon Heights waste rock piles.

Monitored natural recovery would constitute permanent solutions to the maximum extent practicable for soils with PCOCs remaining above the potential terrestrial ecological risk-based levels in the ballfield/wilderness boundary area, area of windblown tailings, LWA, and Honeymoon Heights, because of the disproportionate costs and long-term risks to the native habitats in these areas associated with the removal, covering, or the addition of soil amendments.

5.5 PROVIDE FOR A REASONABLE RESTORATION TIME FRAME

The MTCA specifies that cleanup actions provide for a reasonable restoration time frame though consideration of the following factors (173-340-360[2][b][ii] and [4]):

- Potential risks posed by the Site to human health and the environment;
- Practicability of achieving a shorter restoration time frame;
- Current use of the Site, surrounding areas, and associated resources that are, or may be affected by releases from the Site;
- Potential future use of the Site, surrounding areas, and associated resources that are, or may be affected by releases from the Site;
- Availability of alternative water supplies;
- Likely effectiveness and reliability of institutional controls;
- Ability to control and monitor migration of hazardous substances from the Site;
- Toxicity of the hazardous substances at the Site; and
- Natural processes that reduce concentrations of hazardous substances have been documented to occur at the Site or under similar site conditions.

A longer time frame may be used to achieve cleanup levels at a CPOC if the selected cleanup action has a greater degree of long-term effectiveness than on-site or off-site disposal, isolation, or containment options (WAC 173-340-360[4][c]). An evaluation of the above factors is provided for Alternatives 11 and 13M below. Based on this evaluation, both

Alternatives 11 and 13M would provide a reasonable restoration time frame for site groundwater, surface water and soils.

Potential Risks Posed by the Site to Human Health and the Environment – Alternatives 11 and 13M are expected to provide a high-level of overall protection to human health, aquatic life, and terrestrial ecological receptors following remedy implementation (see Sections 4.1 and 5.1). Potential short-term risks to human health and the environment during construction would be less under Alternative 13M compared to Alternative 11 (see Section 4.5).

Both Alternatives 11 and 13M would be fully protective of human health following implementation and both alternatives would be protective of aquatic life within similar timeframes. Because the implementation of Alternative 11 will require an additional construction season, Alternative 13M will achieve protection of human health and aquatic receptors slightly faster than Alternative 11. A detailed discussion of the expected timeframe until protection is achieved for human health and aquatic and terrestrial ecological receptors is provided in Sections 4.5.3.1 and 4.5.3.2.

Practicability of Achieving a Shorter Restoration Time Frame - Both Alternatives 11 and 13M would be fully protective of human health throughout the Site and of shallow-rooted plants, soil invertebrates, and terrestrial wildlife in the former SRA, lagoon, maintenance yard, former mill building, east and west waste rock piles, and tailings piles immediately following implementation. Because Alternative 13M can be implemented at least one year quicker than Alternative 11, it will provide protection of human health and certain terrestrial habitats slightly faster than Alternative 11. Both alternatives would be protective of aquatic life within similar restoration timeframes. Because of the broad distribution of relatively low levels of contaminants in the tailings, waste rock and underlying groundwater at the Site, it is not feasible to restore these media in a shorter time frame than provided by Alternatives 11 and 13M.

Potential differences in the restoration time between Alternatives 11 and 13M are associated with: (1) protection of deep rooted plants for soils in the former SRA (consolidated onto the tailings), lagoon (consolidated onto the tailings), former mill building, east and west waste rock piles, and tailings piles, (2) protection of terrestrial receptors in the Honeymoon Heights area, and (3) mitigation of potential exposure pathways to terrestrial ecological receptors in portions of the LWA, the ballfield/wilderness boundary area, and portions of the area of windblown tailings.

Alternative 11 would protect deep rooted plants in the east and waste rock piles and tailings piles immediately following implementation; however, the Alternative 11 cover actions are not practicable and the deeper-rooted plants would only remain protected through prevention of their re-establishment. Under Alternative 13M, the deeper rooted plants would be allowed (and are expected) to re-establish in these areas because the available data and observations of the existing plant cover indicate the residual risks to deeper rooted plants are expected to be low. As such, Alternative 11 addresses a short-term, low level risk to deeper rooted plants in a shorter time than Alternative 13M, but it doesn't provide for long term restoration of habitat for deeper rooted plants and the cover actions are disproportionate to the potential environmental benefits.

Similarly, the Alternative 11 actions for Honeymoon Heights (i.e., removal to the tailings and capping) would mitigate the potential exposure pathways to terrestrial receptors upon completion of the removal action. However, because of the significant safety risks associated with road construction and equipment operations in this area, along with the potential for stope collapse and long-term or permanent impairment of the native habitats that are cleared for access and remedy implementation, the Alternative 11 actions in Honeymoon Heights are not practicable and provide limited environmental benefit (given limited risks to biota posed at this AOI). It is estimated that more than 50 to 100 years would be required to re-establish a mid-seral mixed conifer forest in disturbed areas in Honeymoon Heights under Alternative 11, whereas Alternative 13M builds on the 50 years of habitat restoration that has occurred since the mine closed and allows the habitat to continue to be restored under a program of monitored natural recovery.

Although specific remedial actions are not specified in Alternative 11 for the LWA, ballfield/wilderness boundary area, and area of windblown tailings to mitigate potential exposure pathways to terrestrial ecological receptors, active remediation such as removal, covering, and/or amending soils having PCOC concentrations above potential risk-based levels may mitigate potential exposure pathways to terrestrial ecological receptors soon after implementation. However, these actions would require the significant clearing of mature native vegetation and high-quality habitat. Further, the cleared areas would be subjected to erosion/loss of native top soil and possible seed bank; loss of native soil invertebrate communities; loss of native biota; and likely increased expansion of invasive exotic species. Therefore, removal, covering, or amending soils in these areas is not practical and, based on the quality of habitat present in these areas under current conditions, would likely provide limited environmental benefit. It is estimated that more than 50 to 100 years would be required to re-establish a mid-seral mixed conifer forest in the disturbed areas, whereas Alternative 13M builds on the 50 years of habitat restoration that has occurred since the mine closed and allows the habitat to continue to be restored under a program of monitored natural recovery.

In summary, it is not feasible to achieve a restoration time shorter than offered by Alternatives 11 and 13M for protection of: (1) human health, (2) aquatic life, and (3) shallow-rooted plants, soil invertebrates, and terrestrial wildlife for soils in the former SRA, lagoon, maintenance yard, former mill building, east and west waste rock piles, and tailings piles. Further, it is not feasible to restore the tailings, waste rock and underlying groundwater at the Site to meet cleanup levels in a shorter time frame than provided by Alternatives 11 and 13M. Lastly, the faster restoration of other terrestrial receptors offered by Alternative 11 is disproportionate to the loss of habitat required to achieve these goals. Therefore, it is not feasible to achieve a shorter restoration time frame for terrestrial habitat than is offered by the program of monitored natural recovery under Alternative 13M.

Current and Potential Future Uses of the Site, Surrounding Areas, and Associated Resources that Are, or May be Affected by Releases from the Site. The Site is situated in a remote area on the eastern slopes of the Cascade Mountains within the Lake Chelan watershed. The Site is surrounded on three sides by designated wilderness and on one side by National Forest System-managed land. The Holden Village, which operates under a special-use permit issued by the Forest Service, is located north of the Site across Railroad Creek. Alternatives 11 and 13M would result in different levels of short-term impacts to the local communities and, based on communications with the Holden Village directors, the extended construction duration required to implement Alternative 11 may have negative long-term consequences on the viability of the Holden Village.

Availability of Alternative Water Supplies. There are no current or planned uses of surface water or groundwater as a drinking water supply downgradient of site influences. The Holden Village currently obtains potable water from Copper Creek upstream of the Site. No exceedances of human health-based criteria have been measured in site surface water, including Railroad Creek downgradient of the Site, or in groundwater near Lucerne. There are no differences between the alternatives with respect to this criterion.

Likely Effectiveness and Reliability of Institutional Controls. Alternatives 11 and 13M would rely minimally on institutional controls for remedy performance. Institutional controls and access restrictions would be implemented under both alternatives to address potential future risks to human health associated with groundwater and potential physical risks associated with the underground mine and mill building. The institutional controls and restrictions would include land use restrictions; security devices to limit access; and informational devices to notify users about potential risks. Land use restrictions are expected to be implementable, reliable, and adequate in providing long-term protection of human health under both alternatives. The installation of access restrictions around select site features is also expected to be reliable in protecting Holden Village residents and visitors from potential physical hazards. There are no differences between the alternatives with respect to this criterion.

Ability to Control and Monitor Migration of Hazardous Substances from the Site. Both Alternatives 11 and 13M would use proven and reliable methods of water collection and treatment to address the 1500-level portal drainage and groundwater and seeps discharging to Railroad Creek with PCOC concentrations above potential surface water ARARs. Under both alternatives, surface-water monitoring in Railroad Creek and groundwater monitoring in surface water and in existing groundwater monitoring wells would be effective in monitoring site conditions over time. If, after an extended period of monitoring, concentrations of PCOCs in groundwater do not meet potential ARARs at the downgradient CPOC(s), contingent actions would be evaluated under Alternative 13M.

Toxicity of the Hazardous Substances at the Site. Site PCOCs include metals constituents in surface water and groundwater, and metals and total petroleum hydrocarbons (limited areas) in soils. Results of the baseline HHRA and supplemental human health evaluations for the tailings and waste rock (Appendix F) show that PCOC concentrations in site soils, tailings, and waste rock are protective of Holden Village residents and visitors and potential future construction workers. Alternatives 11 and 13M would use institutional controls to mitigate potential risks associated with the use of site groundwater for drinking water.

Both alternatives would decrease PCOC concentrations in Railroad Creek immediately after implementation and would be protective of aquatic life within similar timeframes.

Based on the results of the draft TEE (Appendix G), the source control actions implemented under Alternatives 11 and 13M in the former SRA, lagoon, maintenance yard, former mill building, east and west waste rock piles, and tailings piles are expected to be fully protective of shallow-rooted plants, soil invertebrates, and terrestrial wildlife immediately after implementation. Although deeper rooted plants would continue to be exposed to PCOC concentrations above potential EISCs on the tailings and waste rock under Alternative 13M, data and recent observations of the tailings piles show that deeper rooted plants are re-establishing, and a plant community representative of the surrounding habitats is expected to result over time as a result of natural recovery.

Under Alternative 13M, PCOC concentrations above potential risk-based values for terrestrial ecological receptors would remain in the LWA, Honeymoon Heights, ballfield/wilderness boundary area, and area of windblown tailings. However, based on available data and recent observations of existing habitat quality in these areas, the potential risks to ecological receptors is expected to be low, and mid- to late-seral forested habitats are expected to recover in these areas over time without active remediation.

Natural Processes that Reduce Concentrations of Hazardous Substances have been documented to Occur at the Site or Under Similar Site Conditions. Alternative 13M is expected to meet potential surface water ARARs at a CPOC(s) where groundwater enters Railroad Creek downstream (east) of the Site through documented natural attenuation processes and source control actions, including groundwater collection adjacent to the western portion of tailings pile 2, the collection of seeps adjacent to tailings piles 2 and 3 (if present), upgradient water diversions, surface regrading, and enhanced revegetation to reduce the infiltration of snowmelt and precipitation into the tailings piles.

As described in Section 1.7.2, data obtained from downgradient monitoring wells from 2001 through 2009 strongly suggest that mass loading rates from the tailing piles are declining through time, that that shallow groundwater quality downstream of wells DS-3 and DS-4 meets potential surface water ARARs, and that downward vertical hydraulic gradients are present in the aquifer system. These data indicate that compliance with potential surface water ARARs where groundwater discharges to Railroad Creek downgradient of the Site could be accomplished through natural attenuation.

5.6 *CONSIDER PUBLIC CONCERNS*

The MTCA requires that the selected action consider public concerns. As described under WAC 173-340-600, Ecology's goal is to provide the public with timely information and meaningful opportunities for participation that are commensurate with site conditions through a public participation program that includes:

- Early planning and development of a site-specific public participation plan;
- The provision of public notices;
- A site register;
- Public meetings or hearings; and
- The participation of regional citizens' advisory committees.

Under the site AOC, the Forest Service, USEPA, and State will coordinate public participation and outreach activities for the Site. The Agencies will evaluate public concerns and community acceptance of the proposed remedial action primarily based on comments received from the public on the Proposed Plan. As described in Section 4.9, the local community of the Holden Village will be the most affected by the implementation of the selected remedy, along with the communities of Stehekin and Chelan. The assessment of potential impacts to local communities during and after remedy implementation is ongoing and will continue through remedial design. Some of the factors that will be evaluated and considered are described in Section 4.9.

5.7 *ADDITIONAL MTCA PROVISIONS*

In addition to the seven minimum requirements described above in Sections 5.1 through 5.6 for remedy selection, the Agencies identified several additional provisions under MTCA for evaluation in the SFS. These include provisions for (WAC 173-340-360[2][c] through [h]):

- Groundwater cleanup actions;
- Cleanup Actions for Soils at Current or Potential Future Residential Areas and for Soils at Schools and Child Care Centers;
- Institutional Controls;
- Releases and Migration;
- Dilution and Dispersion; and

- Remediation Levels.

While some of these additional provisions were not identified as ARARs for the Site, a brief evaluation of each is provided in the following subsections.

5.7.1 *Non-Permanent Groundwater Cleanup Actions*

Where a permanent cleanup action that achieves groundwater cleanup levels at the standard point(s) of compliance is not practicable or in the public's interest, Ecology may approve a non-permanent groundwater action, provided the following measures are taken (WAC 173-340-360[2][c]):

- Treatment or removal of the source(s) of the release for liquid wastes, areas contaminated with high concentrations of hazardous substances, highly mobile hazardous substances, or hazardous substances that cannot be reliably contained.
- Groundwater containment, including barriers and/or hydraulic control through groundwater pumping, is implemented to the maximum extent practicable.

Alternatives 11 and 13M include the removal of some site sources, including the former SRA and lagoon. Both alternatives would also remove and/or contain hazardous materials in the underground mine, former mill building, east and west waste rock piles, maintenance yard, Honeymoon Heights, and LWA through capping and/or downgradient groundwater collection and treatment using a fully-penetrating barrier wall and groundwater collection system.

Alternatives 11 and 13M differ with respect to the actions taken to address tailings pile 2 and 3 groundwater. The constructability issues and uncertainties related to the short- and long-term stability of tailings piles 2 and 3 significantly reduce the technical implementability associated with the Alternative 11 actions, including construction of an engineered cap with an impermeable liner and the installation of a barrier wall and groundwater collection system at the base of the two piles. Furthermore, based on the existing data, these actions are not needed for groundwater to achieve potential ARARs at the CPOC(s) east of the Site. As a result, the actions included under Alternative 11 for tailings piles 2 and 3 are not practicable or reasonable, and the Alternative 13M actions are considered AKART for tailings piles 2 and 3 and constitute groundwater containment to the maximum extent practicable.

5.7.2 *Cleanup Actions for Soils at Current or Potential Future Residential Areas and for Soils at Schools and Child Care Centers*

The baseline HHRA found that PCOC concentrations in Holden Village soils are protective of residents and visitors; therefore, the MTCA requirements under WAC 173-340-360(2)(d) for cleanup actions for soils at current or potential future residential areas and for soils at schools and child care centers would not apply to the Holden Village.

5.7.3 *Institutional Controls*

Under WAC 173-340-360(2)(e), MTCA states that cleanup actions using institutional controls shall meet the minimum requirements for cleanup actions specified under WAC 173-340-360(2), demonstrably reduce risks to ensure a protective remedy, and shall not rely primarily on institutional controls and monitoring where it is technically possible to implement a more permanent cleanup action for all or a portion of the Site. As described in Sections 5.1 through 5.6, the actions included under Alternative 13M would meet these requirements.

5.7.4 *Releases and Migration*

Under WAC 173-340-360(2)(f), MTCA requires that cleanup actions prevent or minimize present and future releases and migration of hazardous substances in the environment. Based on the existing data, Alternative 13M is expected to meet potential drinking water ARARs in groundwater and meet potential surface water ARARs at a CPOC(s) where groundwater discharges to Railroad Creek downgradient (east) of the Site through source control and natural attenuation. Therefore, Alternatives 11 and 13M would address site seeps and groundwater with PCOC concentrations above potential ARARs at the CPOC. The tailings pile stabilization and covering actions included under Alternatives 11 and 13M would mitigate the potential for a release of tailings to surface water through sloughing or during a high-water event, as well as the potential for wind-blown transport of tailings down valley.

The Alternative 13M actions would prevent or minimize the release and migration of hazardous substances in the environment. The additional actions included under Alternative 11, such as collection of groundwater associated with tailings piles 2 and 3 and the consolidation and capping of the tailings and waste rock piles with an impermeable liner and 2 feet of soil are not needed to prevent or minimize hazardous substance migration at the Site.

5.7.5 *Dilution and Dispersion*

Under WAC 173-340-360(2)(g), MTCA requires that cleanup actions not rely primarily on dilution and dispersion unless the incremental costs of any active remedial measures over the costs of dilution and dispersion grossly exceed the incremental degree of benefits of those remedial actions. Alternative 13M uses active remedial measures to the maximum extent practicable to reduce PCOC loading to site groundwater and contain, collect, and treat groundwater above potential cleanup levels. As such, Alternative 13M does not rely primarily on dilution and dispersion to attain cleanup levels at the Site and the costs of the additional capping and groundwater collection actions under Alternative 11 exceed the incremental degree of benefits associated with those actions.

5.7.6 *Remediation Levels*

Alternative 13M uses active remedial measures to the maximum extent practicable to protect human health and ecological receptors, reduce PCOC loading to site groundwater, and to contain, collect, and treat groundwater above potential cleanup levels. As such, Alternative 13M meets the requirements under WAC 173-340-360(2)(h) to use remediation levels at the Site, as needed.

6.0 SUMMARY

Based on the available information and results of the evaluations presented in Sections 4 and 5, Alternative 13M is the preferred remedial alternative for the Site. The principal components of Alternative 13M are shown on Figure 3-1 and include the following:

- Control the main portal drainage flow using hydraulic barriers installed within the 1500-level of the mine (if feasible) and reduce air flow through the mine and control human access by placing restrictions in other open underground mine openings.
- Contain, collect, and treat the main portal drainage and seeps and groundwater having metals concentrations that exceed potential surface water quality criteria and would otherwise enter Railroad Creek adjacent to the former mine facility.
- Close the tailings piles and east and west waste rock piles to improve stability, reduce surface water runon, improve surface water runoff, and support native vegetation consistent with the Washington State Standards for Solid Waste Handling.
- Remove soils and mine-related materials from the lagoon area, surface water retention area, and former mill building, and cover the maintenance yard with a concrete slab or impermeable liner to reduce exposures to human and terrestrial ecological receptors and future releases of hazardous substances to groundwater.
- Realign Railroad Creek to the north adjacent to the tailings piles to provide improved long-term channel stability, enhanced aquatic and riparian habitat, and to hydraulically isolate the creek from shallow groundwater in the eastern portion of the Site. The creek realignment would also allow the construction of groundwater collections systems adjacent to tailings piles 1 and 2 without massive excavation and removal of tailings adjacent to the creek.
- Modify the Copper Creek channel to provide long-term erosion control, channel stabilization, and conveyance of water and sediment to the realigned Railroad Creek channel.
- Implement monitored natural recovery for portions of the Site (e.g., ballfield/wilderness boundary, area of windblown tailings, and Honeymoon Heights) where a low potential risk remains to terrestrial ecological receptors (primarily plants and invertebrates), but where

active remediation would cause long-term or permanent impairment of the native habitat.

- Limit potential future exposure to groundwater or source materials that could impact human health or the environment and prevent activities that may interfere with the effectiveness of the remedy components through institutional controls, such as proprietary controls on private property or land use restrictions.
- Monitor surface water, groundwater, biota, sediment, and site operations and maintenance to assess conformance with RAOs and ARARs and the protectiveness and effectiveness of the Alternative 13M remedy components.

The remedy components listed above for Alternative 13M would address all sources of mine-related hazardous substances at the Site and would satisfy the proposed RAOs.

The first RAO is to meet the surface water ARARs or alternative risk-based concentrations that are protective of human health and aquatic life in Railroad Creek and Copper Creek within a reasonable restoration time frame. Alternative 13M satisfies this RAO by containing, collecting and treating the main portal drainage and seeps and groundwater having metals concentrations that exceed potential surface water criteria and that would otherwise enter Railroad Creek adjacent to site features, and hydraulically isolating the realigned creek channel from groundwater. Surface water quality restoration would begin immediately following implementation of Alternative 13M. Diffuse groundwater and seeps entering Railroad Creek upgradient (west) of the realigned creek channel would be contained and collected using a barrier wall and collection trench constructed immediately adjacent to the creek, surface water quality would be restored as soon as possible and a reasonable restoration time frame would be provided.

The second RAO is to meet ARARs or alternative risk-based concentrations that are protective of human health and aquatic life at CPOCs in surface water where groundwater enters Railroad and Copper Creeks within a reasonable restoration time frame. Alternative 13M satisfies this RAO by collecting and treating groundwater having metals concentrations that exceed potential surface water ARARs that would discharge to Railroad Creek adjacent to the former mine facility. Alternative 13M is also expected to meet potential surface water ARARs at a CPOC(s) where groundwater discharges to Railroad Creek downgradient (east) of the former mining facility. This would be accomplished through a combination of: (1) water collection and treatment and source control actions that would reduce PCOC loadings to east area groundwater, and (2) natural attenuation processes that would both reduce PCOC loadings to groundwater over time and reduce PCOC concentrations in the downgradient groundwater with distance from the tailings piles.

The third RAO is to meet Washington State sediment quality requirements that are protective of human health and the environment within a reasonable restoration time frame. Alternative 13M meets this RAO under current conditions, based on the results of bioassay testing conducted on sediment samples from Railroad Creek and Lake Chelan at the Lucerne bar. The Railroad Creek realignment would bypass the portions of the existing channel where ferricrete is observed on the channel bottom and would provide new, clean substrate for aquatic organisms immediately after remedy implementation. The water collection and treatment and source control actions under Alternative 13M would also reduce metals loading to Railroad Creek surface water and sediment and further improve sediment quality downstream of the site over time.

The fourth RAO is to attain surface soil quality that is protective of human health and terrestrial ecological receptors. Results of the baseline HHRA and the supplemental human health risk evaluations presented show that PCOC concentrations in site soils are protective of human health under current and anticipated future land uses and construction activities. Alternative 13M would provide additional protection of human health by removing or covering surface soils having concentrations above potential human-health (direct contact) criteria in the lagoon area and maintenance yard. Institutional controls, including land use restrictions, would also be implemented, as needed, to protect human health in areas where soil concentrations above potential risk-based criteria are managed in place and to mitigate potential exposure pathways to deeper soils.

Alternative 13M would address potential risks to terrestrial ecological receptors by removing soils in the lagoon area and former surface water retention area, and by removing the exposure pathways to soil and other mining-related materials in the maintenance yard and mill building. The available data indicate that the Alternative 13M soil cover on the tailings and east and west waste rock piles would be protective of wildlife, soil invertebrates, and shallow-rooted plants. While a low potential risk to deeper-rooted plants would remain on the piles, data and recent observations of the tailings piles show that deeper rooted plants are re-establishing, and a plant community representative of the surrounding habitats is expected to develop over time as a result of natural recovery.

The incidental removal and/or covering of soils in portions of the lower west area and area of windblown tailings during implementation of other remedy components would also reduce the exposure of terrestrial ecological receptors in these areas. Alternative 13M would implement monitored natural recovery for the remaining portions of the Site (e.g., in the ballfield/wilderness boundary area, lower west area, area of windblown tailings, and Honeymoon Heights) where a low potential risk would remain to terrestrial ecological receptors (primarily plants and soil invertebrates), but where active remediation would result in long-term or permanent impairment of the native habitat.

The fifth RAO is to stabilize the tailings and waste rock pile side slopes, as needed, to satisfy ARARs, prevent future releases of tailings or waste rock into surface water, and protect human health. Alternative 13M would satisfy this RAO by regrading and stabilizing the tailings pile and east and west waste rock pile side slopes to provide adequate static and seismic factors of safety. The realignment of Railroad Creek to the north would provide greater distance between the tailings pile slopes and the creek and further reduce the potential for tailings transport to the creek in the event of sloughing or a slope failure.

The sixth RAO is to prevent access to underground mine workings and reduce the potential for human exposure to hazardous substances remaining on site following remedy implementation, including through use of groundwater as a drinking water source. Alternative 13M would meet this RAO by installing access restrictions in open mine portals and implementing institutional controls, such as proprietary controls on private property or land use restrictions, to limit potential future exposure to groundwater or source materials that could impact human health and prevent activities that may interfere with the effectiveness of the remedy components.

The seventh RAO is to perform appropriate NRDA activities as agreed by the Parties to evaluate the potential for coordinated remediation and natural resource restoration activities. This RAO includes the evaluation and coordination of natural resource restoration activities with remedial action implementation to the extent feasible. Intalco and the natural resource Trustees have performed appropriate NRDA activities and plan to discuss NRD as part of a global Remedial Action and NRD settlement for the Site.

The eighth RAO is to implement the remedial action in a manner that protects human health and the environment, including the Holden Village residential community during and after construction. The implementation of appropriate health and safety measures and close coordination with the Holden Village during construction of Alternative 13M would reduce safety risks to workers, Holden Village residents, and visitors. Similarly, potential environmental impacts during construction would be mitigated to the extent possible through careful construction practices, good housekeeping, and advanced preparation of a spill management other contingency plans.

Based on the information currently available, Alternative 13M is expected to satisfy the threshold requirements under CERCLA and MTCA, and is proposed as the preferred alternative because it would provide the best performance with respect to the balancing and modifying criteria under CERCLA, and the other requirements for selecting a cleanup action under MTCA. Alternative 13M is expected to provide greater long-term effectiveness and permanence, fewer short-term risks to human health and the environment during remedy implementation, greater technical implementability, at a lower total cost than other alternatives that satisfy the threshold criteria.

The magnitude of residual risks to human health and the environment would be low under Alternative 13M, and the actions included under Alternative 13M would provide a comparatively high degree of long-term reliability. Alternative 13M would use open trenches to convey water by gravity to the water treatment systems to the extent possible, thereby reducing the amount of system maintenance and monitoring and the risk of system failure associated with the reliance on energy-intensive pumps and closed piping. Similarly, the Alternative 13M soil cover would require minimal post-closure maintenance and could be repaired relatively quickly with locally-available, conventional equipment in the event of damage.

Alternatives 13M would pose few short-term risks to the local community, workers, and environment during the active construction seasons, and many of these risks can be managed or mitigated during remedy implementation. The short term risks posed by Alternative 13M are manageable because implementation of Alternative 13M includes handling a manageable volume of contaminated materials, a logistically feasible schedule of heavy construction activities, borrow soil and rock quarry requirements that are commensurate with local supply, and a relatively short construction duration. It is estimated that approximately 390,000 cy of tailings would require relocation under Alternative 13M, which is approximately 60 percent less than other alternatives that satisfy the threshold criteria. Furthermore, the current toe of the tailings pile side slopes would remain in place, and the overbank deposits would not be exposed during slope regrading; thereby preserving the overall stability of the tailings piles during construction. Construction of Alternative 13M is expected to be completed within two full construction seasons, with final seeding and planting occurring in year three. This alternative reduces implementation time and the impacts on the local community and environment by a year or more relative to other alternatives that satisfy the threshold criteria.

Alternative 13M is the most implementable of the alternatives that satisfy the threshold criteria because it relies heavily on conventional technologies and construction methods, which allows for use of a locally available work force, and it has comparatively few constructability challenges and safety risks. The regrading and/or relocation actions proposed for the tailings piles and the east and west waste rock piles, construction of the cover for the tailings and waste rock piles, construction of the water conveyance and treatment systems, and most of the Railroad Creek realignment work would be completed using conventional technologies and construction methods and a locally available work force. Specialized equipment and contractors would be required for rock blasting, retaining wall construction, habitat construction within Railroad Creek, barrier wall construction and the installation of hydrostatic bulkheads. However, these activities are common and conventional at mining sites in North America, and the equipment and contractors needed to perform this work are readily available in North America. Alternative 13M has been designed to reduce the constructability challenges and safety risks associated with these specialized work activities to the extent practicable; however, they can be further mitigated by proper planning and the selection of experienced contractors and appropriate equipment.

The total cost is anticipated to be at least 40 percent lower than Alternative 11, the other alternative evaluated that satisfies the threshold criteria. The lower total cost for Alternative 13M is expected because it uses:

- A barrier wall only in areas where groundwater having metals concentrations that exceed potential surface water ARARs would discharge to Railroad Creek;

- Source control actions combined with natural attenuation to address groundwater having metals concentrations that are expected to meet potential surface water ARARs at a CPOC(s) where the groundwater enters Railroad Creek downgradient (east) of the Site;

- Realignment of Railroad Creek to reduce the required regrading and buttressing of the tailings piles;

- An efficient plan for regrading and relocating the east and west waste rock piles that includes placement of rock on the former mill building foundations;

- A protective soil cover for the tailings and east and west waste rock piles, which avoids costly synthetic liners that potentially require a significant maintenance effort and which must be maintained free of treed vegetation native to the local area;

- Source material from the new creek and other on-site excavations to reduce the amount of import soil and rock material needed to complete the construction;

- Low-energy and low-maintenance water collection and treatment systems; and

- Natural recovery rather than active remediation in areas, such as the Honeymoon Heights waste rock piles, where the long-term risks to the environment are low, but the construction safety risk and/or the risk of long-term or permanent impairment of the native habitat caused by active remediation is high.

Alternative 11 is also expected to satisfy the threshold requirements under CERCLA and MTCA; however, it is not the proposed preferred alternative because Alternative 13M is expected to provide the best performance with respect to the balancing and modifying criteria under CERCLA, and the other requirements for selecting a cleanup action under MTCA. As described above, Alternative 13M is expected to provide greater long-term effectiveness and permanence, fewer short-term risks to human health and the environment during remedy implementation, greater technical implementability, and at a lower total cost than Alternative 11.

The actions included under Alternative 11 would provide long-term protection of human health and the environment, but with a lower degree of long-term reliability than the actions included under Alternative 13M because, among other issues, Alternative 11 would rely on pumps and closed piping systems that would require close monitoring and maintenance year-round to prevent blockages. These systems would result in potential releases of untreated water directly to Railroad Creek during times when the pumping capacity is exceeded, periods of power interruption or failure, and/or blockages/breaks in the piping system. Similarly, the Alternative 11 tailings and waste rock pile cover systems would require significant post-closure maintenance to prevent the establishment of deep-rooted plants and burrowing animals that would potentially damage the geomembranes and to maintain the extensive drainage network free of ice and other obstructions. In the event of damage to the Alternative 11 cover, significant effort and specialized construction crews would be required to repair the geomembrane.

The short term risks posed by Alternative 11 risks to the local community, workers, and environment during the active construction seasons are greater than the risks posed by Alternative 13M, because implementation of Alternative 11 includes more handling of contaminated materials, more heavy construction activities, greater borrow soil and rock quarry requirements, and a longer construction duration than Alternative 13M. It is estimated that approximately 960,000 cy of tailings would require relocation under Alternative 11 compared to 390,000 cy under Alternative 13M. Implementation of Alternative 11 would result in the removal of the starter dams, all the strong cemented Zone 1A tailings, and most of the relatively strong Zone 1 tailings that have maintained the steep tailings pile side slopes since the cessation of mining operations. The final exposed tailings slopes would have higher moisture contents, with weaker tailings material than is exposed at present. Additionally, the barrier wall and groundwater collection system located at the toes of tailings piles 2 and 3 under Alternative 11 would require construction after the tailings pile side slopes have been regraded, but before the rockfill buttress is placed, resulting in potential slope stability issues during construction. These conditions could lead to local instabilities and sloughing during construction of Alternative 11. Alternative 11 would likely require more than three full construction seasons to complete, thereby extending the impacts and risks to the local community and environment for an additional year or more.

Alternative 11 is expected to be less implementable than Alternative 13M, due to constructability problems associated with the tailings pile regrading actions, construction issues and safety risks associated with relocation of the Honeymoon Heights waste rock piles, and the greater overall construction requirements and durations. The tailings regrading and cover actions proposed under Alternative 11 would provide comparatively higher constructability challenges and risks because of the relatively large volume of wetter, finer, and weaker tailings that would be excavated, relocated, placed, and compacted. Based on the results of the geotechnical analyses in Appendix C, Alternative 11 would require approximately 160,000 cy of rock to be locally quarried for tailings pile buttress construction compared to 85,000 cy for Alternative 13M. Relocation of the Honeymoon Heights waste rock piles would require re-establishment and expansion of the former primitive access road up to the 550-level mine portal and construction of a new road up to the 300-level mine portal. Based on the relatively shallow nature of the crown pillars that separate the stopes from the ground surface, any above-ground related efforts are considered a risk for potential crown pillar collapse. A collapse of any of the near surface stopes would present obvious safety risks, and would also allow the inflow of additional surface water to the underground mine workings, thereby increasing the metals loading and treatment requirements for the 1500-level main portal. The Alternative 11 barrier wall alignments that extend substantially to the south up the Copper Creek drainage and the wall adjacent to tailings pile 3 are expected to present extreme construction challenges due to the subsurface conditions, steep topography, and depth to bedrock (over 100 feet bgs east of tailings pile 3) suggesting that these barrier wall segments may not be feasible.

As indicated previously, the evaluation of the total costs associated with Alternatives 11 and 13M is ongoing. However, the total cost to implement Alternative 13M is expected to be at least 40 percent lower than the total cost to implement Alternative 11. The rationale for the lower anticipated cost of Alternative 13M is presented above.

7.0 REFERENCES

Dames & Moore. 1999. *Draft Final Remedial Investigation Report,* Holden Mine Site. Prepared for Alumet, Inc. (28 July 1999).

David E. Jackson and Associates, URS Corporation, and ERM-West, Inc. 2007. *Alternative 13 Description and Preliminary Evaluation*, Holden Mine Site, Chelan County, Washington. Prepared for Intalco (15 October 2007).

ERM. 2009a. *Draft Terrestrial Ecological Evaluations Report*, Holden Mine Site, Chelan County, Washington. Prepared for Intalco (March 2009).

ERM. 2009b. *Draft Water Treatment System Performance Evaluations Report*, Holden Mine Site, Chelan County, Washington. Prepared for Intalco (22 June 2009).

Etherington, J.R. 1975. *Environment and Plant Ecology*. John Wiley & Sons. New York, NY.

Makdisi, F. I., and H.B. Seed. (1977). *A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments.* Report No. UCB/EERC-77/19. Springfield VA: National Technical Information Service.

Mayer, A.M. and A. Poljakoff-Mayer. 1982. *The Germination of Seeds*. 3rd Edition. Pergamon Press. New York, NY.

Raven, P.H., R.R. Evert, and S.E. Eichorn. 1999. *Biology of Plants*. 6th Edition. W.H. Freeman & Company. New York, NY.

Reed, W. 1991. *Succession: From Field to Forest*. Enslow Publishers. Hillside, NJ.

Ricklefs, R.R. 1990. *Ecology*. 3rd Edition. W.H. Freeman & Company. New York, NY.

Salisbury F.B. and C.W. Ross. 1978. *Plant Physiology*. 3rd Edition. Wadsworth Publishing Company. Belmont, CA.

Suter, G. W., II. 1992. *Ecological Risk Assessment*. Lewis Publishers, Chelsea, MI.

Suter, G. W., II, A. Redfearn, R. K. White, and R. A. Shaw. 1992. *Approach and Strategy for Performing Ecological Risk Assessments for the Department of*

Energy Oak Ridge Field Office Environmental Restoration Program. ES/ER/TM-33. Environmental Restoration Division, Oak Ridge National Laboratory, Oak Ridge, TN.

United States Committee on Large Dams. 1999 *Updated Guidelines for Selecting Seismic Parameters for Dam Projects.* Prepared by USCOLD Committee on Earthquakes.

United States Department of Agriculture Forest Service. 1990. *Wenatchee National Forest Land and Resource Management Plan.* Wenatchee, Washington.

United States Department of Agriculture Forest Service. 2007a. *Final Draft Proposed Plan, Holden Mine Site, Chelan County, Washington*. (18 September 2007).

United States Department of Agriculture Forest Service. 2007b. *Supplemental Feasibility Study, Holden Mine Site, Chelan County, Washington.* (September 2007).

United States Department of Agriculture Forest Service, Washington State Department of Ecology, and United States Environmental Protection Agency. 2005. *Holden Mine Site, Chelan County, Washington, Site Information Package Prepared for the U.S. Environmental Protection Agency National Remedy Review Board.* Document No. 4769-07 (1 September 2005).

United States Environmental Protection Agency. 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.* Interim Final. (October 1988).

URS. 2002. *Fall 2001 Lake Chelan Sediment Sampling Data Transmittal*. Prepared for Intalco.

URS. 2003. *Fall 2002 Lake Chelan Sediment Sampling Data Transmittal*. Prepared for Intalco (5 May 2003).

URS. 2004. *Draft Final Feasibility Study*, Holden Mine Site, Chelan County, Washington. Prepared for Intalco (19 February 2004).

URS. 2009a. *Appendix D: Draft Proposed Railroad Creek Realignment Technical Memorandum*. Prepared for Intalco (8 June 2009).

URS 2009b. *Appendix C: Draft Geotechnical Technical Memorandum.* Prepared for Intalco (9 July 2009).

URS 2009c. *Attachment B-1: Draft Honeymoon Heights Near-Surface Stope Mapping.* Prepared for Intalco (10 July 2009).

URS 2009d. *Appendix E: Draft Hydrogeology Technical Memorandum.* Prepared for Intalco (10 July 2009).

URS. 2009e. *Appendix F: Draft Supplemental Human Health Risk Evaluation for the Tailings and Waste Rock Piles.* Prepared for Intalco (10 July 2009).

Washington State Department of Ecology. 1989. *Lake Chelan Water Quality Assessment.* Publication No. 89-e36 (January 1989).

Washington State Department of Ecology. 1997. *Effects of Holden Mine on the Water, Sediments, and Benthic Invertebrates at Railroad Creek (Lake Chelan).* Publication No. 97-330 (July 1997).

Washington State Department of Ecology. 2007. *Model Toxics Control Act Cleanup Regulation,* Chapter 173-340 WAC (revised November 2007).

Washington State Department of Ecology. *Water Quality Standards for Surface Waters of the State of Washington.* WAC 173-201A.

Washington State Department of Ecology Dam Safety Office. 1992. *DSO Dam Safety Guidelines Technical Note 2: Selection of Design/Performance Goals for Critical Project Elements.*

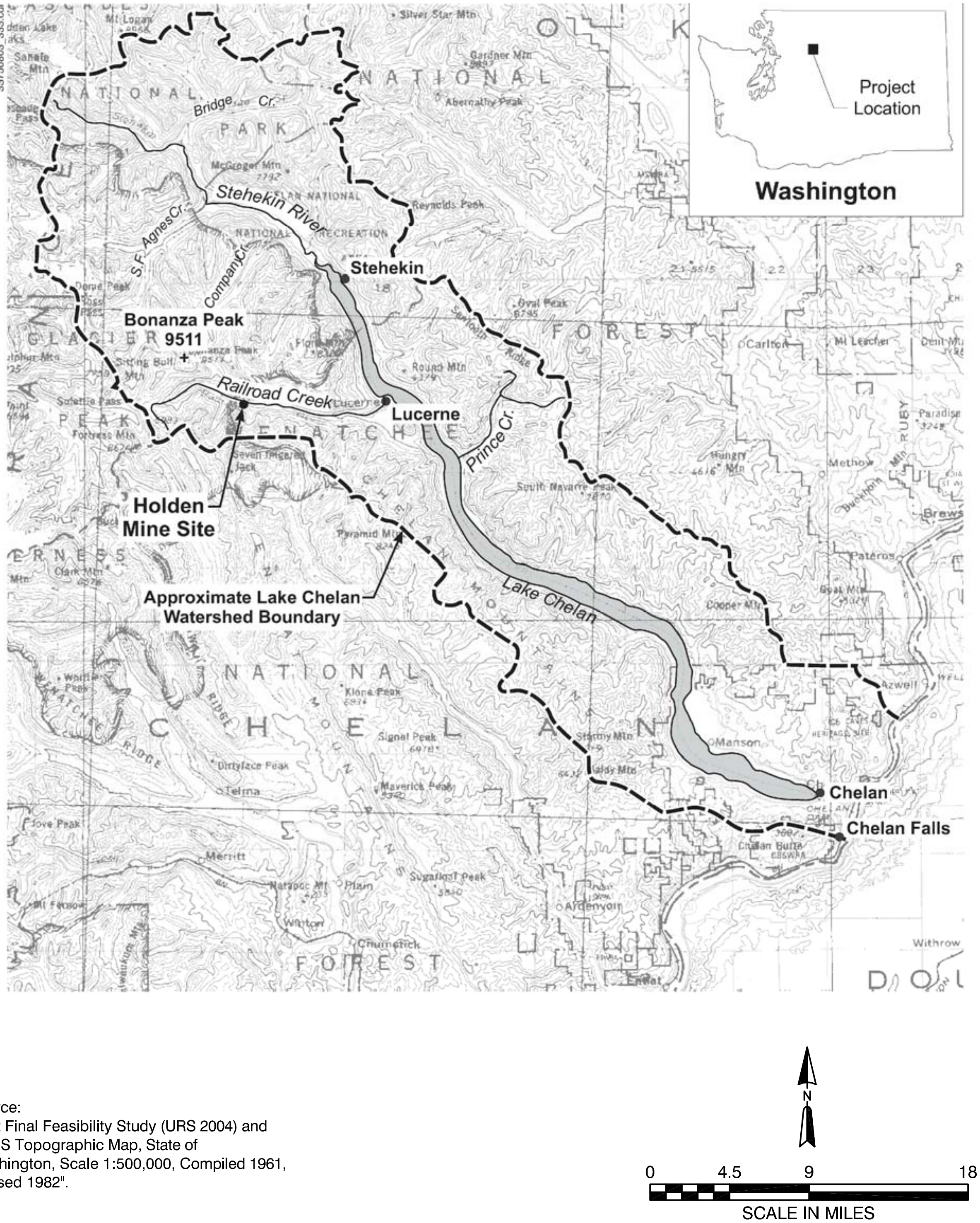
Washington State Department of Ecology Dam Safety Office. 1993. *DSO Dam Safety Guidelines Part IV: Dam Design and Construction.*

Washington State Department of Ecology Dam Safety Office. 2007. *DSO Dam Safety Guidelines Technical Note 1: Dam Break Inundation Analysis and Downstream Hazard Classification (*revised October 2007).

Washington State Department of Ecology Dam Safety Office. 2009. Internal DSO clarifications provided by Mr. Jerald LaVassar, P.E., DSO Geotechnical Engineer, via e-mail.

Figures

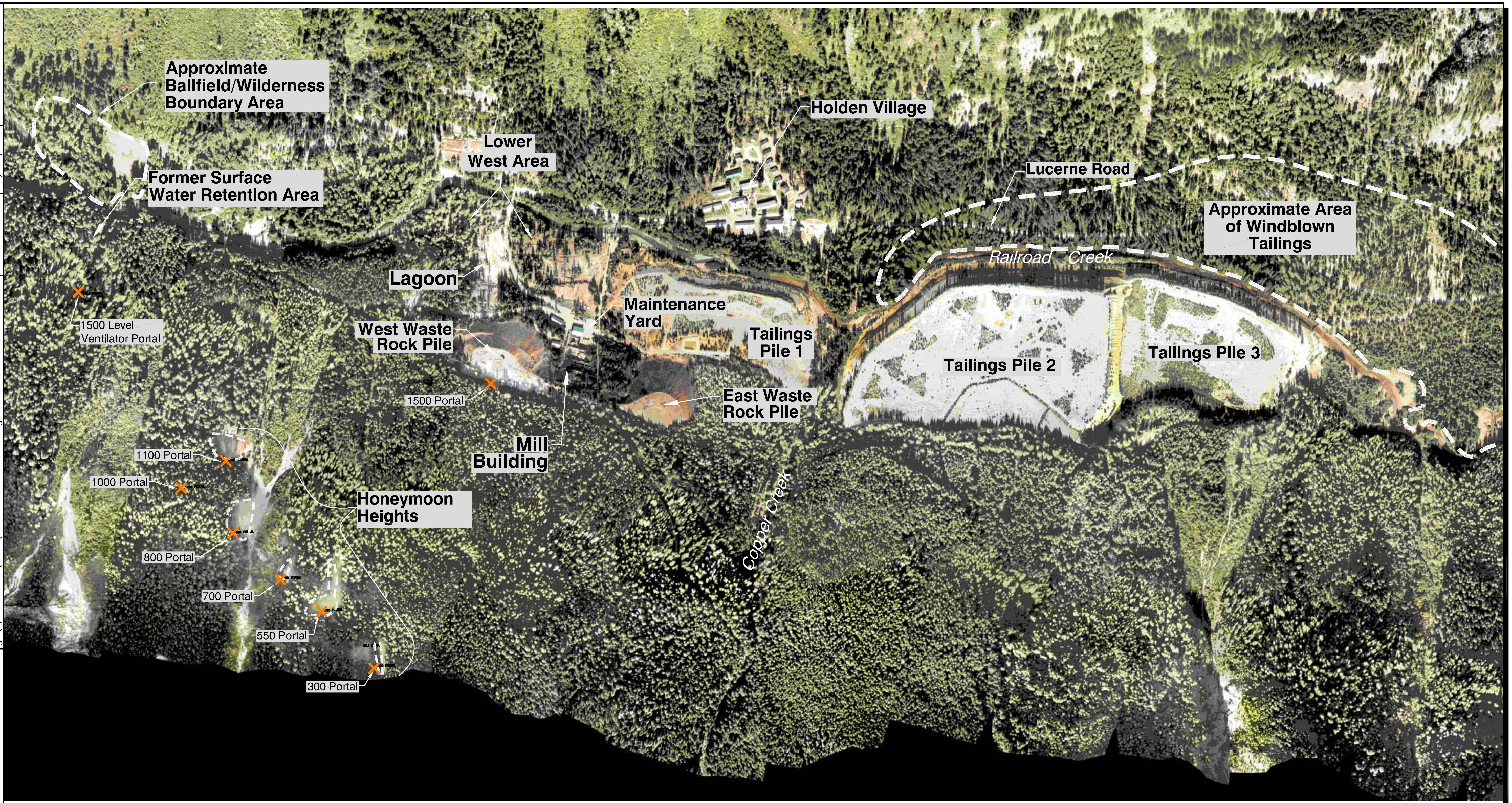
Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\\0069351\100\0069351100-13.dwg



Source:
Draft Final Feasibility Study (URS 2004) and USGS Topographic Map, State of Washington, Scale 1:500,000, Compiled 1961, Revised 1982".

Figure 1-1
Site Location and Lake Chelan Watershed Map
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09



LEGEND

× Portal

N

1" = 600'

0 300' 600' 1200'

Figure 1-2

Principal Site Features

Draft Alternative 13M Evaluation Report

Holden Mine Site, Chelan County, WA

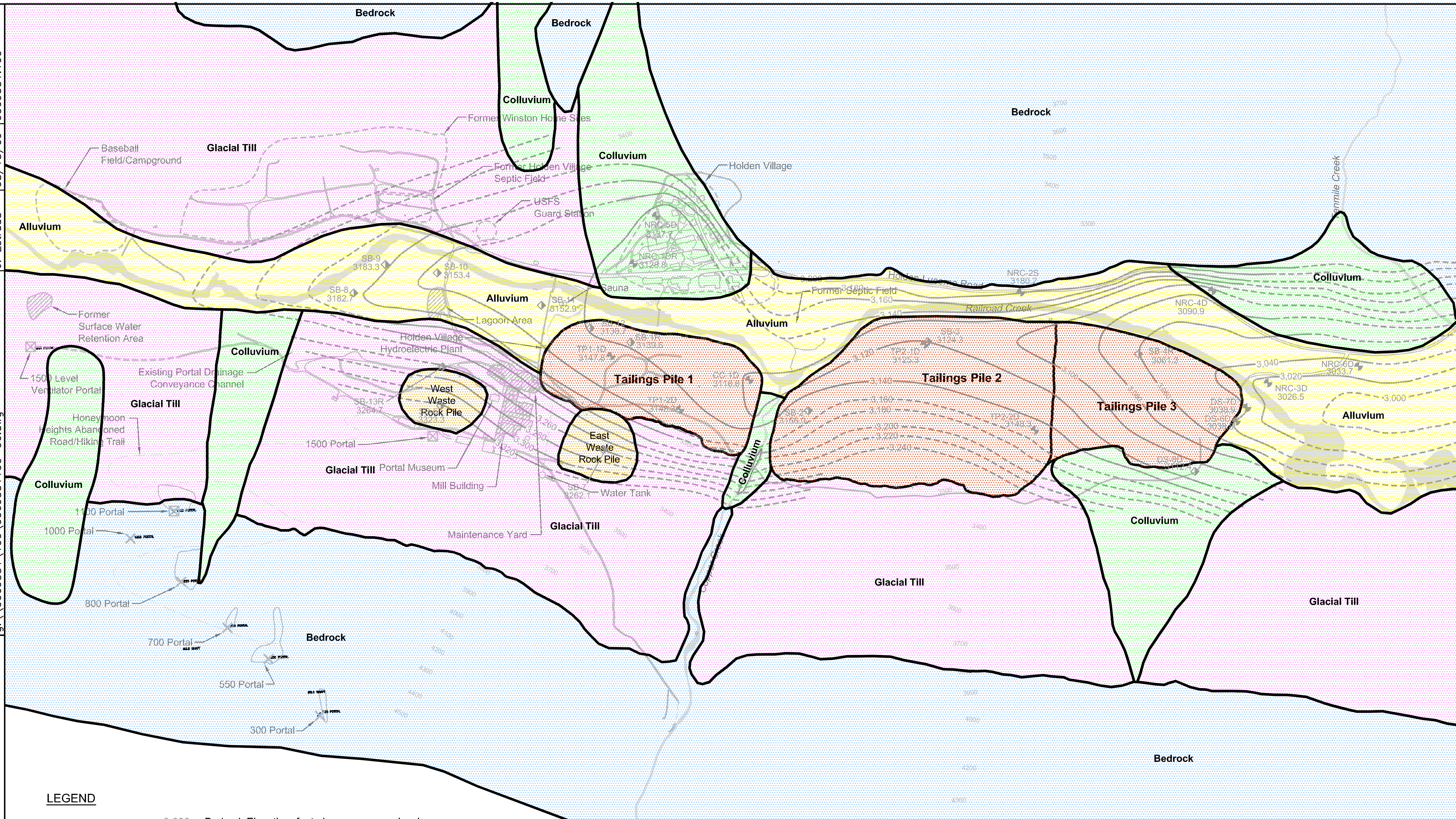
ERM 08/09

Project No. 0069351.100

Date: 08/13/09

Drawn By: J. Estrada

CAD File: g:\\0069351\100\0069351100-14.dwg



LEGEND

Monitoring Well

Soil Boring

3,080 Bedrock Elevation, feet above mean sea level

Bedrock Contour, feet above mean sea level (Dashed where Inferred)

Geologic Contact

Mt	Tailings	Qal	Alluvium
Mwr	Waste Rock	Qgt	Glacial Till
Qcdf	Colluvium/Debris Flow Deposits	Brk	Bedrock

1" = 600'

0 600'

N

Source:
Draft Hydrogeology Technical Memorandum (URS 2009)

Figure 1-3
Generalized Geologic Map
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

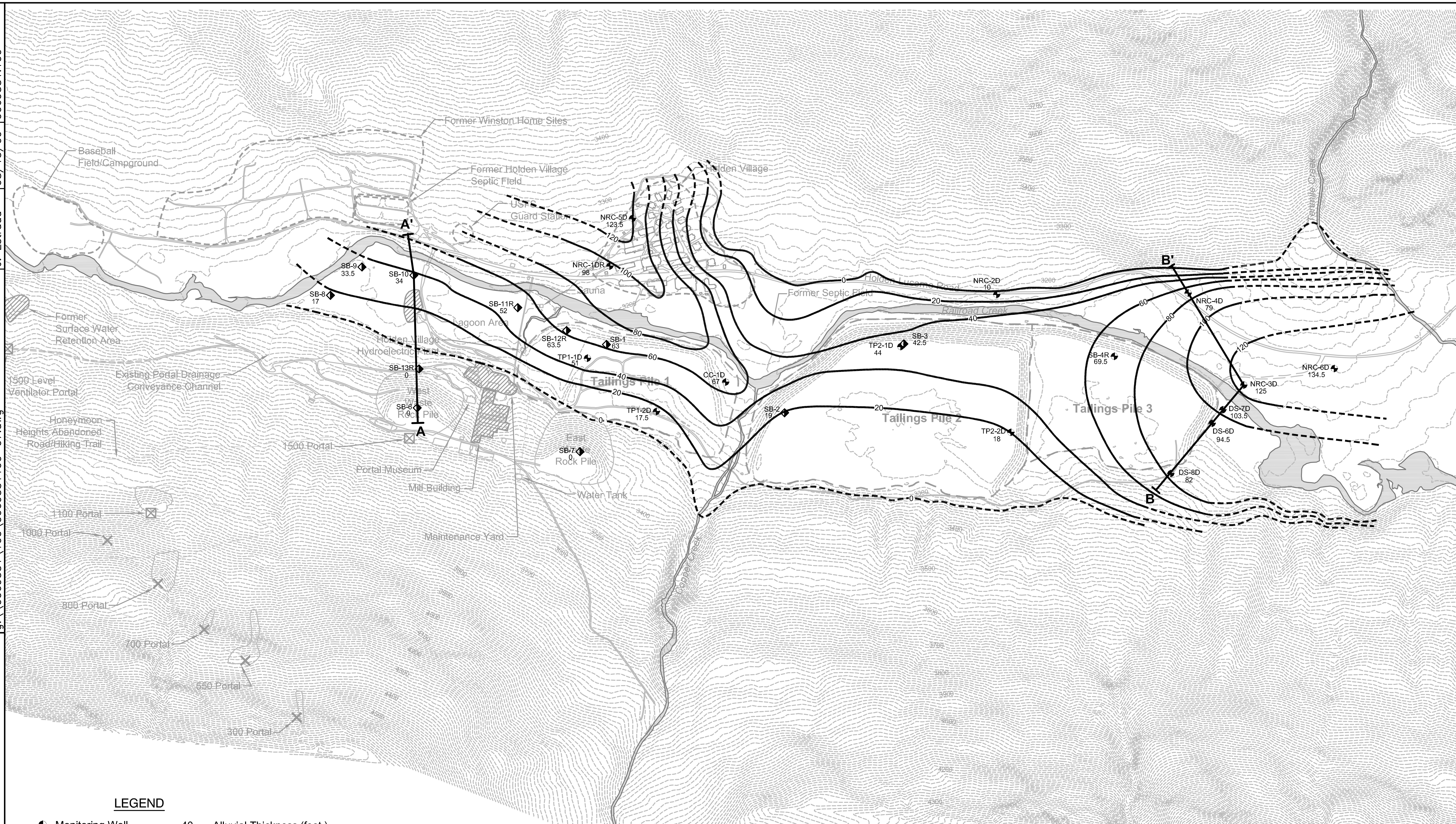
ERM *08/09*

Project No. 0069351.100

Date: 08/13/09

Drawn By: J. Estrada

CAD File: g:\\0069351\100\0069351100-06.dwg



LEGEND

- Monitoring Well
- Soil Boring

40 Alluvial Thickness (feet)

Isopach Contour (Dashed where Inferred)

1" = 600'   0   600'   1200'

N

Source:
Draft Hydrogeology Technical Memorandum (URS 2009)

Figure 1-4

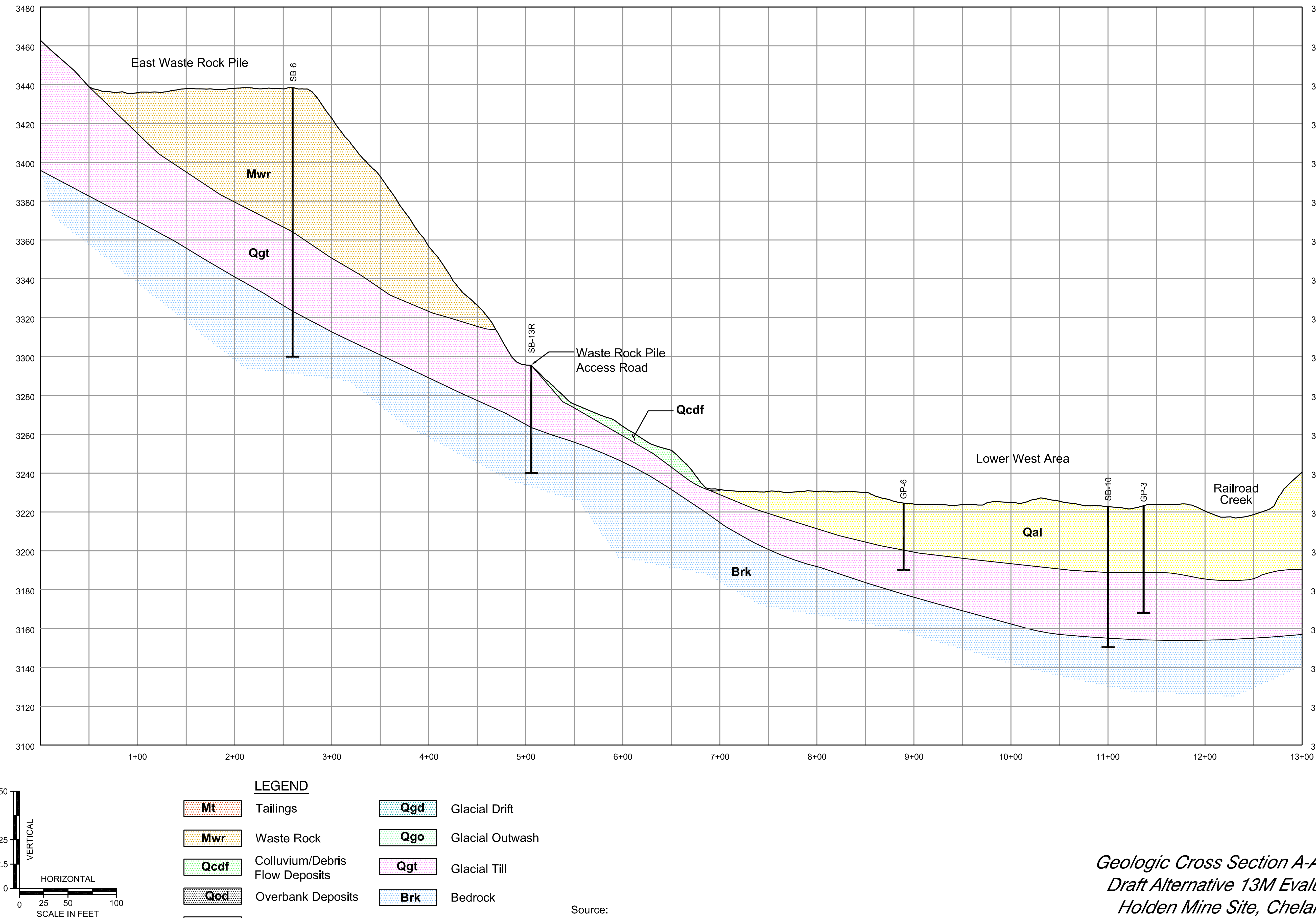
Cross Section Locations and Alluvial Thickness Contours

Draft Alternative 13M Evaluation Report

Holden Mine Site, Chelan County, WA

ERM *08/09*

Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\\0069351\100\0069351100-08.dwg



LEGEND

Mt	Tailings	Qgd	Glacial Drift
Mwr	Waste Rock	Qgo	Glacial Outwash
Qcdf	Colluvium/Debris Flow Deposits	Qgt	Glacial Till
Qod	Overbank Deposits	Brk	Bedrock
Qal	Alluvium		

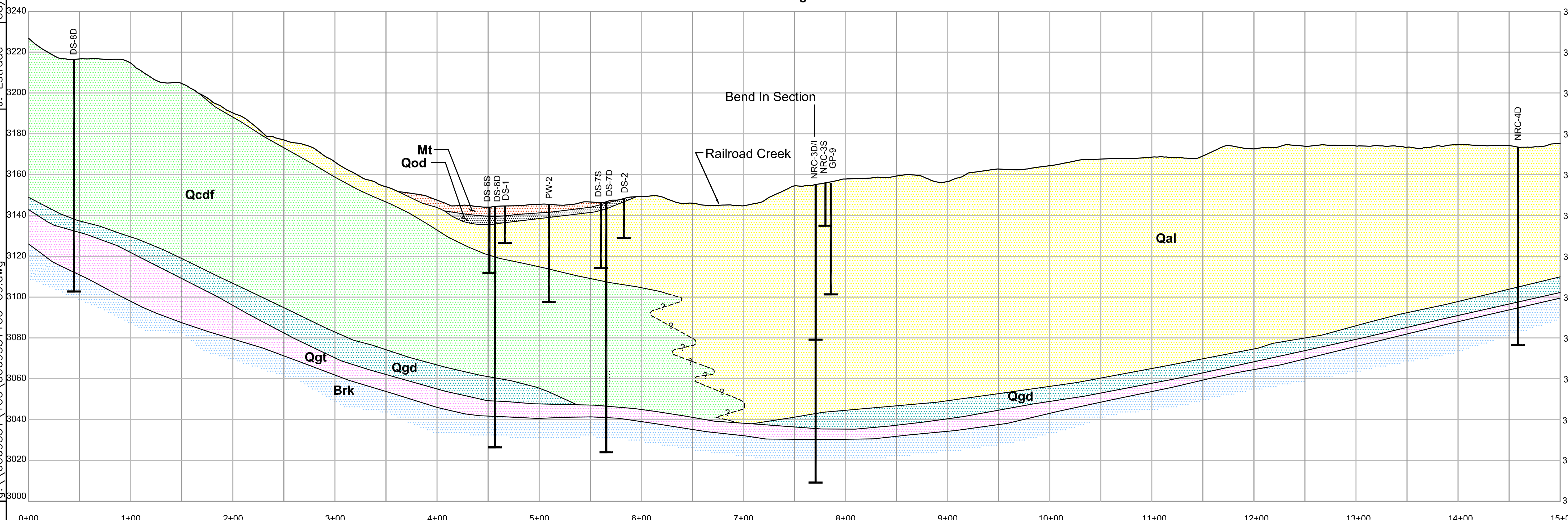
Source:
Draft Hydrogeology Technical Memorandum (URS 2009)

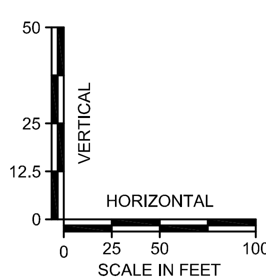
Figure 1-5
Geologic Cross Section A-A' (West Area)
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM *08/09*

Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\\0069351\100\0069351100-09.dwg

Geologic Cross Section B-B'





LEGEND

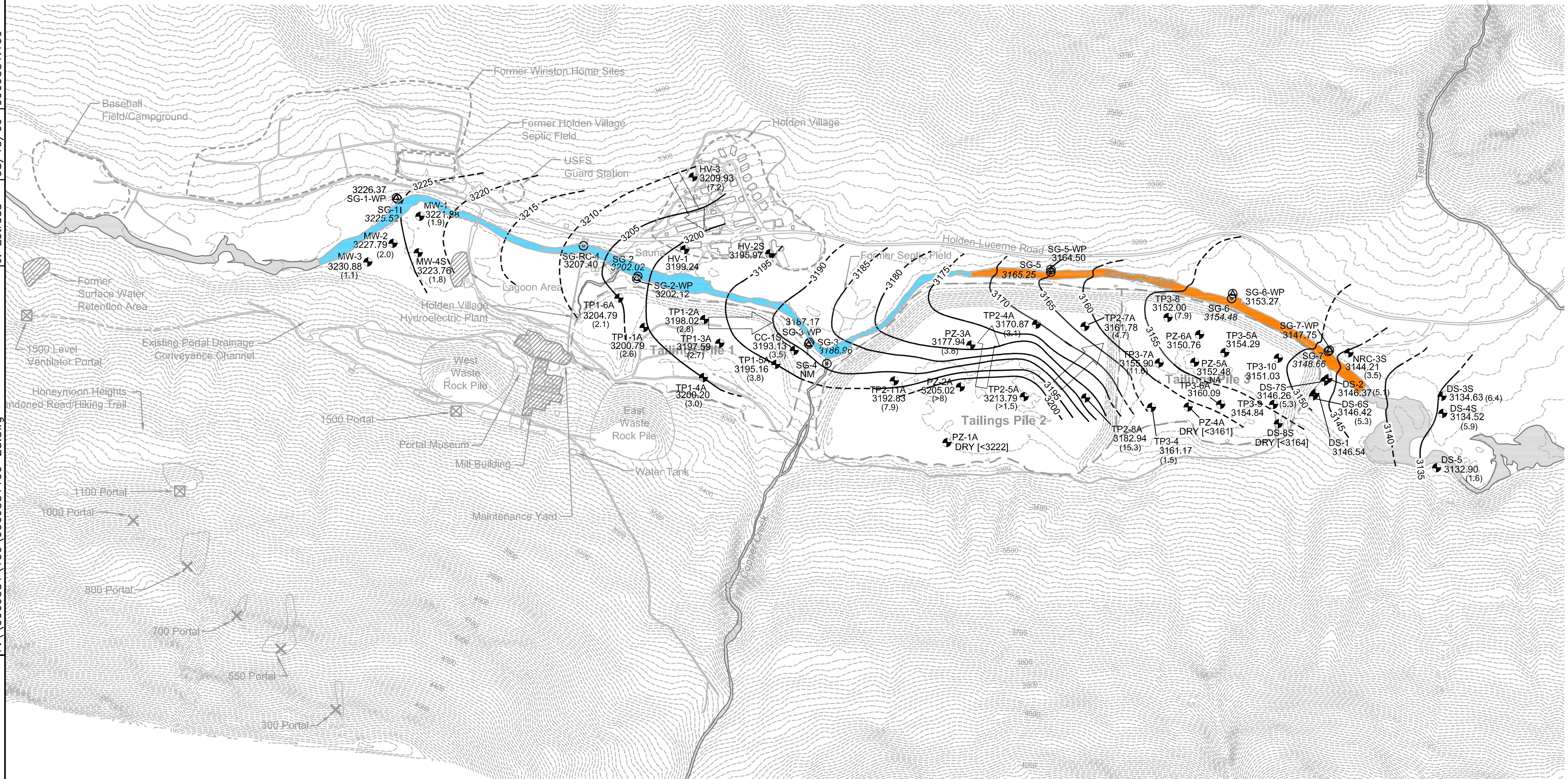
- Mt — Tailings
- Mwr — Waste Rock
- Qcdf — Colluvium/Debris Flow Deposits
- Qod — Overbank Deposits
- Qal — Alluvium
- Qgd — Glacial Drift
- Qgo — Glacial Outwash
- Qgt — Glacial Till
- Brk — Bedrock

Source:
Draft Hydrogeology Technical Memorandum (URS 2009)

Figure 1-6
Geologic Cross Section B-B' (East Area)
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09

Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: F:\0069351\100\0069351100-28.dwg



LEGEND

- Monitoring Well
- Well Point
- 3190.9 Groundwater Elevation, feet above mean sea level
- (4.2) Groundwater Elevation Difference - July-October 2008
- Groundwater Contour, feet above mean sea level (Dashed Where Inferred)
- Staff Gauge
- *3125.52* Surface Water Elevation, feet above mean sea level
- NM Not Measured
- Groundwater Flow Direction

- Estimated Extent of Gaining Reach of Railroad Creek
- Estimated Extent of Losing Reach of Railroad Creek

N

1" = 600'

0 600' 1200'

Figure 1-7

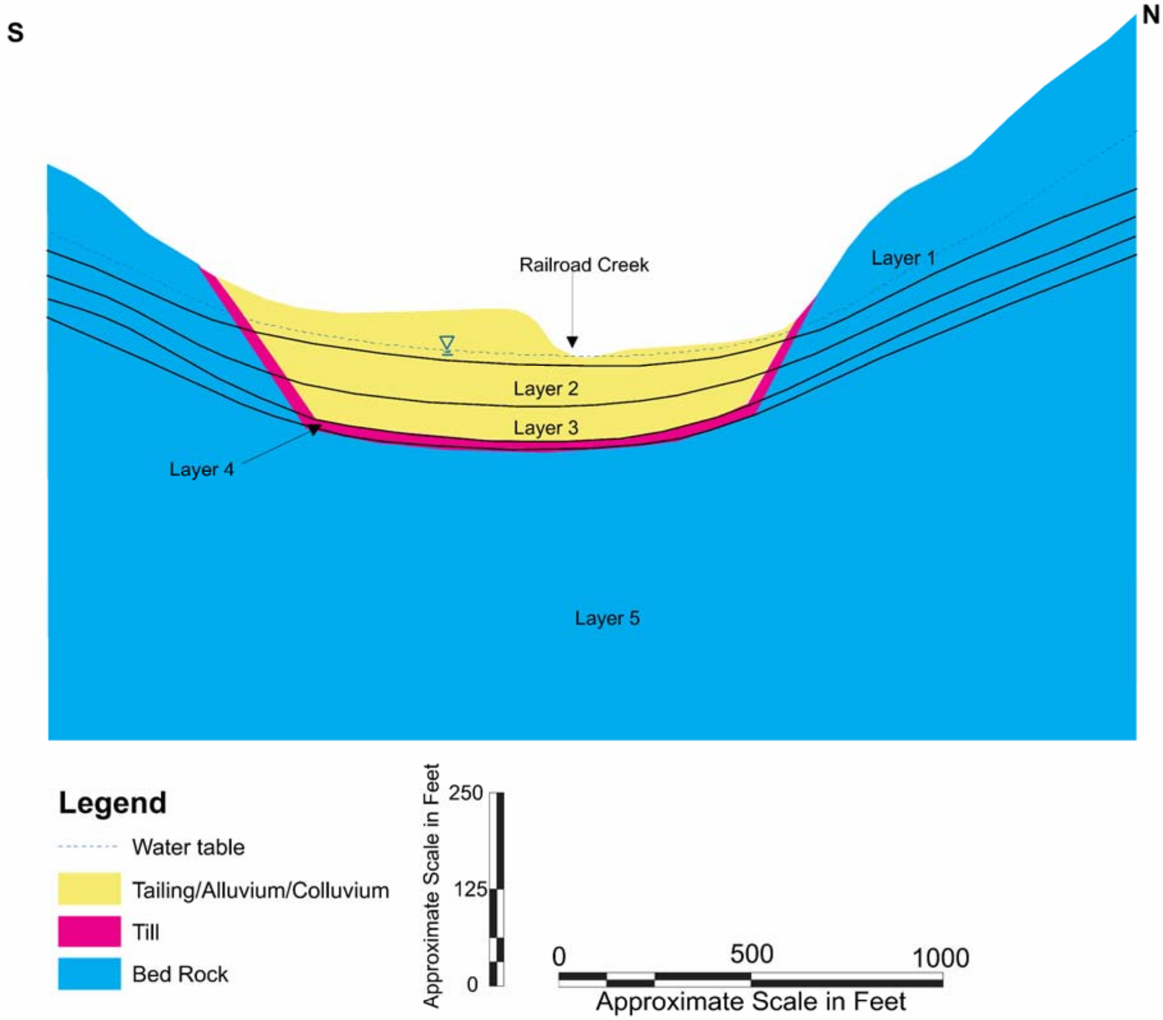
Shallow Alluvial Groundwater Elevations and Estimated Extents of Gaining/Losing Reaches of Railroad Creek - July 2008

Draft Alternative 13M Evaluation Report

Holden Mine Site, Chelan County, WA

ERM *08/09*

Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\\0069351\100\0069351100-11.dwg



Source:
Draft Hydrogeology Technical Memorandum (URS 2009)

Figure 1-8
Groundwater Flow Model Layer Schematic
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM *08/09*

CAD File:	Drawn By:	Date:	Project No.
g:\\0069351\100\0069351100-012.dwg	J. Estrada	08/13/09	0069351.10

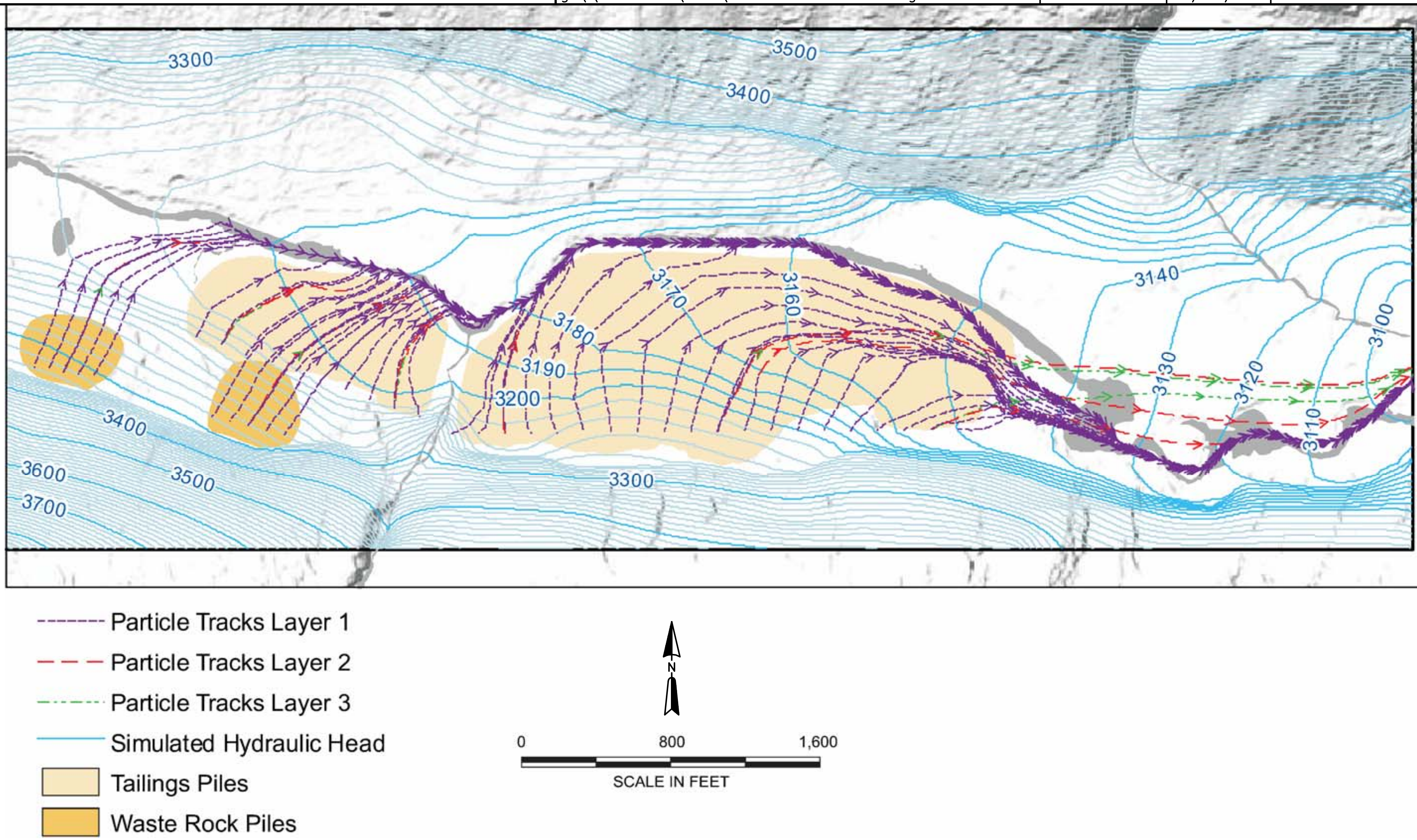


Figure 1-9

Groundwater Elevation Contours and Flow Paths
Low Flow Existing Conditions
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Source:
Draft Hydrogeology Technical Memorandum (URS 2009)

ERM *08/09*

CAD File:	Drawn By:	Date:	Project No.
g:\\0069351\100\0069351100-12.dwg	J. Estrada	08/13/09	0069351.10

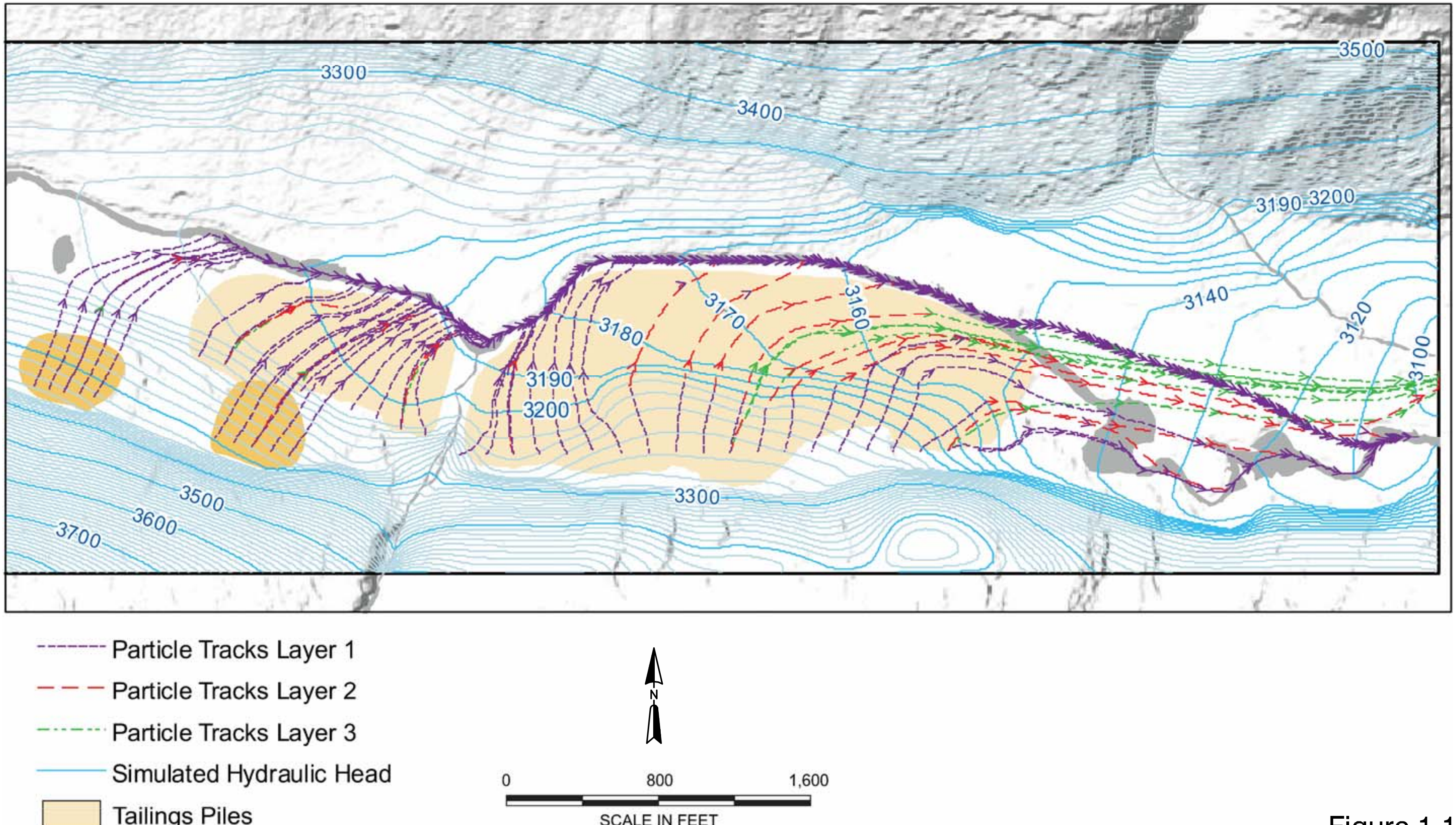


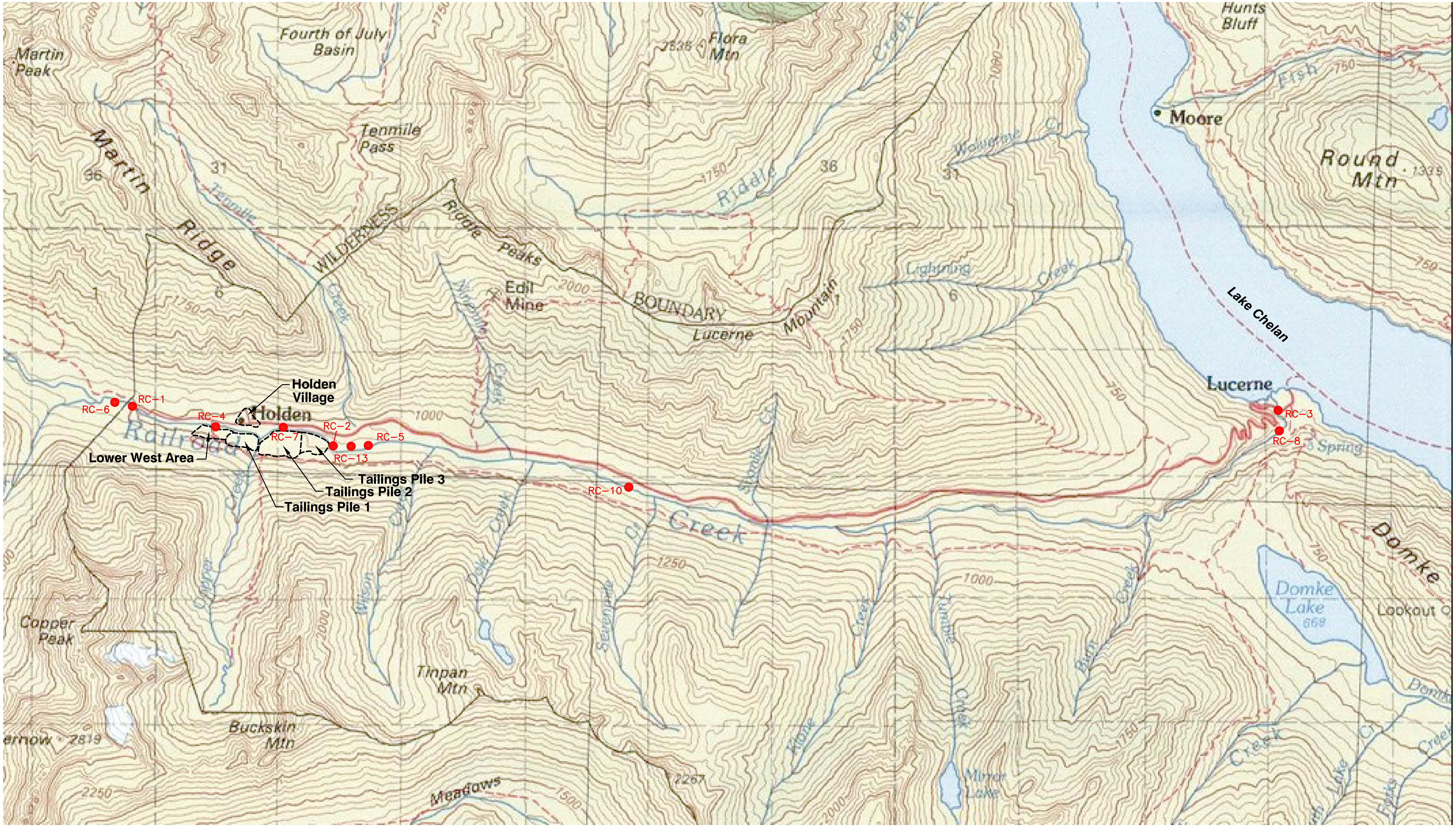
Figure 1-10

Groundwater Elevation Contours and Flow Paths
High Flow Existing Conditions
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Source:
Draft Hydrogeology Technical Memorandum (URS 2009)

ERM *08/09*

Project No. 0060351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: G:\0069351\100\0069351100-01.dwg



LEGEND

Approximate Area of Interest Boundary

Approximate Railroad Creek Surface Water Sample Location

1" = 4000'

0 2000' 4000' 8000'

N

Figure 1-11

Railroad Creek Surface Water Sample Locations
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09

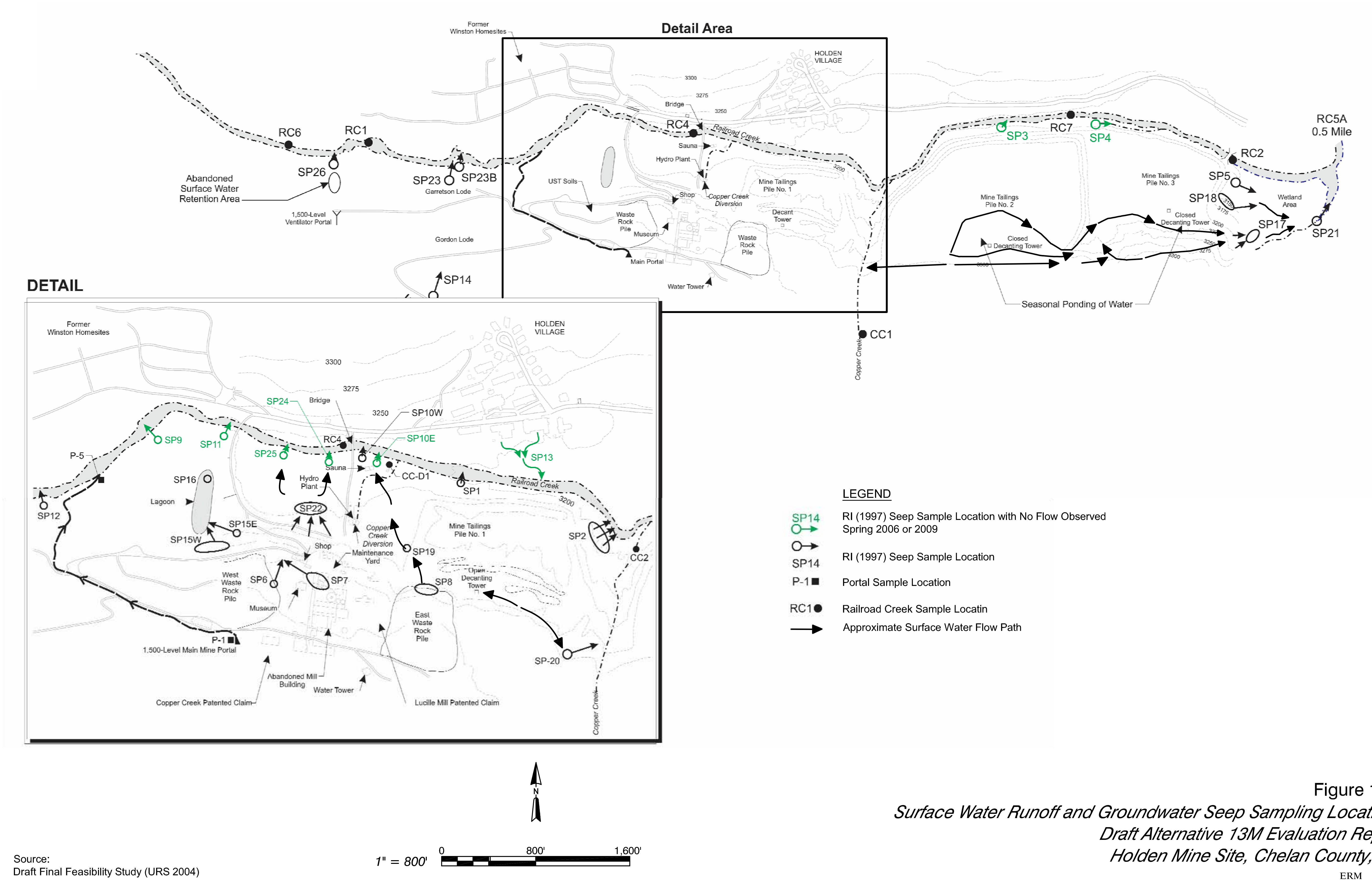


Figure 1-12

Surface Water Runoff and Groundwater Seep Sampling Locations
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09

Source:
Draft Final Feasibility Study (URS 2004)

CAD File: g:\\0069351\100\0069351100-15.dwg
Drawn By: J. Estrada
Date: 08/13/09
Project No. 0069351.100

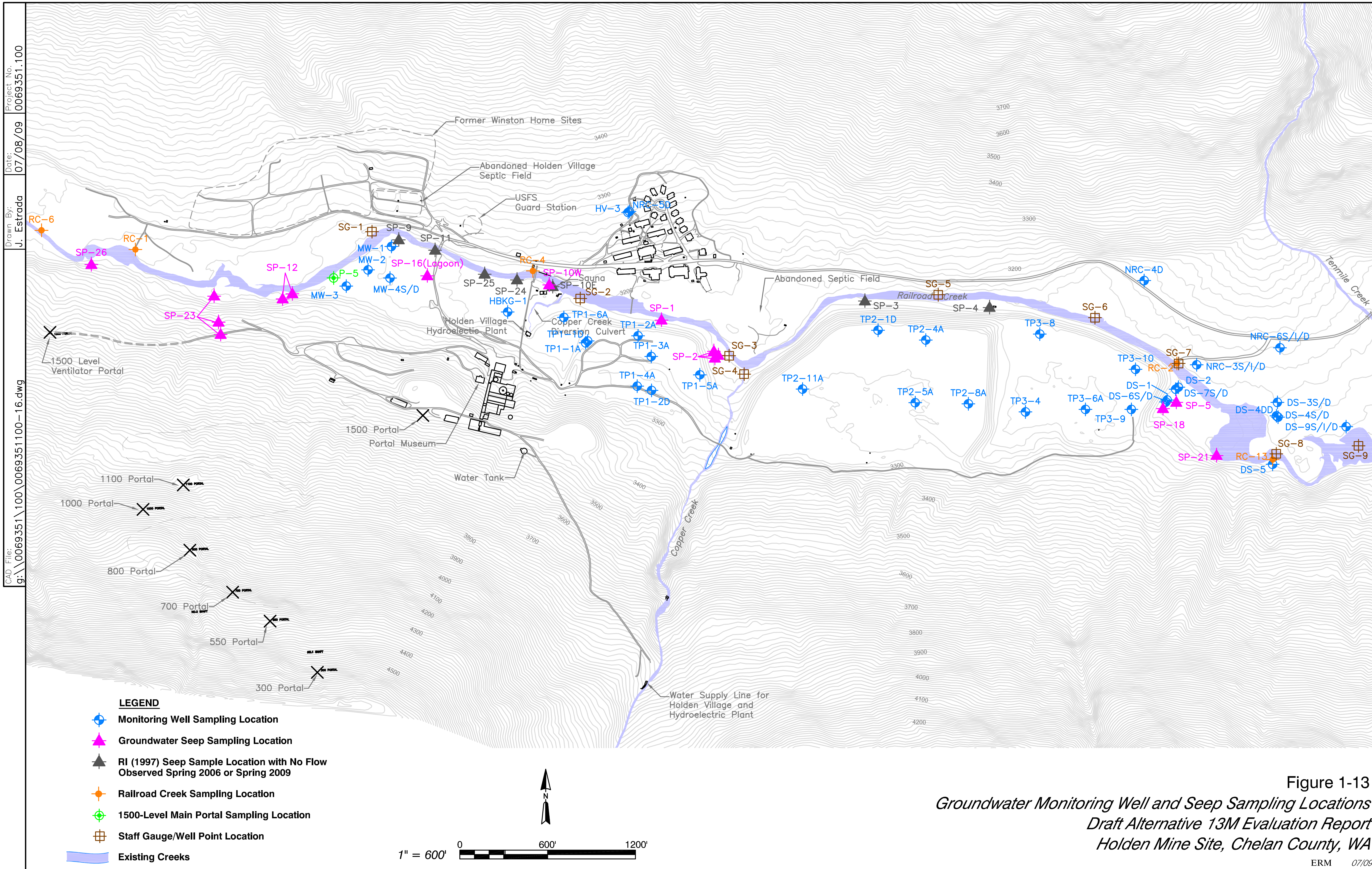


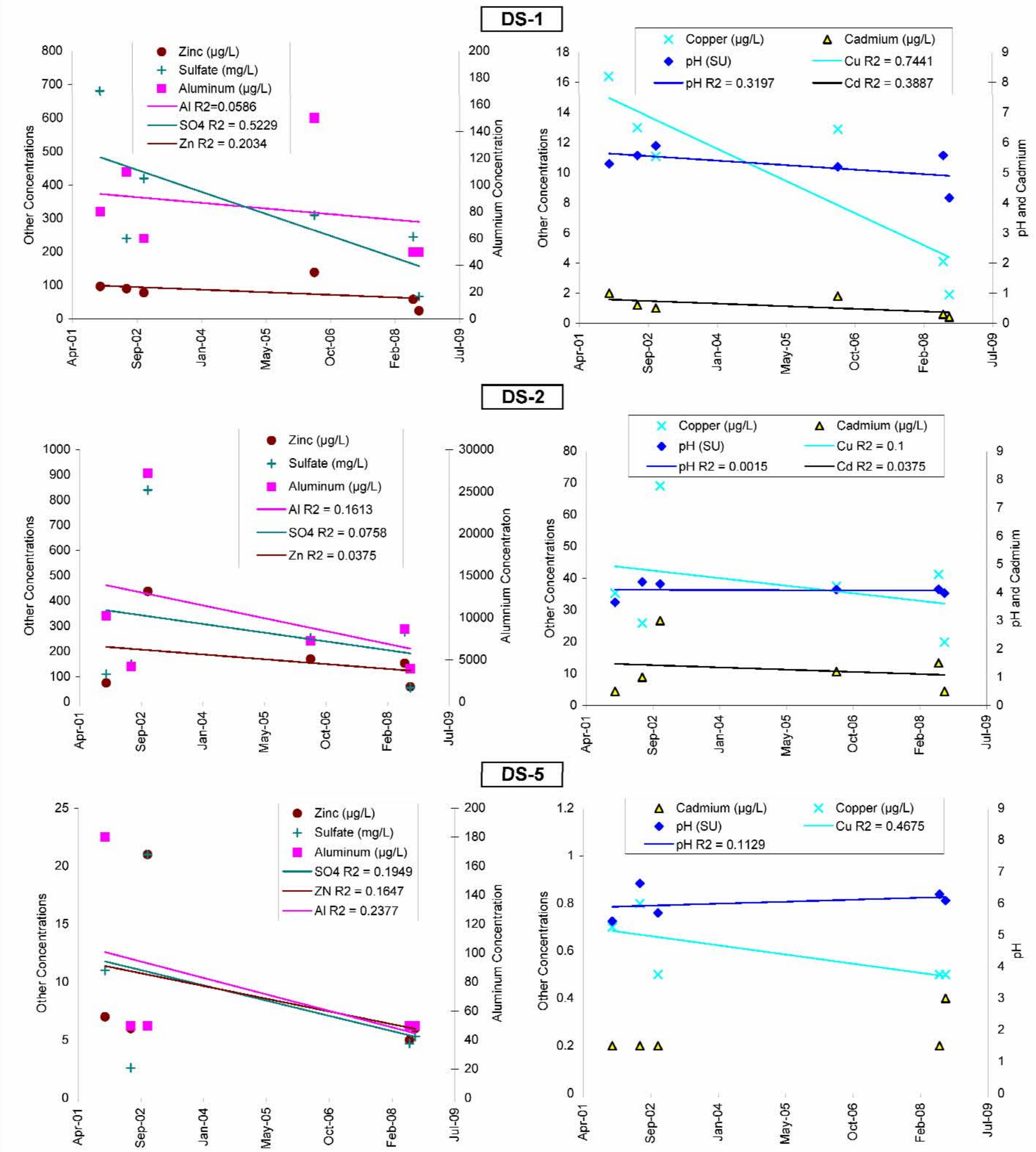
Figure 1-13

Groundwater Monitoring Well and Seep Sampling Locations

Draft Alternative 13M Evaluation Report

Holden Mine Site, Chelan County, WA

CAD File:	Drawn By:	Date:	Project No.
g:\\0069351\100\0069351100-17.dwg	J. Estrada	08/13/09	0069351.100



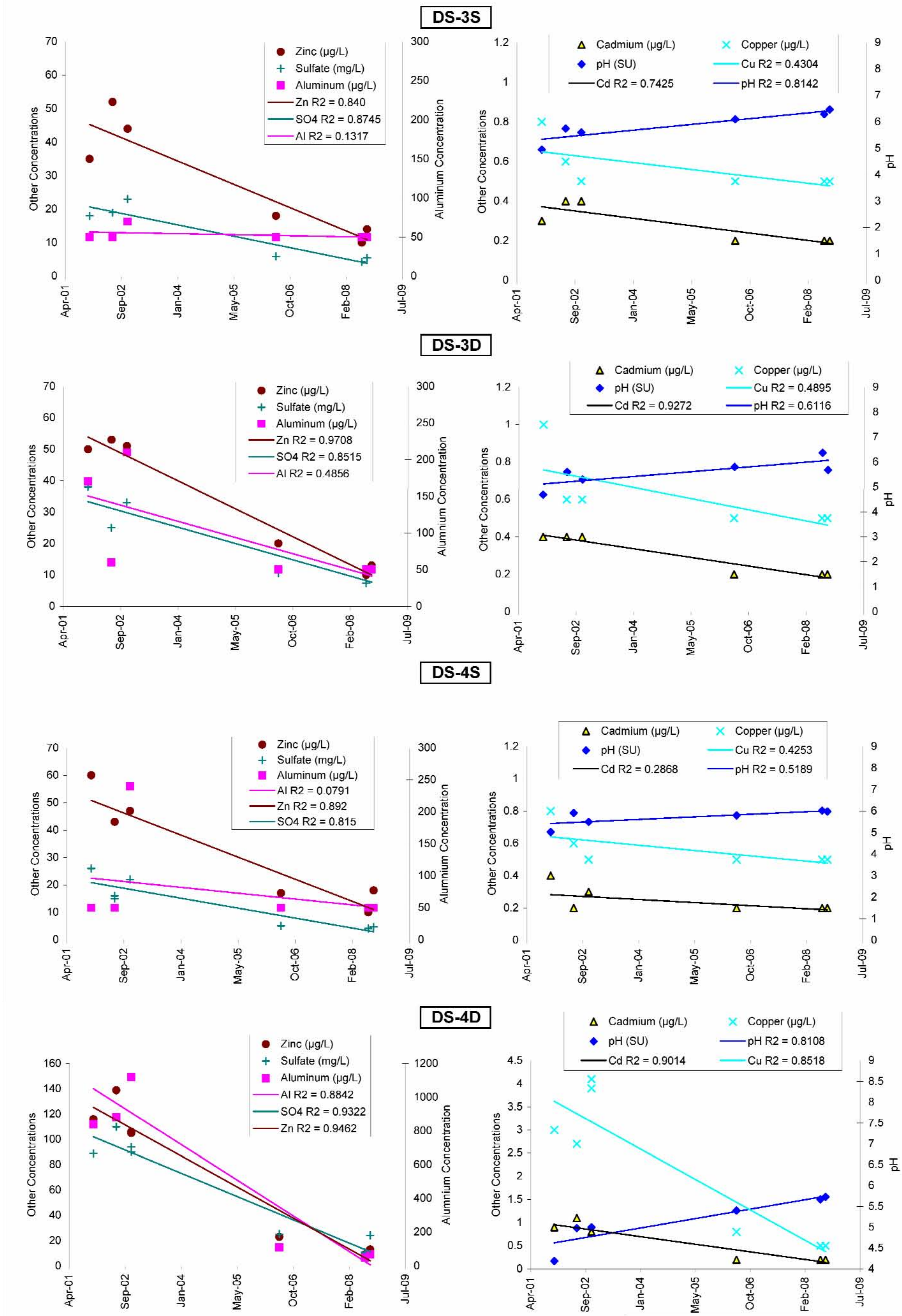
Notes:
Metals concentrations are the dissolved fraction.
Non detected analytical results are plotted at the detection limit

Figure 1-14a
Groundwater Chemistry East of Tailings Pile 3 2001-2008
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Source:
Draft Hydrogeology Technical Memorandum (URS 2009)

ERM *08/09*

CAD File:	Drawn By:	Date:	Project No.
g:\\0069351\100\0069351100-17.dwg	J. Estrada	08/13/09	0069351.100

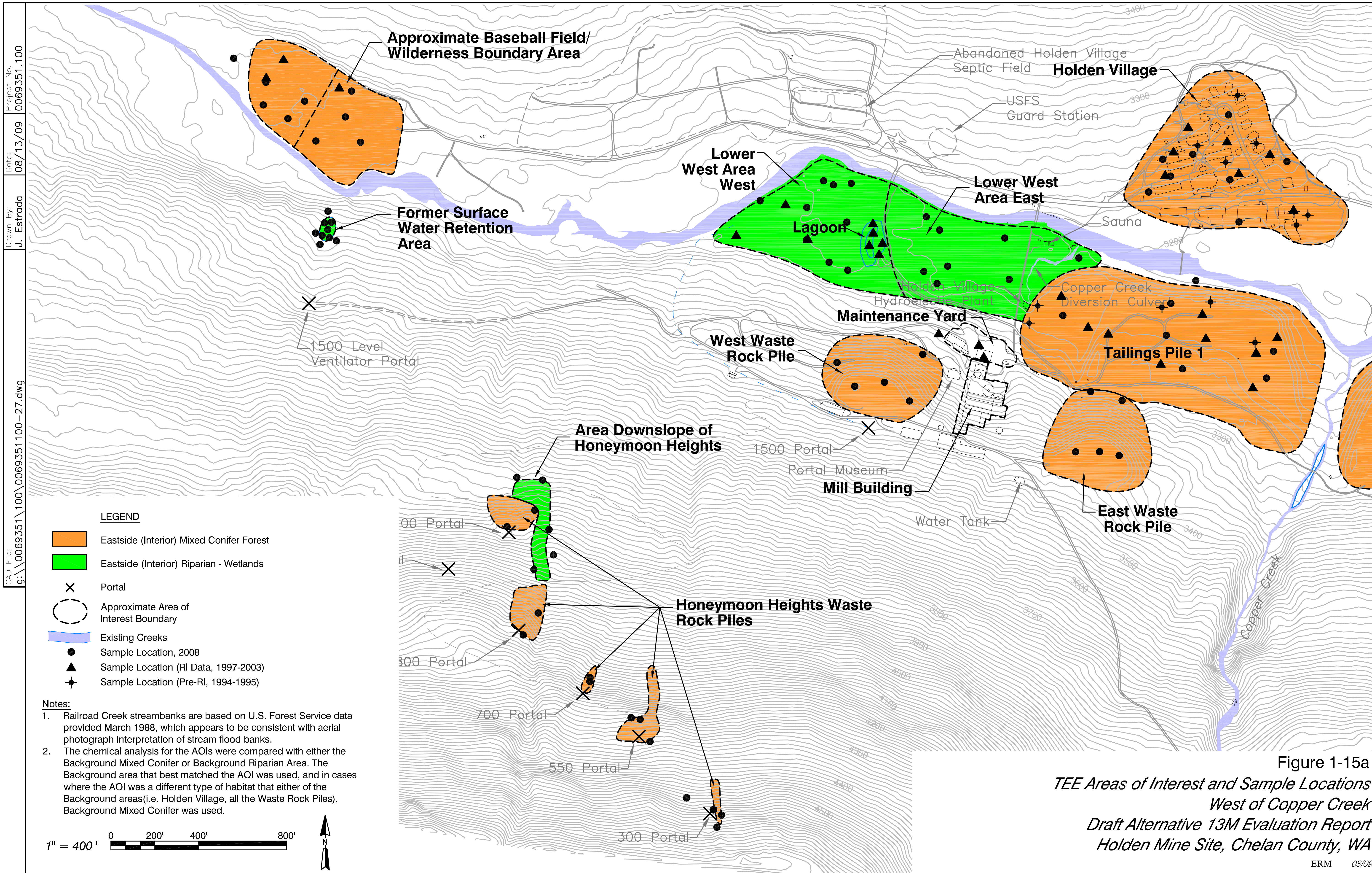


Notes:
Metals concentrations are the dissolved fraction.
Non detected analytical results are plotted at the detection limit

Figure 1-14b
Groundwater Chemistry East of Tailings Pile 3 2001-2008
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

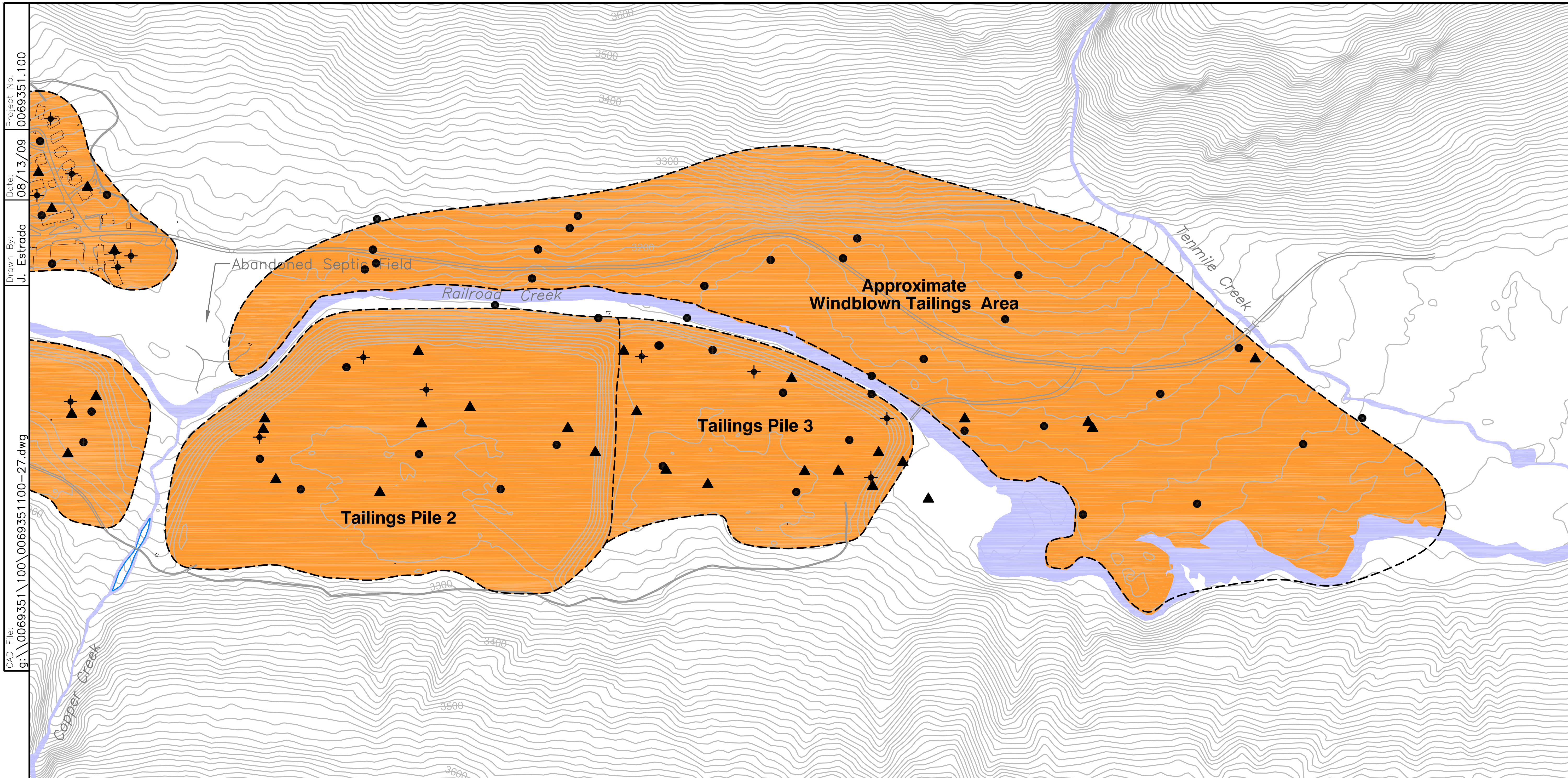
Source:
Draft Hydrogeology Technical Memorandum (URS 2009)

ERM *08/09*



Notes:
1. Railroad Creek streambanks are based on U.S. Forest Service data provided March 1988, which appears to be consistent with aerial photograph interpretation of stream flood banks.
2. The chemical analysis for the AOIs were compared with either the Background Mixed Conifer or Background Riparian Area. The Background area that best matched the AOI was used, and in cases where the AOI was a different type of habitat that either of the Background areas(i.e. Holden Village, all the Waste Rock Piles), Background Mixed Conifer was used.

Figure 1-15a
TEE Areas of Interest and Sample Locations West of Copper Creek
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA



LEGEND

- Eastside (Interior) Mixed Conifer Forest
- × Portal
- Approximate Area of Interest Boundary
- Existing Creeks
- ● Sample Location, 2008
- ▲ Sample Location (RI Data, 1997-2003)
- ✦ Sample Location (Pre-RI, 1994-1995)

Notes:

1. Railroad Creek streambanks are based on U.S. Forest Service data provided March 1988, which appears to be consistent with aerial photograph interpretation of stream flood banks.
2. The chemical analysis for the AOIs were compared with either the Background Mixed Conifer or Background Riparian Area. The Background area that best matched the AOI was used, and in cases where the AOI was a different type of habitat that either of the Background areas(i.e. Holden Village, all the Waste Rock Piles), Background Mixed Conifer was used.

1" = 400 '

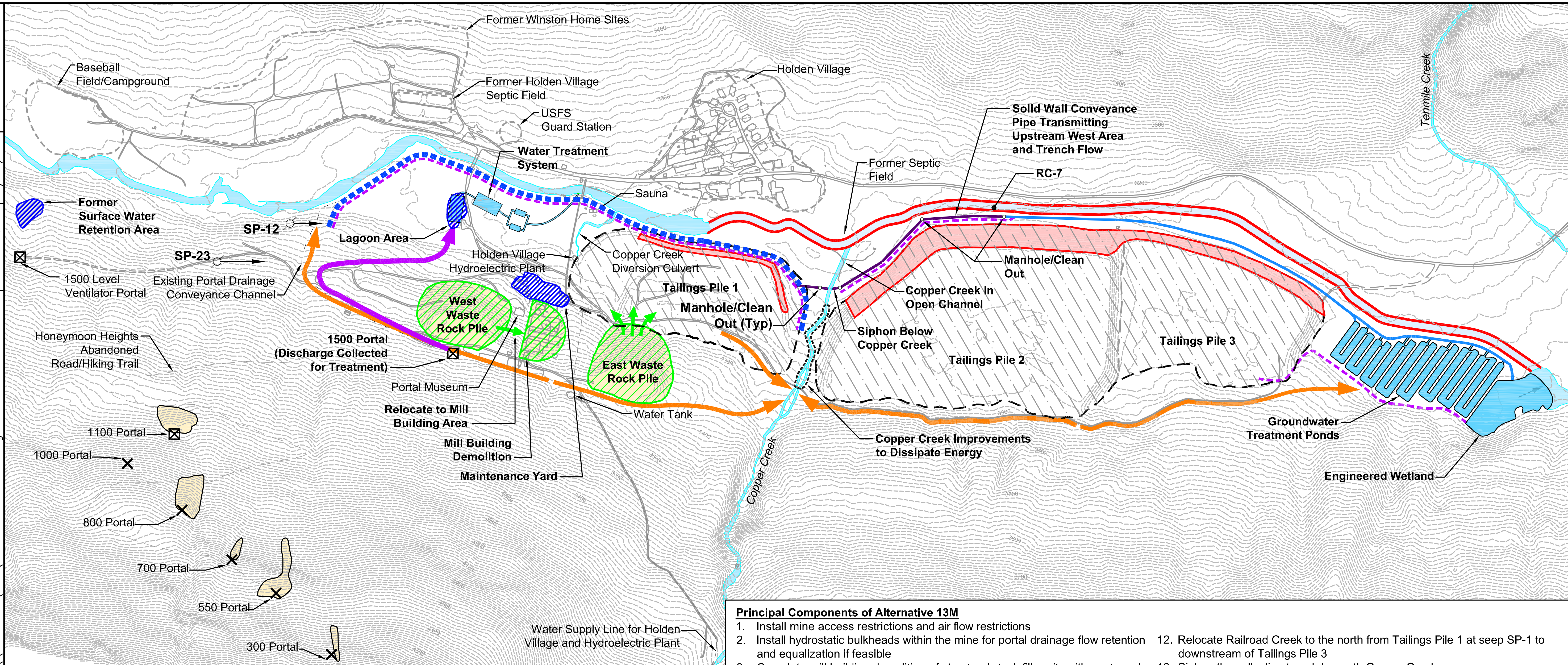
0 200' 400' 800'

N

Figure 1-15b

TEE Areas of Interest and Sample Locations
East of Copper Creek
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09



Principal Components of Alternative 13M

1. Install mine access restrictions and air flow restrictions
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 Restrictions
- 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

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.

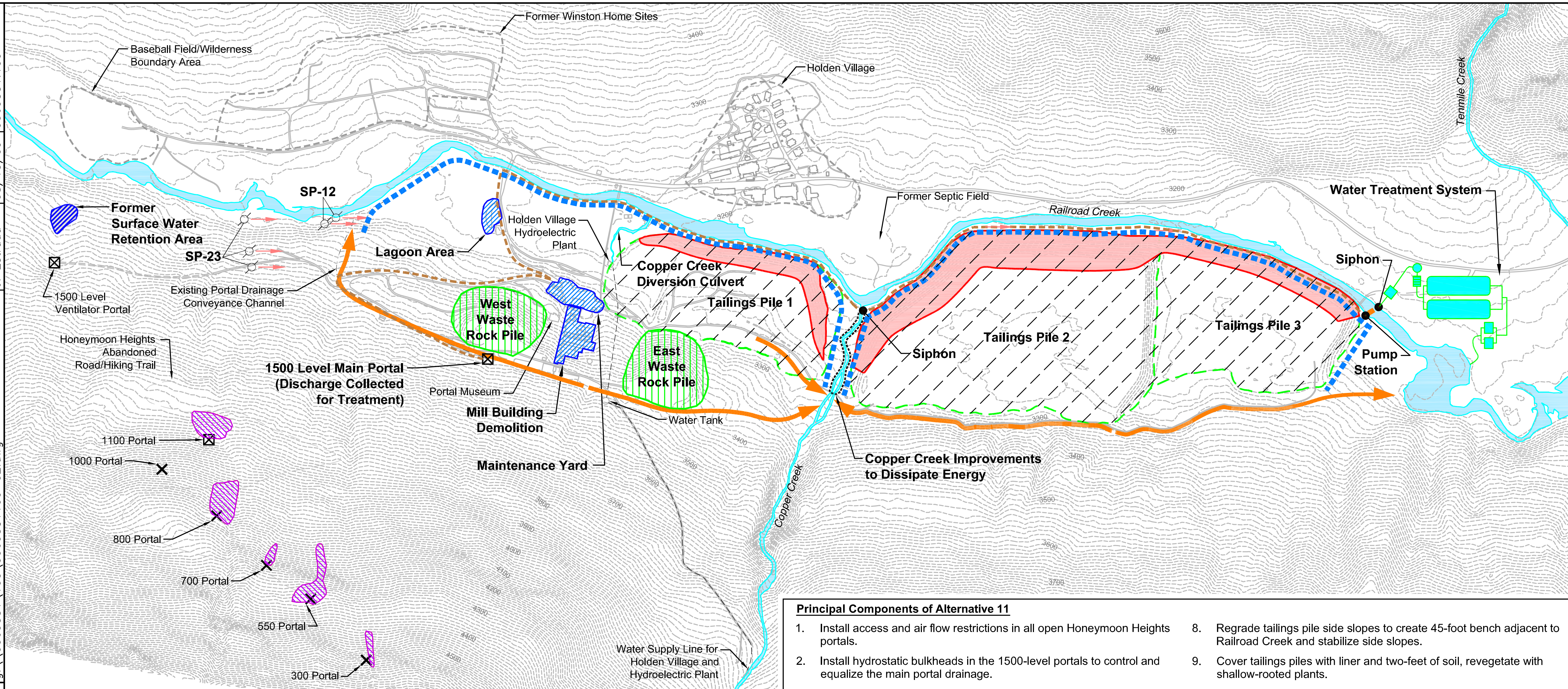
Source:
Draft Geotechnical Technical Memoradum (URS, 2009)

1" = 600'   0   600'   1,200'   N

Figure 3-1
Principal Components of Alternative 13M
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09

Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\0069351\100\0069351100-03A.dwg



Principal Components of Alternative 11

1. Install access and air flow restrictions in all open Honeymoon Heights portals.
2. Install hydrostatic bulkheads in the 1500-level portals to control and equalize the main portal drainage.
3. Relocate Honeymoon Heights waste rock piles to tailings piles.
4. Install water diversion swales upgradient of site features.
5. Demolish mill building structure.
6. Regrade and relocate portions of the east and west waste rock piles onto tailings pile 1, cover waste rock with liner and 2-feet of soil and revegetate.
7. Remove contaminated soil from the lagoon and former surface water retention area and dispose on site. Cover maintenance yard with pavement.
8. Regrade tailings pile side slopes to create 45-foot bench adjacent to Railroad Creek and stabilize side slopes.
9. Cover tailings piles with liner and two-feet of soil, revegetate with shallow-rooted plants.
10. Stabilize and improve Copper Creek channel to dissipate energy.
11. Improve rip rap armoring along south bank of Railroad Creek.
12. Discretely collect Seeps SP-23, SP-12, and the portal drainage.
13. Collect lower west area and tailings pile 1 groundwater with a fully-penetrating barrier wall/open collection trench.
14. Collect tailings piles 2 and 3 groundwater with a fully-penetrating barrier wall/open collection trench.
15. Construct a single low-energy water treatment system downstream of the site.

LEGEND

- Relocate Waste Rock Piles to Tailings Piles
- Removal or Covering of Contaminated Soils
- Regrade Tailings and Provide 45-Ft Bench at Toe
- Relocate Portions of East and West Waste Rock Piles to Tailings Piles, Regrade, and Cover with 2 Ft of soil and Geomembrane.
- Cover with 2 Ft of Soil and Geomembrane
- Upgradient Runoff Diversion Trench
- Conceptual Pipe Line Route
- Fully-Penetrating Barrier Wall and Open Collection Trench
- Portal to be Closed with Hydrostatic Bulkhead
- Portal to be Closed with Air Flow Restrictions
- SP-23 Discrete Seep Collected for Treatment Via Gravity Conveyance

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.

1" = 600' 0 600'

N

Figure 3-2

Principal Components of Alternative 11
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM *08/09*

Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\\0069351\100\0069351100-02.dwg

CAD File:	Drawn By:	Date:	Project No.
g:\\0069351\100\0069351100-21.dwg	J. Estrada	08/13/09	0069351.10

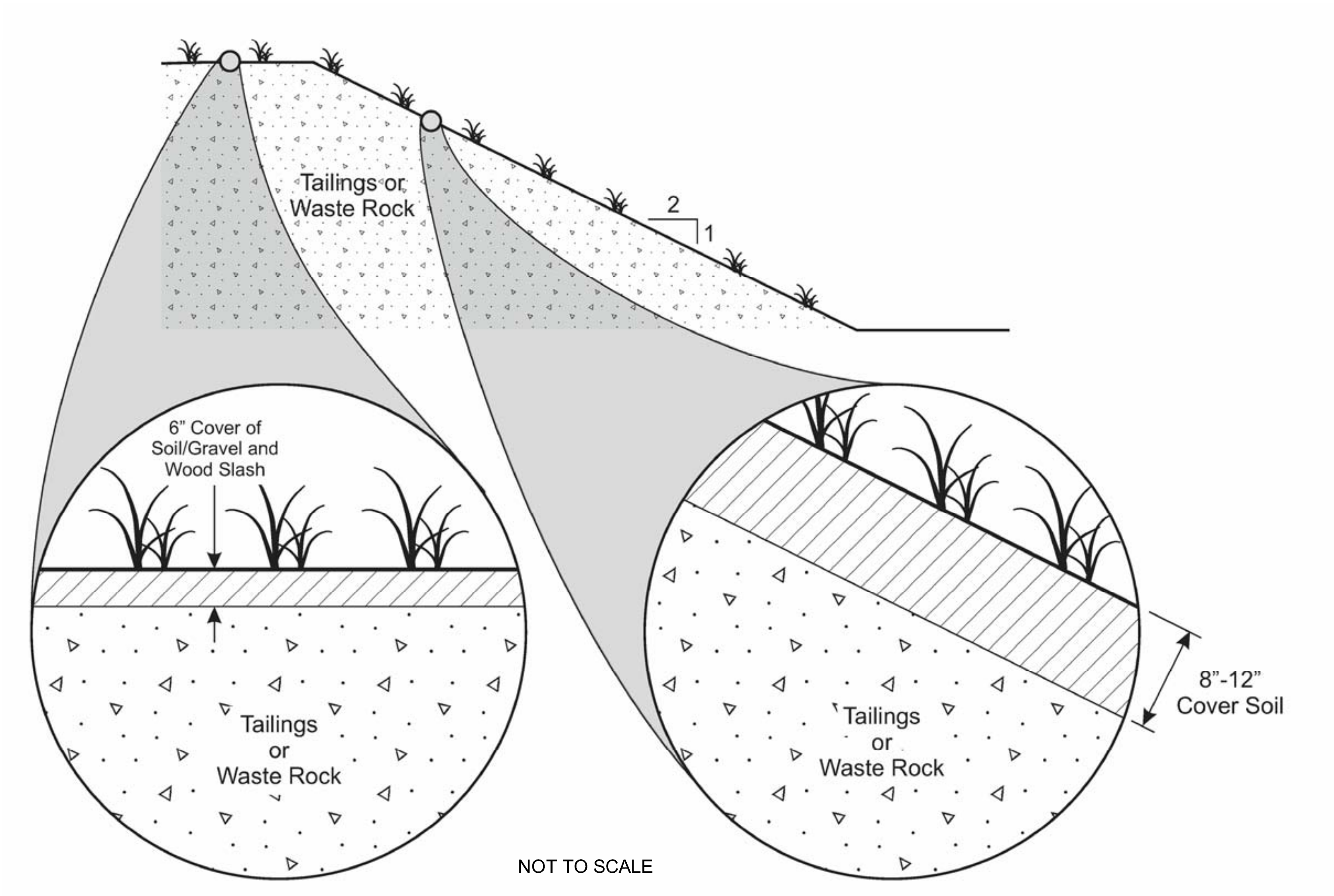


Figure 3-3

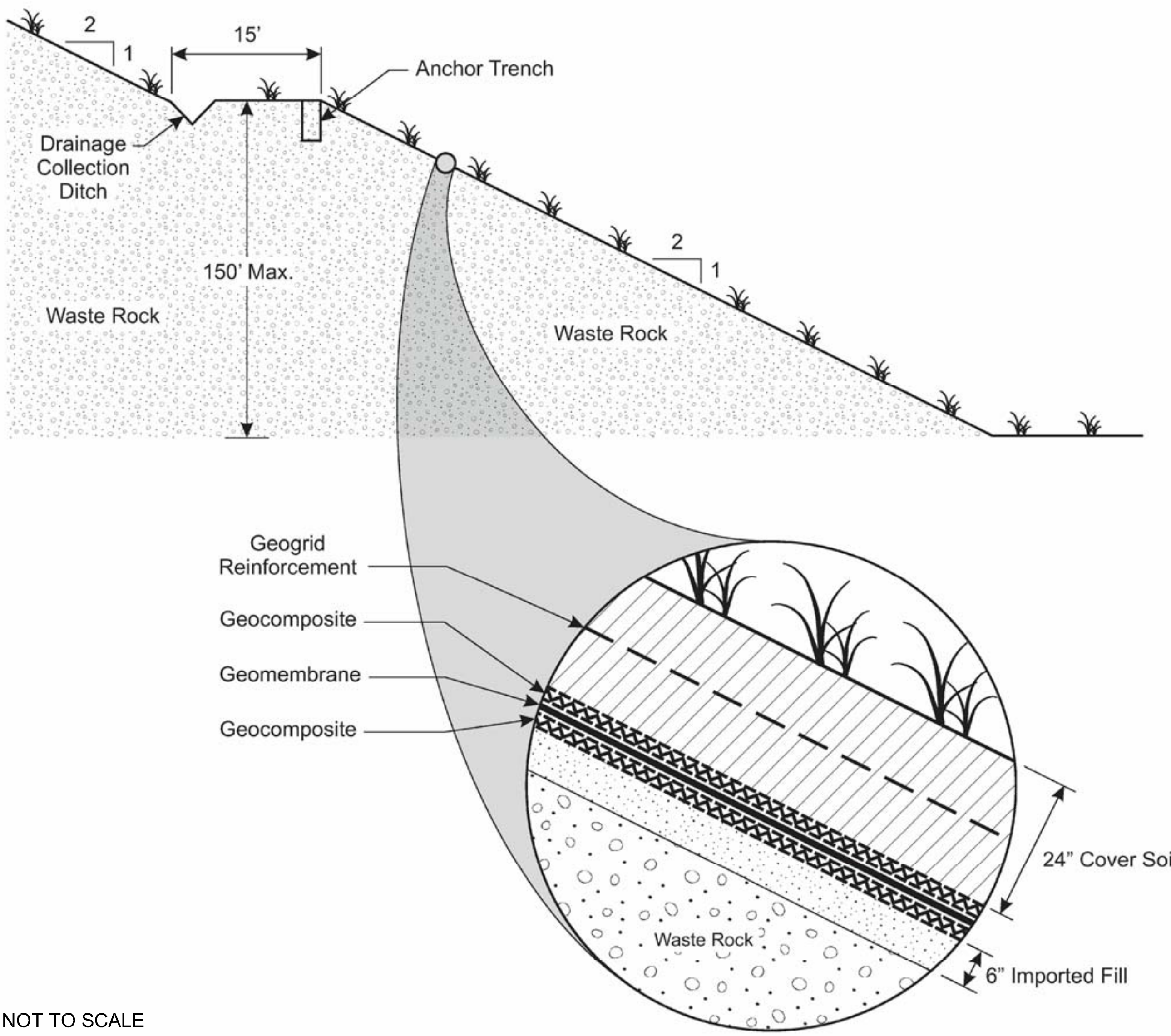
Alternative 13M - Tailings and Waste Rock Pile Cover

Draft Alternative 13M Evaluation Report

Holden Mine Site, Chelan County, WA

ERM *08/09*

Source:
Draft Geotechnical Technical Memorandum (URS 2009)

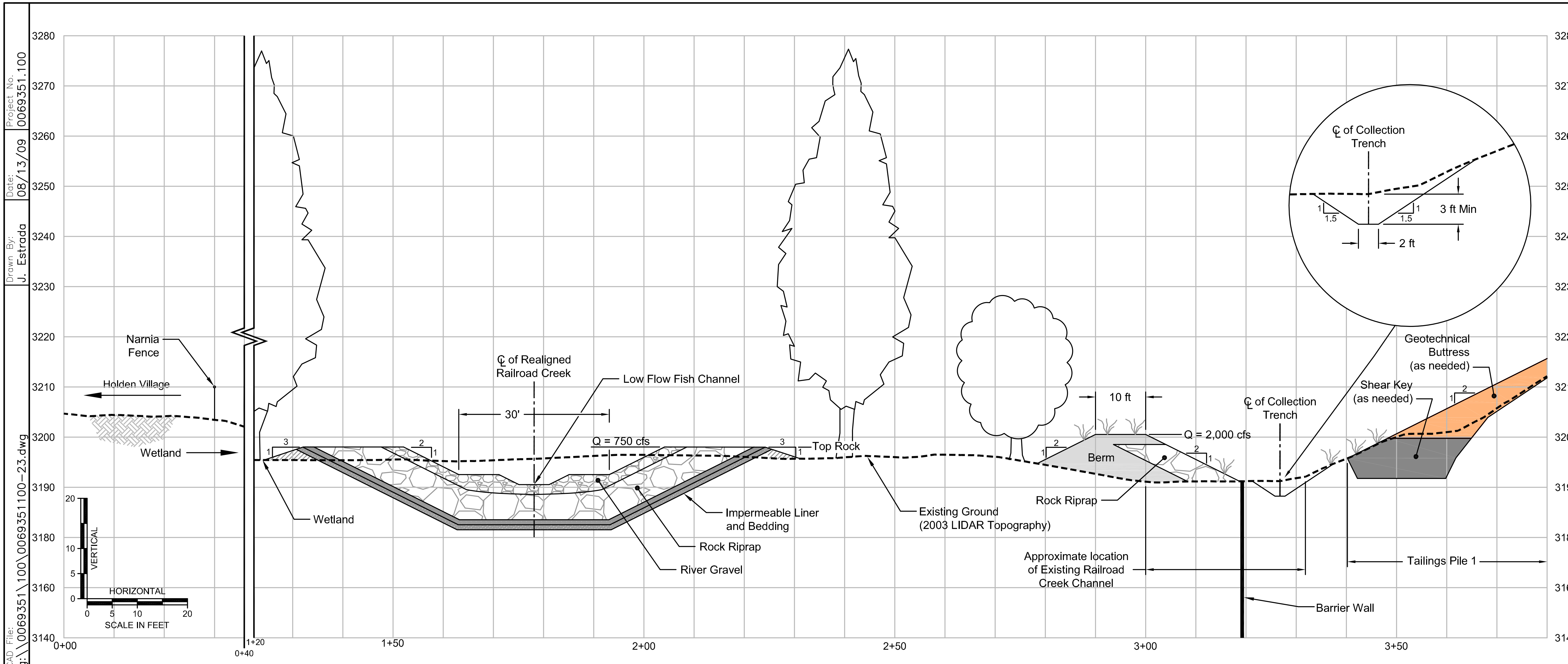


NOT TO SCALE

Source:
Draft Geotechnical Technical Memorandum (URS 2009)

Figure 3-4
Alternative 11 - Waste Rock Pile Cover
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM *08/09*



Notes:

1. Rock armoring material is approximately 4-ft minus material placed 6-ft thick.
2. Banks to be vegetated with seeding and native plantings.
3. Riffle-pool habitat to be restored within realigned channel using large woody debris, logs and/or rock drops (see detail on Figure D5-7).
4. Live stake plantings within riparian area. Species may consist of cuttings from local stock, such as willows. Typical spacing is 2 to 6 ft, depending on size of stock available.
5. Existing channel used for groundwater collection. Channel improvements, such as the construction of settling ponds/drop structures would be evaluated as part of the final design.
6. Existing trees and riparian vegetation outside of channel footprint to be preserved if possible.
7. Berm to be constructed in existing channel if possible with least impact to tress.
8. Depiction of tailings pile regrading will be updated as necessary to be consistent with Appendix C, Geotechnical Technical Memorandum when the appendices are finalized.

Legend

Q_x X - Discharge Channel Flow Elevation

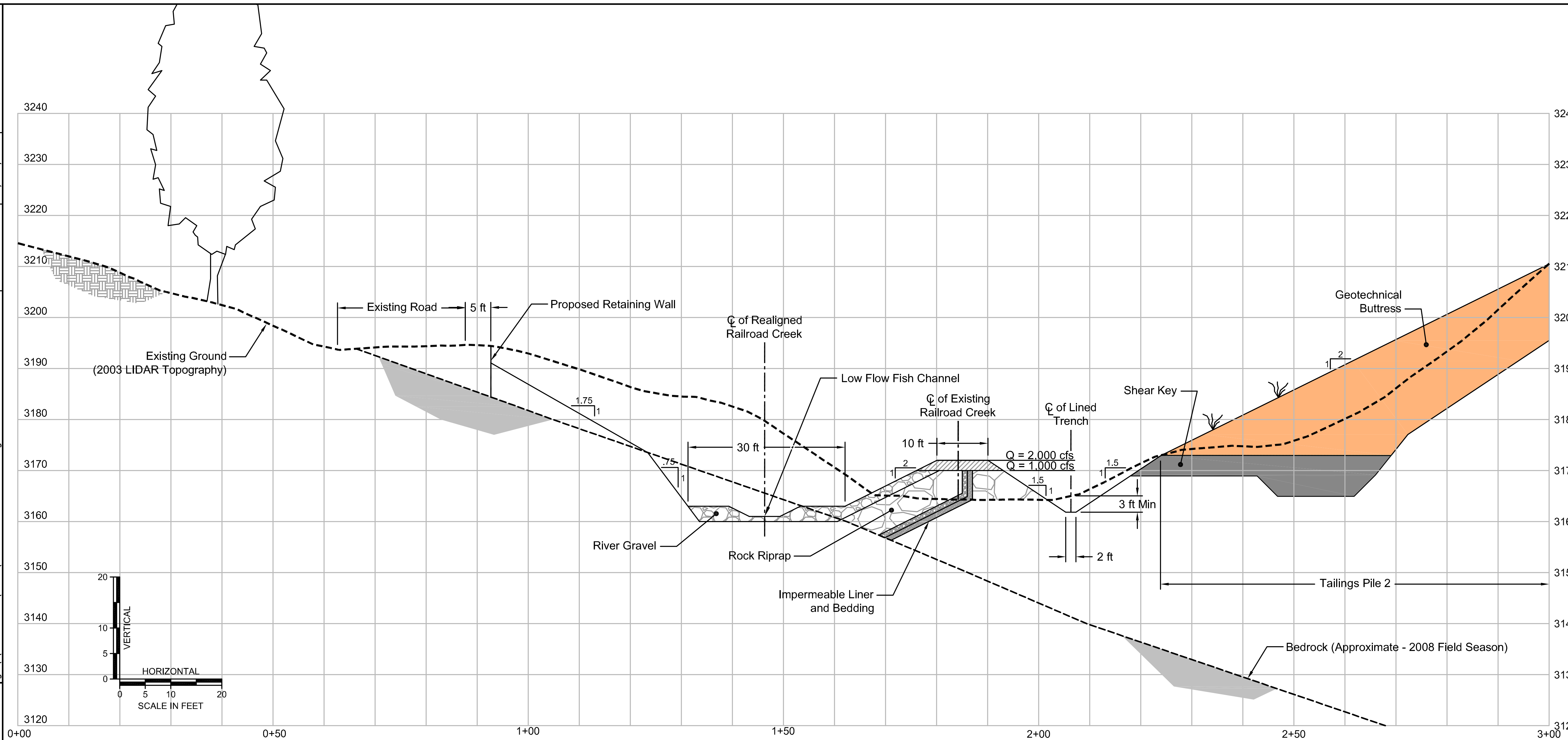
Source:
Draft Proposed Railroad Creek Realignment
Technical Memoradum (URS, 2009)

Figure 3-5

Conceptual Cross-Section for Realigned Railroad Creek at Tailings Pile 1
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09

Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\\0069351\100\0069351100-24.dwg



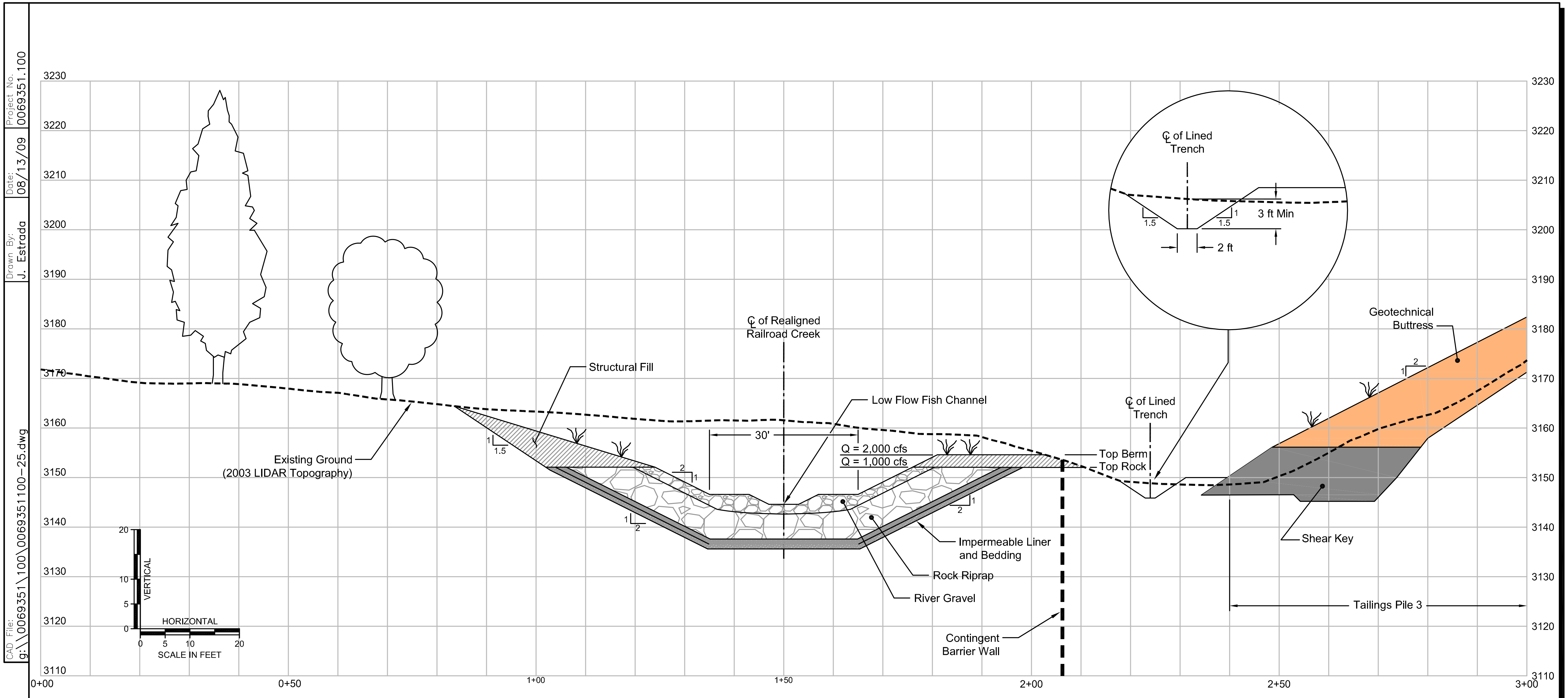
Notes:
1. Rock armoring material is approximately 4-ft minus material placed 6-ft thick.
2. Banks to be vegetated with seeding and native plantings.
3. Riffle-pool habitat to be restored within realigned channel using large woody debris, logs and/or rock drops (see detail on Figure D5-7).
4. Live stake plantings within riparian area. Species may consist of cuttings from local stock, such as willows. Typical spacing is 2 to 6 ft, depending on size of stock available.
5. Existing channel used for groundwater collection. Channel improvements, such as the construction of settling ponds/drop structures would be evaluated as part of the final design.
6. Existing trees and riparian vegetation outside of channel footprint to be preserved if possible.
7. Liner may be extended to cover bedrock based on inspection at time of construction.
8. Slope of cut in bedrock to be determined during final design or at time of construction.
9. Depiction of tailings pile regrading will be updated as necessary to be consistent with Appendix C, Geotechnical Technical Memorandum when the appendices are finalized.

Source:
Draft Proposed Railroad Creek Realignment
Technical Memoradum (URS, 2009)

Legend
X - Discharge Channel Flow Elevation Q_x

Figure 3-6
Conceptual Cross-Section for Realigned Railroad Creek at Tailings Pile 2
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09



Notes:

1. Rock armoring material is approximately 4-ft minus material placed 6-ft thick.
2. Banks to be vegetated with seeding and native plantings.
3. Riffle-pool habitat to be restored within realigned channel using large woody debris, logs and/or rock drops (see detail on Figure D5-7).
4. Live stake plantings within riparian area. Species may consist of cuttings from local stock, such as willows. Typical spacing is 2 to 6 ft, depending on size of stock available.
5. Existing channel used for groundwater collection. Channel improvements, such as the construction of settling ponds/drop structures would be evaluated as part of the final design.
6. Existing trees and riparian vegetation outside of channel footprint to be preserved if possible.
7. Depiction of tailings pile regrading will be updated as necessary to be consistent with Appendix C, Geotechnical Technical Memorandum when the appendices are finalized.
8. Construction of contingent barrier wall will require reconstruction of the collection trench since the contingent wall construction would require a temporary platform.

Legend

Q_x X - Discharge Channel Flow Elevation

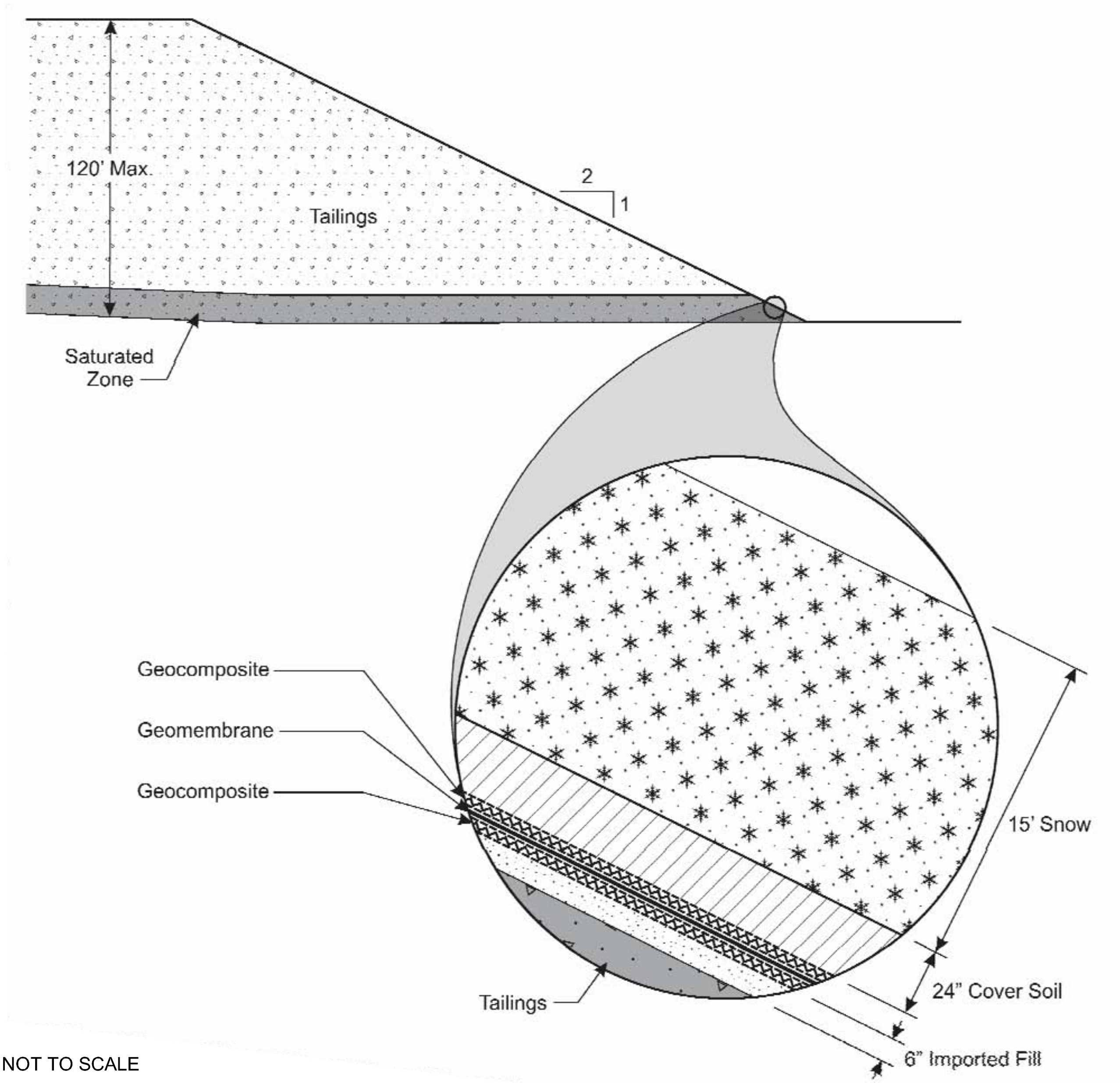
Source:
Draft Proposed Railroad Creek Realignment
Technical Memoradum (URS, 2009)

Figure 3-7

Conceptual Cross-Section for Realigned Railroad Creek at Tailings Pile 3
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM *08/09*

Project No.
0069351.100
Date:
08/13/09
Drawn By:
J. Estrada
CAD File:
g:\\0069351\100\0069351100-21.dwg



NOT TO SCALE

Source:
Draft Geotechnical Technical Memorandum (URS 2009)

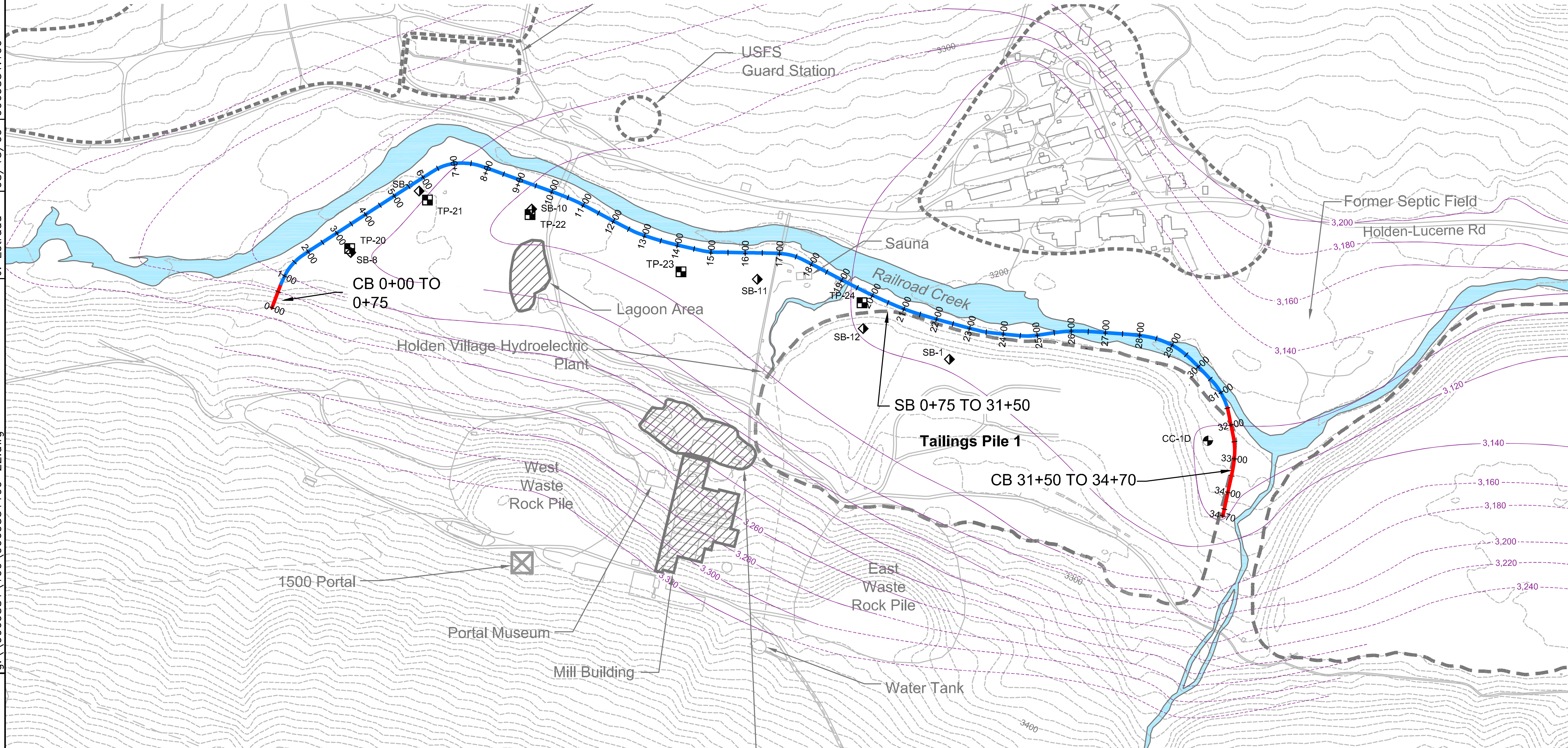
Figure 3-8
Alternative 11 Tailings Pile Cover, Wet Conditions with Snow Load
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Project No. 0069351.100

Date: 08/13/09

Drawn By: J. Estrada

CAD File: g:\\0069351\100\0069351100-22.dwg



LEGEND

- Barrier Wall, Cement Bentonite (CB) Construction
- Barrier Wall, Soil Bentonite (SB) Construction
- Bedrock Contour, (ft MSL), (Dashed where Inferred)
- Ground Surface Contour, (ft MSL), 10-foot Interval

N

1" = 300'

0 300' 600'

Source:
Draft Geotechnical Technical Memorandum (URS 2009)

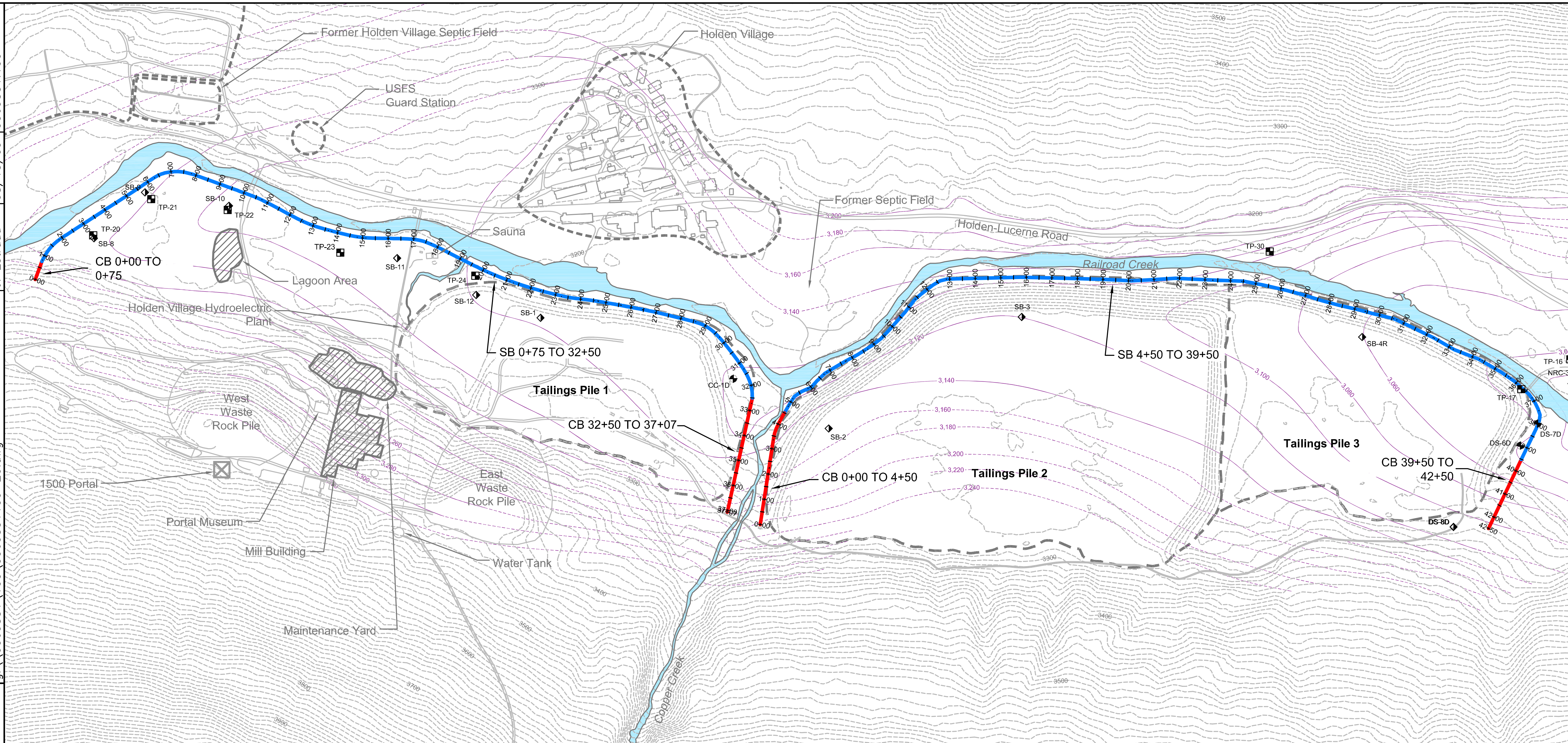
Figure 3-9

Alternative 13M Barrier Wall

Draft Alternative 13M Evaluation Report

Holden Mine Site, Chelan County, WA

ERM *08/09*



LEGEND

- Barrier Wall, Cement Bentonite (CB) Construction
- Barrier Wall, Soil Bentonite (SB) Construction
- 3140 Bedrock Contour, (ft MSL), (Dashed where Inferred)
- Ground Surface Contour, (ft MSL), 10-foot Interval

N

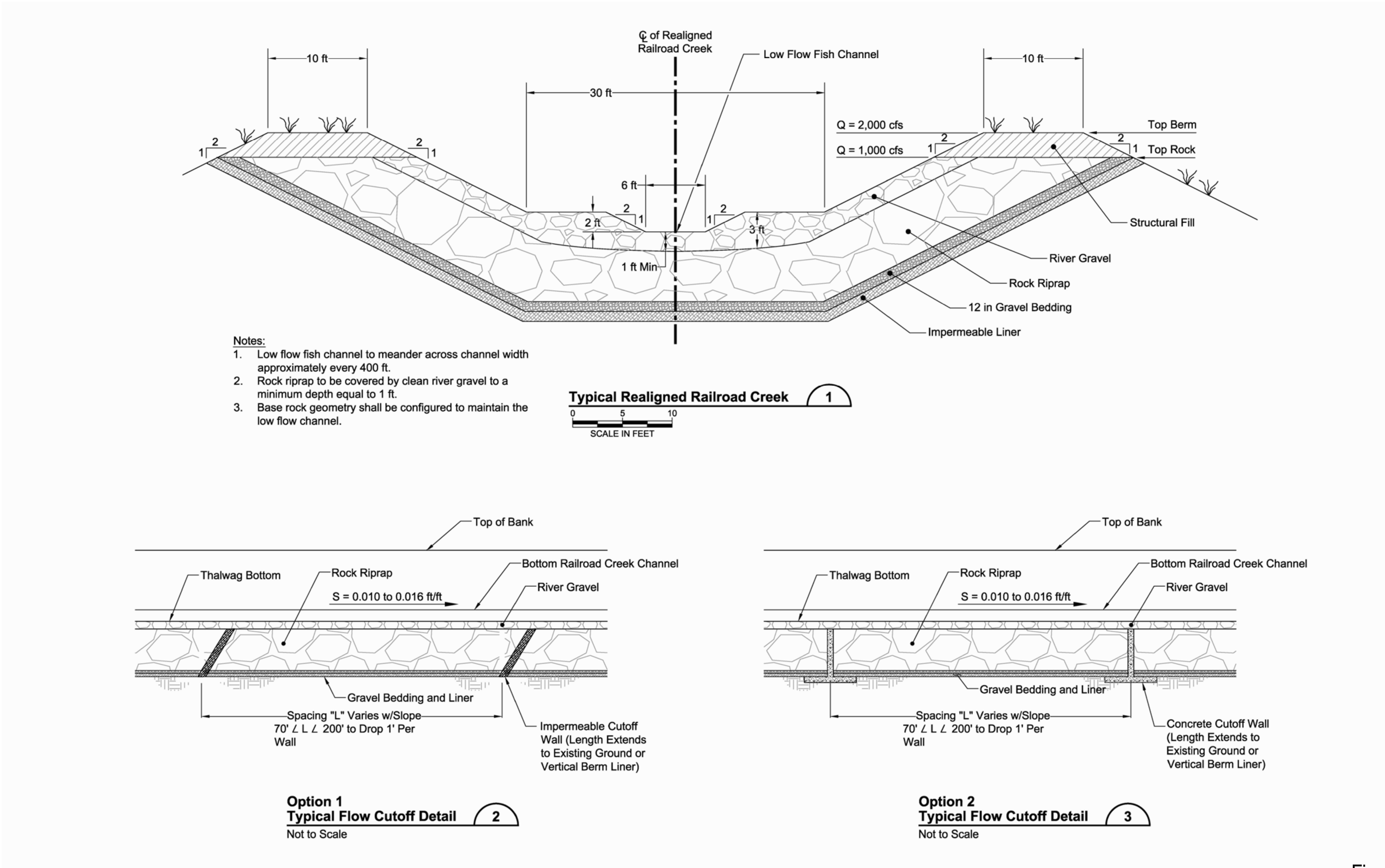
1" = 400' 0 400' 800'

Source:
Draft Geotechnical Technical Memorandum (URS 2009)

Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\\0069351\100\0069351100-20.dwg

Figure 3-10
Alternative 11 Barrier Walls
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09



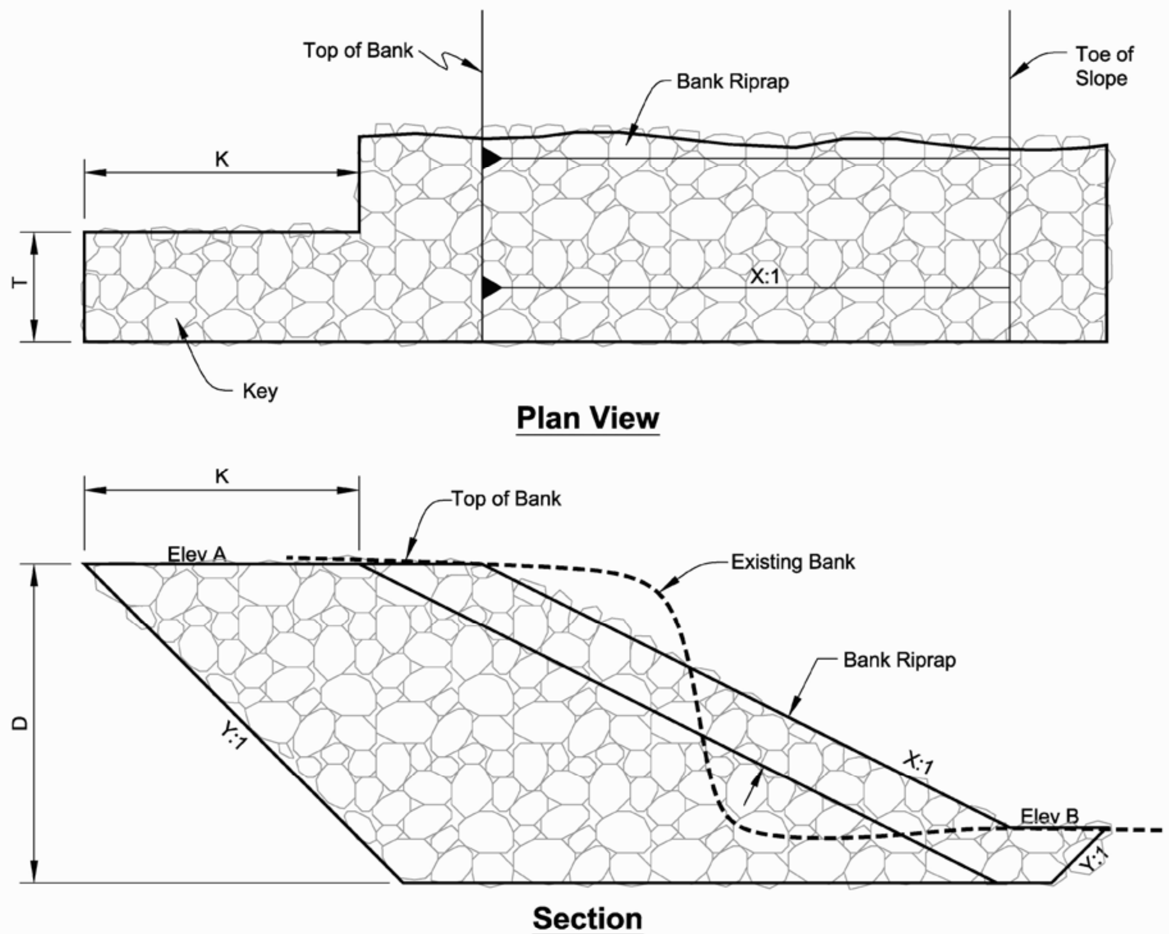
Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\\0069351\100\0069351100-04.dwg

Source:
Draft Proposed Railroad Creek Realignment Technical Memoradum (URS, 2009)

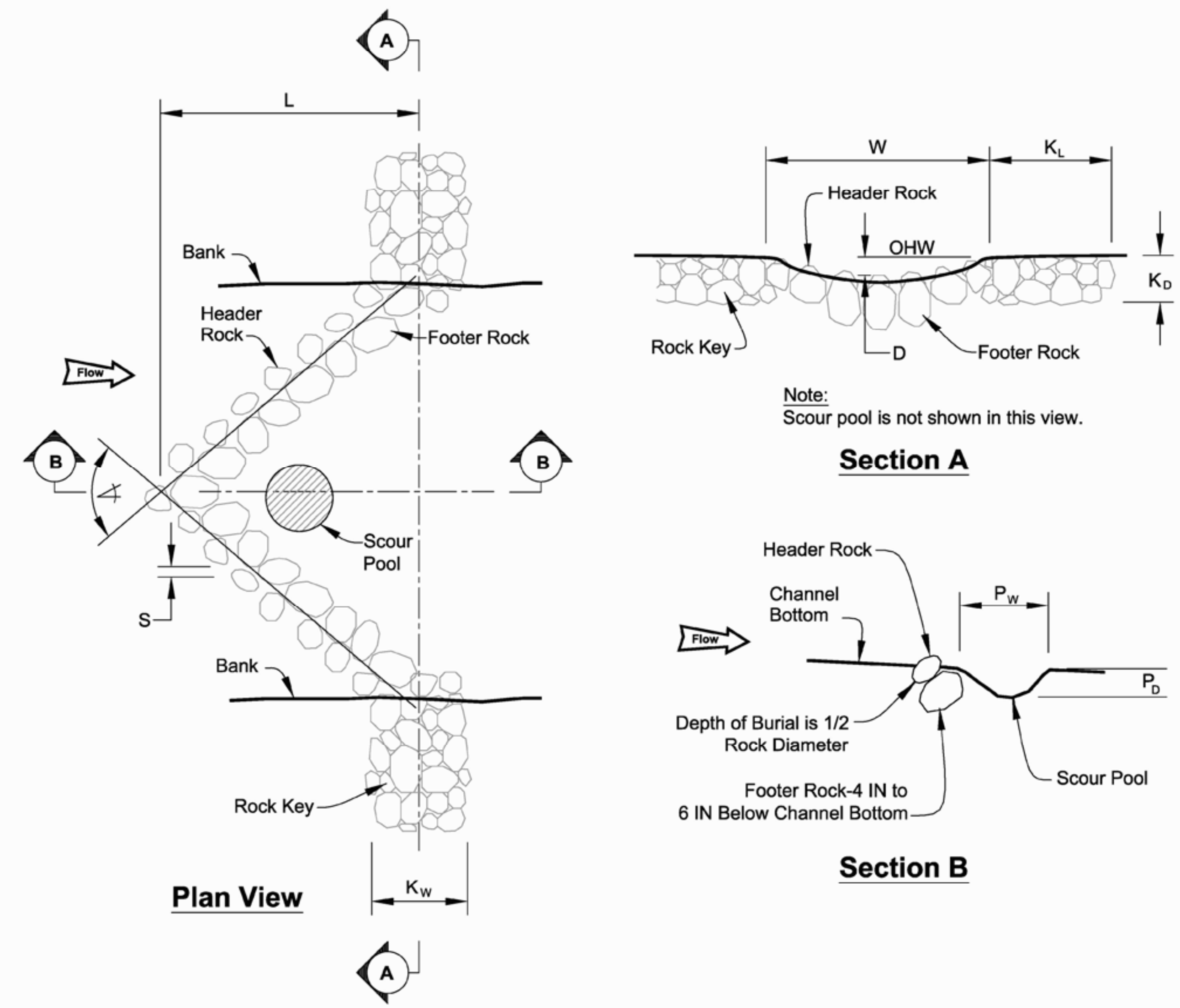
Figure 3-11
Realigned Railroad Creek Liner Details
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09/

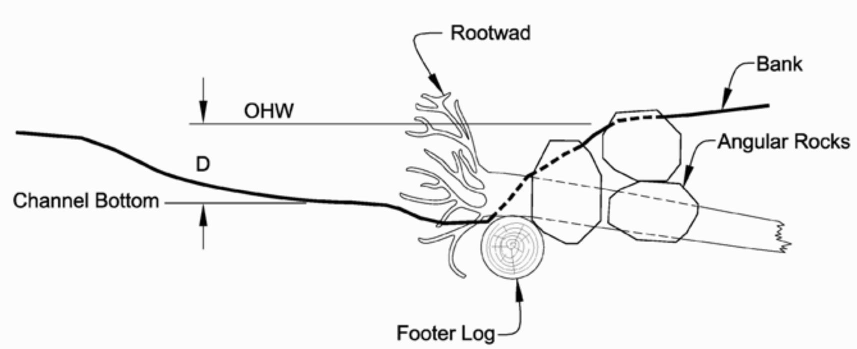
Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\\0069351\100\0069351100-04.dwg



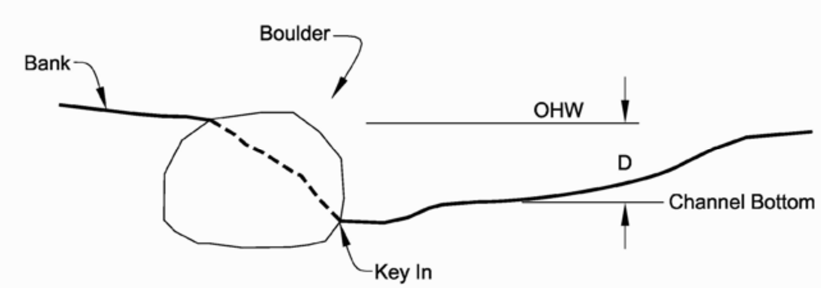
Rock Riprap Key 1
Not to Scale



Angled Vortex Rock Weir 2
Not to Scale



Habitat Rootwad 3
Not to Scale



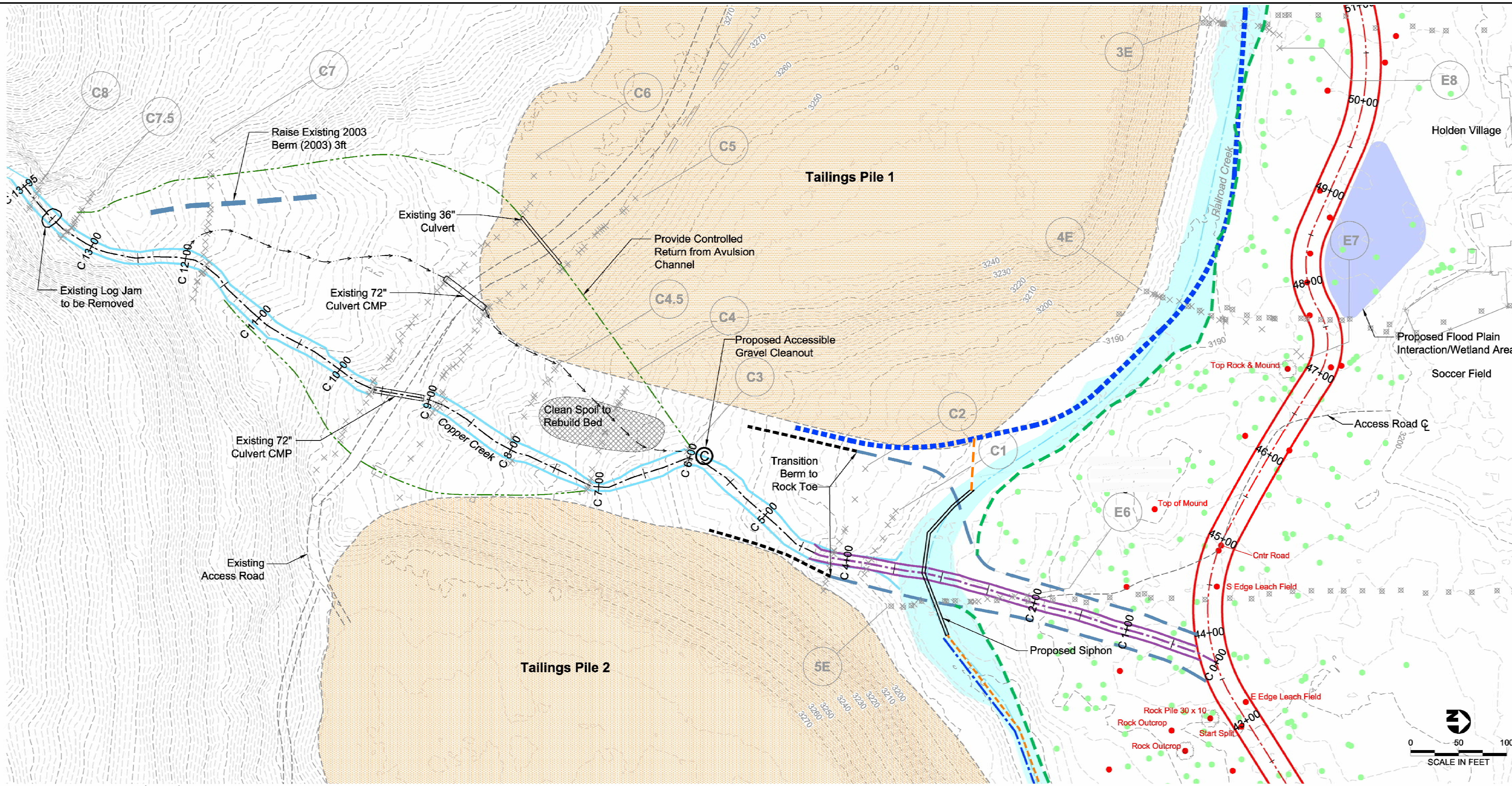
Habitat Boulder 4
Not to Scale

Note:
Dimensions for habitat features will be provided at final design.

Source:
Draft Proposed Railroad Creek Realignment
Technical Memoradum (URS, 2009)

Figure 3-12
Realigned Railroad Creek Habitat Details
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09



Legend

- Existing Railroad Creek Channel Based on 2003 Lidar Data
- Existing Copper Creek Channel Based on Surveyed Transects
- 2ft LIDAR Topography, 2003
- 2003 Overflow Channel
- Historical Avulsion Channel
- Trees Greater than 20 Inches DBH
- Other GPS Points
- 2003 Erlandsen Transect Survey Point
- 2008 Erlandsen Transect Survey Point
- C# Copper Creek Transect
- E# Railroad Creek Transect
- Proposed Realigned Railroad Creek Channel Bottom
- Proposed Extended Copper Creek Channel Bottom
- Proposed Rock Toe
- Proposed Berm to Q=350 cfs WSEL
- Proposed Berm to Q=2000 cfs WSEL
- Proposed Surface Water Collection Trench in Existing Channel
- Proposed Solid Wall Conveyance Pipe
- Proposed Fully-Penetrating Barrier Wall and Open Collection Trench

Source:
Draft Proposed Railroad Creek Realignment
Technical Memoradum (URS, 2009)

Figure 3-13

Conceptual Copper Creek Improvements
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09

Project No. 0069351.100
Date: 08/13/09
Drawn By: J. Estrada
CAD File: g:\0069351\100\0069351100-04.dwg

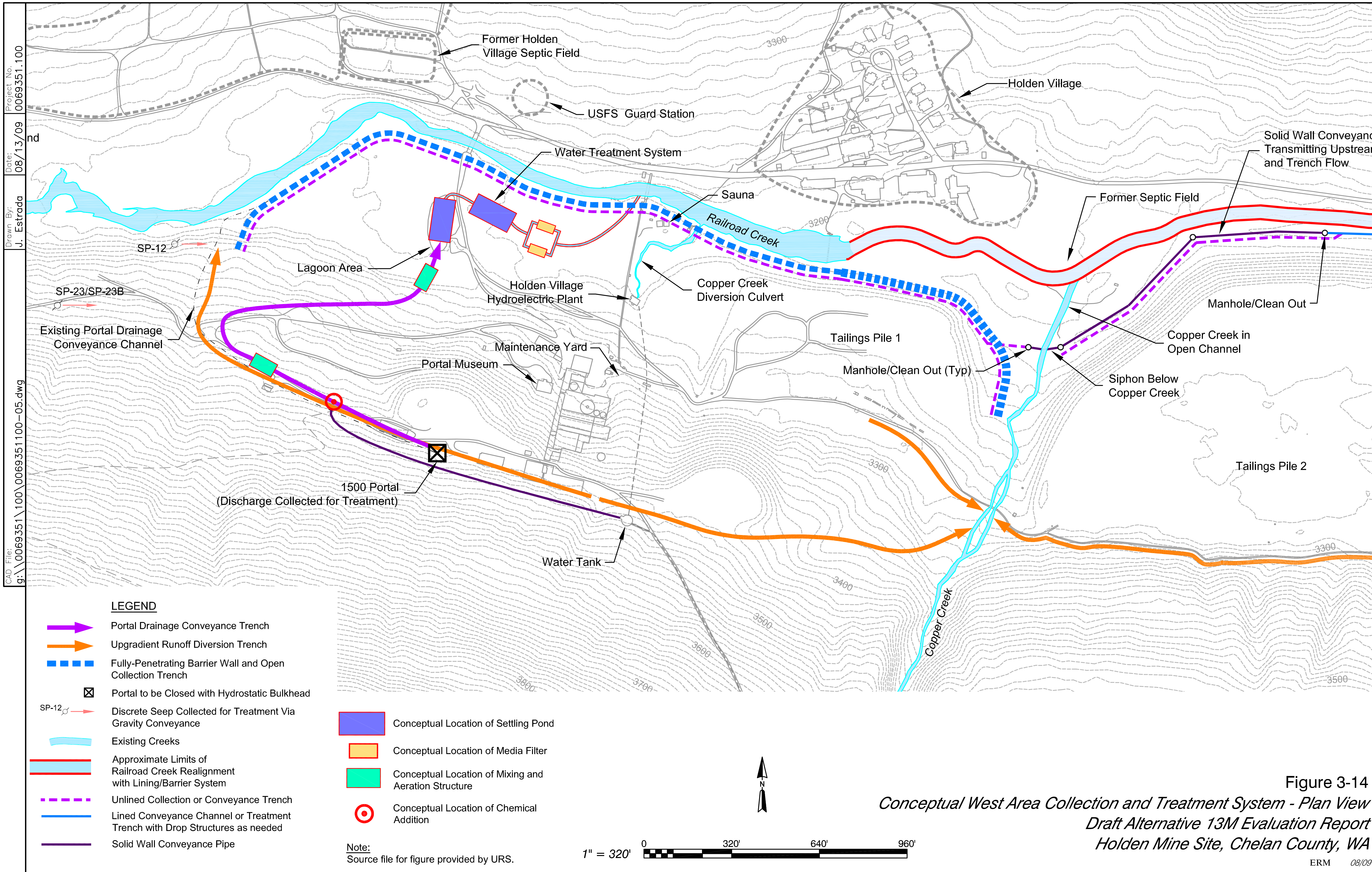
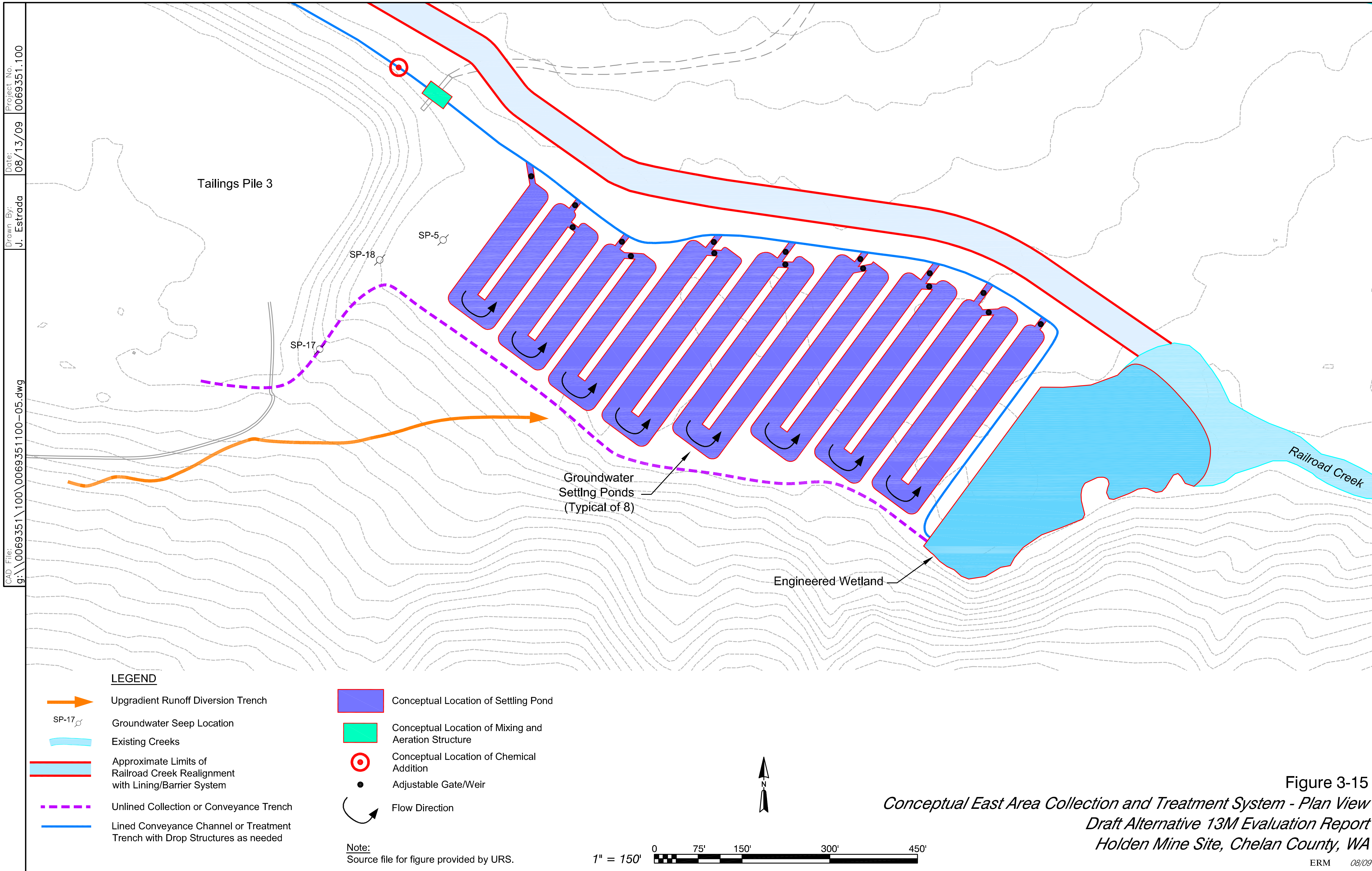


Figure 3-14
Conceptual West Area Collection and Treatment System - Plan View
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA



Note:
Source file for figure provided by URS.

Figure 3-15
Conceptual East Area Collection and Treatment System - Plan View
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

ERM 08/09

Tables

Table 1-1
Hydraulic Conductivity Summary
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Hydrostratigraphic Unit	Slug Tests (Rising and Falling Head)		Pumping Tests (Drawdown and Recovery)	
	Number of Wells	Hydraulic Conductivity (feet/day)	Number of Wells	Hydraulic Conductivity (feet/day)
Alluvium	7	2.2 - 420	6	49 - 390
Alluvium / Colluvium	0	--	1	74
Alluvium / Glacial Drift	1	200	0	--
Alluvium / Glacial Till	1	3	0	--
Colluvium	1	26	2	210 - 540
Colluvium / Glacial Outwash	1	260	0	--
Colluvium / Glacial Till	1	3.2	0	--
Glacial Drift	3	12 - 300	0	--
Glacial Outwash	2	15 - 300	1	140

Source: Appendix E - Draft Hydrogeology Technical Memorandum, Holden Mine Site (URS 2009_)

PCOC	Lowest Potential Criterion [a]	Background Surface Water Concentration [b]	Railroad Creek Surface Water Sampling Location													
			RC-6		RC-1		RC-4		RC-2		RC-5 / RC-13		RC-10		RC-8 / RC-3	
			High Flow	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow	Low Flow
Total Metals (μg/L)																
Aluminum	144 (B)	144	40 - **180**	<50	40 - **160**	70	40 - **200**	<50 - 50	100 - **250**	70 - 90	120 - **250**	100 - **340**	90 - **300**	80	90 - **260**	70
Iron	1,000 (N)	177	<50 - 180	50	70 - 160	110	<50 - 170	50 - 90	290 - **1,290**	550 - **1,340**	310 - **2,300**	840 - **2,620**	270 - 790	990	220 - 900	620 - 640
Dissolved Metals (μg/L)																
Cadmium	0.07 (B)	0.07	<0.04 - 0.08	0.017	<0.04 - 0.11	<0.04	0.09 - 0.67	0.048 - 0.06	**0.08 - 0.68**	**0.10** - <0.2	**0.10 - 0.58**	**0.12 - 0.24**	**0.14 - 0.4**	**0.12**	0.07 - **0.28**	**0.10**
Copper	1.5 (N) [c]	1.06	0.5 - 1.0	0.4	<0.6 - 1.1	0.4	**3.4 - 41.9**	**1.6 - 1.8**	**1.9 - 35.7**	1.2 - 1.5	**1.6 - 26.9**	0.5 - **2.8**	**5.0 - 18.5**	1.3	**1.9 - 12.6**	1.2 - 1.4
Zinc	17 (S)	7.81	3.2 - 12	<6	<4 - 13	<4	17 - **114**	10 - 11	**24 - 113**	16 - **28**	**24 - 98**	**24 - 49**	**21.6 - 69**	**22**	15.9 - **49**	**20**
Hardness (mg/L $CaCO_3$)																
Hardness	--	--	8.0 - 15	14	8.9 - 16	12	9.4 - 19	12 - 15	9.6 - 22	15 - 16	11 - 26	17 - 26	13 - 24	20	13 - 32	20

Notes:

Bolded value indicates concentration exceeds the potential criterion identified.

Railroad Creek surface water sampling locations are shown in Figure 1-11

High flow condition samples collected April - July

Low flow condition samples collected August - November

ARAR = Applicable or Relevant and Appropriate Requirement

mg/L = milligrams per liter

PCOC = Potential constituent of concern

TBC = To be considered

μg/L = micrograms per liter

(B) - Background surface water concentration; values shown are for total aluminum, and dissolved cadmium.

(N) - 2006 National Recommended Water Quality Criteria (NRWQC) (EPA 2006)

(S) - State of Washington Surface Water Quality Criteria (WAC 173-201A)

[a] Intalco has previously expressed its views that certain state and federal regulations and guidance are not ARARs or TBCs. While reserving its concerns, the lowest potential surface water quality criteria identified in the SFS (USDA Forest Service 2007b) are presented for this evaluation. Hardness-adjusted values for copper, and zinc are based on a hardness of 12 mg/L $CaCO_3$, consistent with the SFS (USDA Forest Service 2007b). The potential criteria shown are based on dissolved concentrations for cadmium, copper, and zinc, and on total concentrations for aluminum and iron.

[b] Background values are calculated in DRI Section 5.3 (Dames & Moore 1999)

[c] The lowest potential copper criterion is based upon the 2006 NRWQC, as evaluation of the 2007 Copper NRWQC is ongoing.

Table 1-3
Groundwater PCOC Concentrations within Contaminant Plume, 1997 - 2008
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

PCOC	Drinking Water Criterion [a]	Background Groundwater Concentration [b]	Lower West Area [c]		Tailings Pile 1 [d]		Tailings Pile 2 [e]		Tailings Pile 3 [f]		East of Tailings Pile 3 [g]	
			High Flow	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow	Low Flow	High Flow	Low Flow
Dissolved Metals (μg/L)												
Cadmium	5 (MCL)	<0.04 - 0.2	<0.2 - **53.5**	<0.2 - **55.6**	<0.2 - **100**	<0.2 - **28**	0.9 - **40.3**	<0.2 - 4.9	<0.6 - **25**	<0.2 - 4.4	<0.2 - 1.1	<0.2 - 1.3
Copper	592 (Adj MCL)	<0.5 - 3.2	1.2 - **3,660**	1.2 - **4,030**	1.9 - **1,100**	<0.5 - **811**	3 - **1,280**	0.7 - 90	<2 - **1,220**	<0.5 - 51	<0.5 - 2.7	<0.5 - 29
Lead	15 (MCL)	<1 - 2.6	<0.3 - **20**	<1 - 8	<1 - <100	<1 - <10	<1 - 1	<1 - <5	<1 - 14	<1 - <5	<1	<1
Manganese	747 (MTCA B)	<0.5 - 2.3	<1 - **993**	0.8 - **2,030**	166 - **8,780**	147 - **9,330**	1 - **3,410**	118 - **3,850**	57 - **1,810**	3 - **3,490**	<0.5 - 284	<0.5 - **774**
Nickel	100 (MCL)	<0.1 - 0.6	3 - 30	<0.5 - 20	<10 - **200**	<10 - **120**	<10 - 30	<10 - 10	6.2 - 40	6.9 - 40	<0.5 - 6.9	<0.5 - 7.3
Zinc	4800 (MTCA B)	<6 - 8	7.14 - **7,690**	13 - **6,080**	28 - **11,400**	8 - **8,100**	<11 - 4,030	7 - 611	57 - 2,230	<4 - 534	<6 - 139	5 - 210

Notes:

Bolded value indicates concentration exceeds the potential criterion identified.

High flow condition samples collected May - July 1997, May 1998, June 2000, May 2001, June 2002, June 2006 and/or June 2008.

Low flow condition samples collected September - October 1997, November 2001, October 2002, October 2003, and/or July - August 2008.

MCL = Maximum Contaminant Level

MTCA = Model Toxics Control Act

PCOC = Potential constituent of concern

μg/L = micrograms per liter

[a] Values shown are the lowest potential groundwater criteria and include the following:

MCL = Federal/State MCLs/Non-Zero MCLGs. Sources: MCLs and non-zero MCLGs, Drinking Water Standards and Health Advisories, Office of Water, US EPA, Summer 2000, EPA-822-B-00-001. Washington State Department of Health (WDOH) Drinking Water Standards (RCW 70.19A; WAC 246-290-310(3)). Based on Total Metals. The non-zero MCLGs for these constituents are equal to the MCLs. The MCL for nickel is based on WDOH criteria as no federal criteria exists.

Adj MCL = Adjusted MCL; adjusted based on a HQ = 1 or cancer risk of 1 x 10-5 as appropriate using MTCA Method B equations (WAC173-340-720(7)(b)).

MTCA B= MTCA Method B groundwater cleanup level from: Cleanup Levels and Risk Calculations under the Model Toxic Control Act Cleanup Regulation (CLARC) Version 3.1, updated November 2001.

[b] Site-specific background groundwater concentrations measured in samples from monitoring well HV-3 collected 1997 - 2006

[c] Lower west area: monitoring wells MW-1, MW-2, MW-3, MW-4S, MW-4D, and HBKG-1 and seeps SP-9, SP-10E/W, SP-11, SP-16, SP-24, SP-25

[d] Tailings pile 1: monitoring wells TP1-1A, TP1-1D, TP1-2A, TP1-2D, TP1-3A, TP1-4A, TP1-5A, and TP1-6A and seeps SP-1 and SP-2

[e] Tailings pile 2: monitoring wells TP2-1D, TP2-4A, TP2-5A, TP2-8A and TP2-11A and seeps SP-3 and SP-4

[f] Tailings pile 3: monitoring wells TP3-4, TP3-6A, TP3-8, TP3-9, TP3-10, DS-1, DS-2, DS-6S/D and DS-7S/D and seeps SP-5 and SP-18

[g] East of tailings pile 3: monitoring wells DS-3S/D, DS-4S/D, DS-5, NRC-3S/I/D, and NRC-6S/I/D

Constituent	Potential Soil Criteria [a]		Background Soil Concentration				Areas Downslope of Honeymoon Heights Waste Rock Piles (Mixed Conifer)	Lagoon (Riparian)	Maintenance Yard (Mixed Conifer)	Lower West Area East (Riparian)		Lower West Area West (Riparian)	
	MTCA Direct Contact	MTCA Protection of Groundwater	Mixed Conifer		Riparian		0 to 1 ft bgs	0 to 7.5 ft bgs	0 to 2 ft bgs	0 to 1 ft bgs	0 to 6 ft bgs	0 to 1 ft bgs	0 to 6 ft bgs
			BG-MC	(Min - Max)	BG-R	(Min - Max)	RME	Min - Max	Min - Max	RME	RME	RME	RME
Total Metals (mg/kg dry weight)													
Arsenic	20 [b] (A)	20 [b] (A)	4.8	(0.5 - **98**)	16	(0.7 - **22.5**)	<20 [e]	3.7 - 5	1.7 - **60**	**23**	20	**25**	**26**
Cadmium	80 (B)	3.3 (BG-MC) / 1.8 (BG-R) [c]	3.3	(<0.2 - **17.4**)	1.8	(0.2 - **3.2**)	**5.3**	0.7 - **184**	0.9 - **21.6**	**78**	**130**	1.1	1.7
Copper	10,571 (RL)	263 (B)	45	(5.2 - 65)	110	(8.8 - **323**)	**1,679**	**294** - **24,100**	260 - **3,160**	**4,680**	**6,231**	67	80
Lead	400 (RL)	3,000 (B)	14	(3 - 56)	25	(3 - 55)	77	52 - **800**	7 - 392	347	**644**	14	13
Manganese	11,200 (B)	NE	--	(244 - 448)	--	(71.3 - 2,970)	NS	255 - 625	150 - 426	NS	NS	NS	NS
Nickel	1,600 (B)	130 (B)	--	(4 - 23)	--	(4 - 8)	NS	<10 - 13	11 - 23	NS	NS	NS	NS
Zinc	24,000 (B)	5,970 (B)	136	(6 - 518)	1,007	(32.5 - 407)	1,007	387 - **23,700**	147 - 3,240	2,153	**17,314**	117	132
Total Petroleum Hydrocarbons (mg/kg)													
Gasoline	No risk indicated [f]	30 / 100 [d] (A)	--		--		--	<9 - <11	<5.9 - **1,200**	--	--	--	--
Diesel	3,300 [f]	2,000 (A)	--		--		--	98 - **2,200**	<5.5 - **12,000**	--	--	--	--
Heavy Oils	4,300 [f]	2,000 (A)	--		--		--	120 - 1,900	<11 - **9,800**	--	--	--	--

Notes:

Bolded value indicates concentration exceeds the potential criterion identified.

BG-R = background soil concentration for eastside riparian wetland habitat, as calculated in the Draft Terrestrial Ecological Evaluation Report (ERM 2009)

BG-MC = background soil concentration for eastside mixed conifer forest habitat, as calculated in the Draft Terrestrial Ecological Evaluation Report (ERM 2009)

ft bgs = feet below ground surface

mg/kg = milligrams per kilogram

MTCA = Model Toxics Control Act, Chapter 173-340 WAC

NC = not calculated due to no detections; values shown are the range of non-detections

NE = not established

NS = Not sampled or not analyzed as part of the Remedial Investigation (RI) or Terrestrial Ecological Evaluation (TEE)

RME = reasonable maximum exposure concentration, which is equal to the lesser of the 95 percent upper confidence limit on the mean (95%UCL) or the maximum detected concentration, as described in the Draft Terrestrial Ecological Evaluation Report (ERM 2009)

[a] Values shown are based on the MTCA regulations and include the following types of soil criteria:

(A) = MTCA Method A value for unrestricted land use for protection of direct contact and groundwater for drinking water use pathways.

(B) = MTCA Method B values for direct contact pathway (for ingestion only) or MTCA Method B values for protection of groundwater for drinking water use pathways.

(RL) = Remediation level for recreational user (based on a child). Appendix F: Draft Supplemental Human Health Risk Evaluation for the Tailings and Waste Rock Piles. (URS 2009)

[b] The MTCA Method A value for unrestricted land use for arsenic is adjusted for the State of Washington natural background concentration for soil (WAC 173-340-900 Table 740-1).

[c] The MTCA protection of groundwater value for cadmium is lower than the background soil concentration, therefore criteria are adjusted upward to the background soil concentrations

[d] The MTCA Method A value for gasoline is 100 mg/kg for gasoline mixtures without benzene and with total toluene, ethylbenzene, and xylenes less than 1 percent of the gasoline mixture; for all other gasoline mixtures the cleanup level is 30 mg/kg.

Sediment Sampling Location and Date	Sample Identification	Bioassay Results				
Railroad Creek 1996 [a]		*Hyalella azteca* Percent Survival [b]				Microtox EC50 (Percent) [c]
	Control Sample	93.3				--
	Railroad Creek at RC-1 (upstream of Site)	65.0				>90
	Railroad Creek at RC-2	93.3				>90
	Railroad Creek near Sevenmile Creek	91.7				>90
	Railroad Creek at RC-3	63.3				>90
Lucerne Bar 2001 - 2002 [d]		*Hyalella azteca* 21-day (2001)		*Chironomus tentans* 10-day (2002)		
		Mean Percent Survival	Mean Individual Weight (mg)	Mean Percent Survival	Mean Individual Weight (mg)	
	Lucerne Bar Sediment	80.0 to 93.8	0.084 to 0.189	58.75 to 77.50	0.869 to 1.000	
	Reference Site (Stehekin)	73.8 to 86.3	0.061 to 0.100	68.75 to 82.50	0.886 to 0.949	
	Laboratory Control	74.2 to 93.8	0.104 to 0.183	53.75 to 73.75	0.735 to 1.136	
Washington State Sediment Management Standards [e]		SQS: Mean mortality higher than reference (p≤0.05) and mean mortality greater than 25 percent absolute CSL: Mean mortality higher than reference (p≤0.05) and mean mortality greater than reference mortality plus 30 percent				SQS: Light output <80 percent relative to reference, statistically different (p≤0.05)

Notes:

[a] Railroad Creek sediment sampling and bioassay testing was performed in 1996 for Ecology by CH2MHill and is reported in "Effects of Holden Mine on the Water, Sediments and Benthic Invertebrates of Railroad Creek (Lake Chelan)", Ecology Publication No. 97-330.

[b] Amphipod tests were performed according to *Standard Guide for Conducting Toxicity Tests with Freshwater Invertebrates*, ASTM E1383-90.

[c] Microtox tests were performed as eluate tests, with results reported as the EC50, which is effective concentration (percent) of sediment sample eluate to dilution water reducing bacteria luminescence (light output) by 50 percent. The Microtox testing showed no reduction in bacteria luminescence when compared to the control.

[d] The Lucerne Bar is located at the mouth of Railroad Creek in Lake Chelan.

[e] Biological test criteria provided in the Washington State Sediment Management Standard (WAC 173-204) on the basis of survival or growth and include the following standards:

SQS = Sediment Quality Standards (WAC 173-204-320) criteria for chemical and biological effects tests that correspond to sediment quality that will result in no adverse affects to biological resources or significant risk to human health.

Microtox: The mean light output of the highest concentration of the test sediment is less than 80 percent of the mean light output of the reference sediment, and the two means are statistically different from each other (t test, p≤0.05).

Amphipod: The test sediment has a higher (statistically significant, t test, p≤0.05) mean mortality than the reference sediment and the test sediment mean mortality exceeds 25 percent, on an absolute basis.

CSL = Cleanup Screening Levels (WAC 173-204-520) criteria for chemical and biological effects tests that correspond to an upper bound of sediment quality that will result in minor adverse effects to biological resources or no significant risk to human health.

Amphipod: The test sediment has a higher (statistically significant, t test, p≤0.05) mean mortality than the reference sediment and the test sediment mean mortality is greater than a value represented by the reference sediment mean mortality plus 30 percent.

Receptor	Representative Surrogate	AOI HQs > 1	AOI HQs Food	AOI HQs Soil	AOI HQs ≈ Background	AOI HQs > Background	Soil Attributes GS	Soil Attributes Compact	Soil Attributes pH	Soil Attributes TOC	Existing Habitat	Survey Findings Plant	Survey Findings Soil Invertebrate	Potential for Recovery	Conclusion
Shallow Plant Community	–	Ba, Cu, Pb, Mo, Ag, Zn	–	–	Ba, Ag	Cu, Pb, Mo, Zn	Supp	Supp	Mixed	NSupp	Marginal refuge/foraging habitat supporting limited wildlife Small area relative to eastside mixed conifer forest habitat in the valley	Patches of grass/forbs; low (< 6 ft) shrubs	–	Anticipate recovery May not approach community observed in background area	• HQs suggest a potential for risks to plant communities • HQs may be a poor indicator of potential risks to plant communities • Soil attributes likely a factor in observed stands of mixed conifer vegetation and scattered patch of grass/shrub • Given observations, current plant community and anticipated succession may be consistent with proposed land uses at the tailings piles
Conifer Community	–	Cd, Cu, Cr, Pb, Hg, Mo, Tl, Zn	–	–	Hg, Tl	Cd, Cu, Cr, Pb, Mo, Ag, Zn	Supp	Supp	Mixed	NSupp		Recruitment of trees observed	–		
Soil Invertebrate Community	–	Cu, Zn	–	–	None	Cu, Zn	Supp	Supp	–			–	Characteristic of open, sparsely vegetated space	Characteristic of the plant community that is eventually established at this AOI	• HQs suggest a potential for risks to soil invertebrate communities • HQs may be a poor indicator of potential risks to soil invertebrate communities • Community is characteristic of existing plant community • Potential recovery likely to be characteristic of the plant community that eventually establishes at this AOI
Birds, Herbivorous	Grouse	None			–			–				–		–	• HQs suggest no potential risk
Bird, Invertivore	American Robin	Ba	None	None	Ba	None		–				–		–	• Weight-of-evidence suggests potential risks are unlikely
Bird, Carnivore	Northern Goshawk	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Vole	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Snowshoe Hare	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Mule Deer	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Invertivore	Shrew	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Carnivore	Weasel	None			–			–				–		–	• HQs suggest no potential risk

Notes:

Invertivore = invertebrate-consuming biota
Birds = bird populations
Mammals = mammal populations
Representative Surrogate = representative surrogate species
Metals are indicated by standard abbreviations of chemical name
Plant and soil invertebrate surveys conducted by expert botanist and entomologist, respectively
AOI HQ = area of interest hazard quotient
> 1 = HQ greater than one
Food = HQ greater than one for food ingestion pathway only
Soil = HQ greater than one for incidental ingestion of soil pathway only
≈ Backgrnd = HQ less than/comparable to corresponding HQ for background area
> Backgrnd = HQ greater than corresponding HQ for background area
GS = grain size/coarseness
Compact = compaction
TOC = total organic carbon (indicator of organic content of soils)
Supp = supportive of eastside mixed conifer forest plant or soil invertebrate community
Mixed = mixed results regarding supportive of eastside mixed conifer forest plant or soil invertebrate community
NSupp = not supportive of eastside mixed conifer forest plant or soil invertebrate community

Receptor	Representative Surrogate	AOI HQs					Soil Attributes				Existing Habitat	Survey Findings		Potential for Recovery	Conclusion
		> 1	Food	Soil	≈ Background	> Background	GS	Compact	pH	TOC		Plant	Soil Invertebrate		
Plant Community	–	Cu, Mo, Zn	–	–	Cu, Zn	Mo	Supp	Supp	Supp	Supp	Suitable refuge/foraging habitat supporting wildlife Small area relative to eastside mixed conifer forest habitat in the valley	Mixed conifer forest w/ open understory	–	Anticipate recovery to eastside mixed conifer forest	• HQs suggest a potential for risks to plant communities • HQs may be a poor indicator of potential risks to plant communities • Little evidence of impact to plants is observed • Anticipated to eventually establish a mid-/late-stage mixed conifer forest at this AOI
Soil Invertebrate Community	–	Cu	–	–	None	Cu	Supp	Supp	–			–	Characteristic of open understory	Characteristic of the plant community that is eventually established at this AOI	• HQs suggest a potential for risks to soil invertebrate communities • HQs may be a poor indicator of potential risks to soil invertebrate communities • Community is characteristic of existing plant community • Potential recovery likely to be characteristic of the plant community that eventually establishes at this AOI
Birds, Herbivorous	Grouse	None	–				–					–		–	• HQs suggest no potential risk
Bird, Invertivore	American Robin	None	–				–					–		–	• HQs suggest no potential risk
Bird, Carnivore	Northern Goshawk	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Vole	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Snowshoe Hare	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Mule Deer	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Invertivore	Shrew	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Carnivore	Weasel	None	–				–					–		–	• HQs suggest no potential risk

Notes:

Invertivore = invertebrate-consuming biota
Birds = bird populations
Mammals = mammal populations
Representative Surrogate = representative surrogate species
Metals are indicated by standard abbreviations of chemical name
Plant and soil invertebrate surveys conducted by expert botanist and entomologist, respectively

AOI HQ = area of interest hazard quotient
> 1 = HQ greater than one
Food = HQ greater than one for food ingestion pathway only
Soil = HQ greater than one for incidental ingestion of soil pathway only
≈ Backgrnd = HQ less than/comparable to corresponding HQ for background area
> Backgrnd = HQ greater than corresponding HQ for background area
GS = grain size/coarseness
Compact = compaction
TOC = total organic carbon (indicator of organic content of soils)
Supp = supportive of eastside mixed conifer forest plant or soil invertebrate community
Mixed = mixed results regarding supportive of eastside mixed conifer forest plant or soil invertebrate community
NSupp = not supportive of eastside mixed conifer forest plant or soil invertebrate community

Receptor	Representative Surrogate	AOI HQs					Soil Attributes				Existing Habitat	Survey Findings		Potential for Recovery	Conclusion
		> 1	Food	Soil	≈ Background	> Background	GS	Compact	pH	TOC		Plant	Soil Invertebrate		
Plant Community	–	As, Ba, Cd, Cr, Cu, Pb, Hg, Mo, Ag, Zn	–	–	As, Ba, Cd, Hg	As, Cr, Cu, Pb, Mo, Ag, Zn	NSupp	NSupp	Mixed	NSupp	Unattractive refuge/foraging habitat supporting wildlife Small area relative to eastside mixed conifer forest habitat in the valley	Little plant cover; only an occasional pine tree	–	Do no anticipate recovery to mature eastside mixed conifer forest Unlikely to approach community observed in background area	• HQs suggest a potential for risks to plant communities • Soil attributes likely a factor in observed limited vegetation cover • Given observations, current plant community and anticipated succession are unlikely to approach a late-seral mixed conifer forest
Conifer Community	–	As, Ba, Cd, Cr, Cu, Pb, Mo, Ag, Zn	–	–	Ba, Cr	As, Ba, Cd, Cu, Pb, Mo, Ag, Zn	–	–	–	–		–	–		
Soil Invertebrate Community	–	Cr, Cu, Hg, Zn	–	–	Cr	Cu, Hg, Zn	NSupp	Supp	–			–	Characteristic of open space	Characteristic of the plant community that is eventually established at this AOI	• HQs suggest a potential for risks to soil invertebrate communities • Community is characteristic of existing plant community • Potential recovery likely to be characteristic of the plant community that eventually establishes at this AOI
Birds, Herbivorous	Grouse	None			–			–				–		–	• HQs suggest no potential risk
Bird, Invertivore	American Robin	None			–			–				–		–	• HQs suggest no potential risk
Bird, Carnivore	Northern Goshawk	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Vole	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Snowshoe Hare	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Mule Deer	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Invertivore	Shrew	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Carnivore	Weasel	None			–			–				–		–	• HQs suggest no potential risk

Notes:

Invertivore = invertebrate-consuming biota
Birds = bird populations
Mammals = mammal populations
Representative Surrogate = representative surrogate species
Metals are indicated by standard abbreviations of chemical name
Plant and soil invertebrate surveys conducted by expert botanist and entomologist, respectively
AOI HQ = area of interest hazard quotient
> 1 = HQ greater than one
Food = HQ greater than one for food ingestion pathway only
Soil = HQ greater than one for incidental ingestion of soil pathway only
≈ Backgrnd = HQ less than/comparable to corresponding HQ for background area
> Backgrnd = HQ greater than corresponding HQ for background area
GS = grain size/coarseness
Compact = compaction
TOC = total organic carbon (indicator of organic content of soils)
Supp = supportive of eastside mixed conifer forest plant or soil invertebrate community
Mixed = mixed results regarding supportive of eastside mixed conifer forest plant or soil invertebrate community
NSupp = not supportive of eastside mixed conifer forest plant or soil invertebrate community

Receptor	Representative Surrogate	AOI HQs					Soil Attributes				Existing Habitat	Survey Findings		Potential for Recovery	Conclusion
		> 1	Food	Soil	≈ Background	> Background	GS	Compact	pH	TOC		Plant	Soil Invertebrate		
Plant Community	–	As, Cu, Pb, Hg, Mo, Ag, Tl, Zn	–	–	None	As, Cu, Pb, Hg, Mo, Ag, Tl, Zn	NSupp	–	NSupp	NSupp	Unattractive refuge/foraging habitat supporting wildlife Small area relative to eastside mixed conifer forest habitat in the valley	Little plant cover; only an occasional pine tree	–	Do no anticipate recovery to mature eastside mixed conifer forest Unlikely to approach community observed in background area	• HQs suggest a potential for risks to plant communities • Soil attributes likely a factor in observed limited vegetation cover • Given observations, current plant community and anticipated succession are unlikely to approach a late-seral mixed conifer forest
Soil Invertebrate Community	–	Cu, Pb, Hg, Zn	–	–	None	Cu, Pb, Hg, Zn	NSupp	Supp	–			–	Characteristic of open space	Characteristic of the plant community that is eventually established at this AOI	• HQs suggest a potential for risks to soil invertebrate communities • Community is characteristic of existing plant community • Potential recovery likely to be characteristic of the plant community that eventually establishes at this AOI
Birds, Herbivorous	Grouse	None	–				–					–		–	• HQs suggest no potential risk
Bird, Invertivore	American Robin	Pb	None	None	None	Pb (HQ=3.6)	–					–		–	• Weight-of-evidence suggests potential risks are unlikely
Bird, Carnivore	Northern Goshawk	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Vole	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Snowshoe Hare	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Mule Deer	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Invertivore	Shrew	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Carnivore	Weasel	Pb	None	None	Pb	None	–					–		–	• Weight-of-evidence suggests potential risks are unlikely

Notes:
Invertivore = invertebrate-consuming biota
Birds = bird populations
Mammals = mammal populations
Representative Surrogate = representative surrogate species
Metals are indicated by standard abbreviations of chemical name
Plant and soil invertebrate surveys conducted by expert botanist and entomologist, respectively
AOI HQ = area of interest hazard quotient
> 1 = HQ greater than one
Food = HQ greater than one for food ingestion pathway only
Soil = HQ greater than one for incidental ingestion of soil pathway only
≈ Backgrnd = HQ less than/comparable to corresponding HQ for background area
> Backgrnd = HQ greater than corresponding HQ for background area
GS = grain size/coarseness
Compact = compaction
TOC = total organic carbon (indicator of organic content of soils)
Supp = supportive of eastside mixed conifer forest plant or soil invertebrate community
Mixed = mixed results regarding supportive of eastside mixed conifer forest plant or soil invertebrate community
NSupp = not supportive of eastside mixed conifer forest plant or soil invertebrate community

Receptor	Representative Surrogate	AOI HQs					Soil Attributes				Existing Habitat	Survey Findings		Potential for Recovery	Conclusion
		> 1	Food	Soil	≈ Background	> Background	GS	Compact	pH	TOC		Plant	Soil Invertebrate		
Plant Community	–	As, Cd, Cu, Pb, Hg, Mo, Se, Ag, Zn	–	–	As, Cd, Ag	Cu, Pb, Hg, Mo, Se, Zn	–	–	Supp	Supp	Suitable refuge/foraging habitat supporting wildlife Small area relative to eastside riparian wetland habitat in the valley	Different stages of succession (recovery) within this collective AOI. Some areas support mostly bare ground; while other areas support early- to mid-stage eastside riparian wetland vegetation Overall cover and plant species richness is significantly lower than that observed in the eastside riparian wetland background area	–	Anticipate recovery to eastside riparian wetland habitat characteristic of avalanche chutes Unlikely to approach community observed in background area	• HQs suggest a potential for risks to plant communities • HQs may be a poor indicator of potential risks to plant communities • Physical disturbance (rock/snow avalanche) likely a factor in observed vegetation • Given observations, current plant community and anticipated succession are likely to support vegetation consistent with avalanche chutes
Soil Invertebrate Community	–	Cu, Hg, Zn	–	–	None	Cu, Hg, Zn	–					–	Characteristic of open habitat	Characteristic of the plant community that is eventually established at this AOI	• HQs suggest a potential for risks to soil invertebrate communities • HQs may be a poor indicator of potential risks to soil invertebrate communities • Community is characteristic of existing plant community • Potential recovery likely to be characteristic of the plant community that eventually establishes at this AOI
Birds, Herbivorous	Grouse	None			–		–					–		–	• HQs suggest no potential risk
Bird, Invertivore	American Robin	Cu, Zn	None	None	Cu, Zn	None	–					–		–	• Weight-of-evidence suggests potential risks are unlikely
Bird, Carnivore	Northern Goshawk	None			–		–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Vole	Cu	None	None	Cu	None	–					–		–	• Weight-of-evidence suggests potential risks are unlikely
Mammals, Herbivorous	Snowshoe Hare	None			–		–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Mule Deer	None			–		–					–		–	• HQs suggest no potential risk
Mammals, Invertivore	Shrew	Cu	None	None	None	Cu (HQ=3.0)	–					–		–	• Weight-of-evidence suggests potential risks are unlikely
Mammals, Carnivore	Weasel	None			–		–					–		–	• HQs suggest no potential risk

Notes:

Invertivore = invertebrate-consuming biota
Birds = bird populations
Mammals = mammal populations
Representative Surrogate = representative surrogate species
Metals are indicated by standard abbreviations of chemical name
Plant and soil invertebrate surveys conducted by expert botanist and entomologist, respectively
AOI HQ = area of interest hazard quotient
> 1 = HQ greater than one
Food = HQ greater than one for food ingestion pathway only
Soil = HQ greater than one for incidental ingestion of soil pathway only
≈ Backgrnd = HQ less than/comparable to corresponding HQ for background area
> Backgrnd = HQ greater than corresponding HQ for background area
GS = grain size/coarseness
Compact = compaction
TOC = total organic carbon (indicator of organic content of soils)
Supp = supportive of eastside mixed conifer forest plant or soil invertebrate community
Mixed = mixed results regarding supportive of eastside mixed conifer forest plant or soil invertebrate community
NSupp = not supportive of eastside mixed conifer forest plant or soil invertebrate community

Receptor	Representative Surrogate	AOI HQs					Soil Attributes				Existing Habitat	Survey Findings		Potential for Recovery	Conclusion
		> 1	Food	Soil	≈ Background	> Background	GS	Compact	pH	TOC		Plant	Soil Invertebrate		
Plant Community	–	As, Cd, Cu, Pb, Hg, Mo, Se, Ag, Tl, Zn	–	–	Hg, Se, Tl	As, Cd, Cu, Pb, Mo, Ag, Zn	Supp	–	Supp	Supp	Suitable refuge/foraging habitat supporting wildlife Small area relative to eastside riparian wetland habitat in the valley	Lower overall cover and structural complexity (taxa richness) as compared to eastside riparian wetland background area Existing plants appeared healthy and showed signs of recent growth Observed cover and structure were attributable, in part, to physical disturbance and observed compaction of soils by heavy equipment	–	May recovery to eastside riparian wetland habitat Unlikely to approach community observed in background area	• HQs suggest a potential for risks to plant communities • HQs may be a poor indicator of potential risks to plant communities • Physical disturbance (clearing, vehicular traffic) likely a factor in observed vegetation • Given observations, current plant community and anticipated succession may be consistent with proposed land uses at this AOI
Soil Invertebrate Community	–	Cd, Cu, Pb, Hg, Zn	–	–	Hg	Cd, Cu, Pb, Zn	Supp		–			–	Characteristic of open habitat	Characteristic of the plant community that is eventually established at this AOI	• HQs suggest a potential for risks to soil invertebrate communities • HQs may be a poor indicator of potential risks to soil invertebrate communities • Community is characteristic of existing plant community • Potential recovery likely to be characteristic of the plant community that eventually establishes at this AOI
Birds, Herbivorous	Grouse	None			–			–				–		–	• HQs suggest no potential risk
Bird, Invertivore	American Robin	Cu, Pb, Zn	None	None	None	Cu (HQ=2.8), Pb (HQ=1.5), Zn (HQ=1.6)		–				–		–	• Weight-of-evidence suggests potential risks are unlikely
Bird, Carnivore	Northern Goshawk	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Vole	Cu, Mo	None	None	Mo	Cu (HQ=1.8)		–				–		–	• Weight-of-evidence suggests potential risks are unlikely
Mammals, Herbivorous	Snowshoe Hare	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Mule Deer	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Invertivore	Shrew	Cu	None	None	None	Cu (HQ=2.8)		–				–		–	• Weight-of-evidence suggests potential risks are unlikely
Mammals, Carnivore	Weasel	Cd, Cu	None	None	Cd	Cu (HQ=3.8)		–				–		–	• Weight-of-evidence suggests potential risks are unlikely

Notes:

Invertivore = invertebrate-consuming biota
Birds = bird populations
Mammals = mammal populations
Representative Surrogate = representative surrogate species
Metals are indicated by standard abbreviations of chemical name
Plant and soil invertebrate surveys conducted by expert botanist and entomologist, respectively
AOI HQ = area of interest hazard quotient
> 1 = HQ greater than one
Food = HQ greater than one for food ingestion pathway only
Soil = HQ greater than one for incidental ingestion of soil pathway only
≈ Backgrnd = HQ less than/comparable to corresponding HQ for background area
> Backgrnd = HQ greater than corresponding HQ for background area
GS = grain size/coarseness
Compact = compaction
TOC = total organic carbon (indicator of organic content of soils)
Supp = supportive of eastside mixed conifer forest plant or soil invertebrate community
Mixed = mixed results regarding supportive of eastside mixed conifer forest plant or soil invertebrate community
NSupp = not supportive of eastside mixed conifer forest plant or soil invertebrate community

Receptor	Representative Surrogate	AOI HQs					Soil Attributes				Existing Habitat	Survey Findings		Potential for Recovery	Conclusion
		> 1	Food	Soil	≈ Background	> Background	GS	Compact	pH	TOC		Plant	Soil Invertebrate		
Plant Community	–	As	–	–	None	As	Supp	–	Supp	Supp	Suitable refuge/foraging habitat supporting wildlife Small area relative to eastside riparian wetland habitat in the valley	Differs only slightly in cover and structural complexity from background area Conditions favor support of dense stands of eastside riparian wetland habitat	–	Anticipate recovery to eastside riparian wetland habitat	• HQs suggest a potential for risks to plant communities • HQs may be a poor indicator of potential risks to plant communities • Anticipated to eventually establish a mid-/late-stage eastside riparian wetland habitat
Soil Invertebrate Community	–	None			–			–				–	Characteristic of open habitat	Characteristic of eastside riparian wetland habitat	• HQs suggest no potential risk
Birds, Herbivorous	Grouse	None			–			–				–		–	• HQs suggest no potential risk
Bird, Invertivore	American Robin	None			–			–				–		–	• HQs suggest no potential risk
Bird, Carnivore	Northern Goshawk	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Vole	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Snowshoe Hare	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Mule Deer	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Invertivore	Shrew	None			–			–				–		–	• HQs suggest no potential risk
Mammals, Carnivore	Weasel	None			–			–				–		–	• HQs suggest no potential risk

Notes:

Invertivore = invertebrate-consuming biota
Birds = bird populations
Mammals = mammal populations
Representative Surrogate = representative surrogate species
Metals are indicated by standard abbreviations of chemical name
Plant and soil invertebrate surveys conducted by expert botanist and entomologist, respectively
AOI HQ = area of interest hazard quotient
> 1 = HQ greater than one
Food = HQ greater than one for food ingestion pathway only
Soil = HQ greater than one for incidental ingestion of soil pathway only
≈ Backgrnd = HQ less than/comparable to corresponding HQ for background area
> Backgrnd = HQ greater than corresponding HQ for background area
GS = grain size/coarseness
Compact = compaction
TOC = total organic carbon (indicator of organic content of soils)
Supp = supportive of eastside mixed conifer forest plant or soil invertebrate community
Mixed = mixed results regarding supportive of eastside mixed conifer forest plant or soil invertebrate community
NSupp = not supportive of eastside mixed conifer forest plant or soil invertebrate community

Receptor	Representative Surrogate	AOI HQs					Soil Attributes				Existing Habitat	Survey Findings		Potential for Recovery	Conclusion
		> 1	Food	Soil	≈ Background	> Background	GS	Compact	pH	TOC		Plant	Soil Invertebrate		
Plant Community	–	Not a terrestrial receptor of concern									Primarily maintained lawn, ornamental shrubs, and trees. Habitat is ruderal and heavily influenced/disturbed by human activities.	Vegetation primarily lawn, ornamental shrubs, and trees. Most of the vegetation has low structural complexity do to active management.	The much greater abundance of ants (both species and individuals) at Holden Village indicates a more open habitat.	Under current plans, Holden Village will continue to operate as an interdenominational retreat. Lawns and ornamental plants will continue to be maintained on the grounds.	• Not a terrestrial receptor of concern
Soil Invertebrate Community	–	Not a terrestrial receptor of concern													• Not a terrestrial receptor of concern
Birds, Herbivorous	Grouse	None		–				–							• HQs suggest no potential risk
Bird, Invertivore	American Robin	None		–				–							• HQs suggest no potential risk
Bird, Carnivore	Northern Goshawk	None		–				–							• HQs suggest no potential risk
Mammals, Herbivorous	Vole	None		–				–							• HQs suggest no potential risk
Mammals, Herbivorous	Snowshoe Hare	None		–				–							• HQs suggest no potential risk
Mammals, Herbivorous	Mule Deer	None		–				–							• HQs suggest no potential risk
Mammals, Invertivore	Shrew	None		–				–							• HQs suggest no potential risk
Mammals, Carnivore	Weasel	None		–				–							• HQs suggest no potential risk

Notes:

Invertivore = invertebrate-consuming biota
Birds = bird populations
Mammals = mammal populations
Representative Surrogate = representative surrogate species
Metals are indicated by standard abbreviations of chemical name
Plant and soil invertebrate surveys conducted by expert botanist and entomologist, respectively
AOI HQ = area of interest hazard quotient
> 1 = HQ greater than one
Food = HQ greater than one for food ingestion pathway only
Soil = HQ greater than one for incidental ingestion of soil pathway only
≈ Backgrnd = HQ less than/comparable to corresponding HQ for background area
> Backgrnd = HQ greater than corresponding HQ for background area
GS = grain size/coarseness
Compact = compaction
TOC = total organic carbon (indicator of organic content of soils)
Supp = supportive of eastside mixed conifer forest plant or soil invertebrate community
Mixed = mixed results regarding supportive of eastside mixed conifer forest plant or soil invertebrate community
NSupp = not supportive of eastside mixed conifer forest plant or soil invertebrate community

Receptor	Representative Surrogate	AOI HQs: > 1	AOI HQs: Food	AOI HQs: Soil	AOI HQs: ≈ Background	AOI HQs: > Background	Soil Attributes: GS	Soil Attributes: Compact	Soil Attributes: pH	Soil Attributes: TOC	Existing Habitat	Survey Findings: Plant	Survey Findings: Soil Invertebrate	Potential for Recovery	Conclusion
Plant Community	–	Zn	–	–	Zn	None	Supp	Supp	Supp	Supp	The wilderness boundary area portion (WBA) of this AOI supports dense plant cover with high species richness and structural complexity similar to the eastside mixed conifer forest background area Ballfield (BF) portion of this AOI has low structural complexity because it appears to be frequently mowed to keep trees and shrub from establishing	Mixed conifer forest (WBA) Native/non-native grasses (BF)	–	Characteristic of the plant community that is eventually established at this AOI	• HQs suggest a potential for risks to plant communities • Little evidence of impact to plants is observed at WBA • Maintenance explains vegetation at BF • Weight-of-evidence suggests potential risks are unlikely
Soil Invertebrate Community	–	Cu	–	–	Cu	None	Supp	Supp	–			–	Characteristic of existing plant community		• HQs suggest a potential for risks to plant communities • Little evidence of impact to soil invertebrates is observed • Weight-of-evidence suggests potential risks are unlikely
Birds, Herbivorous	Grouse	None	–				–					–		–	• HQs suggest no potential risk
Bird, Invertivore	American Robin	None	–				–					–		–	• HQs suggest no potential risk
Bird, Carnivore	Northern Goshawk	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Vole	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Snowshoe Hare	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Herbivorous	Mule Deer	None	–				–					–		–	• HQs suggest no potential risk
Mammals, Invertivore	Shrew	Cu	Cu	None	None	Cu (HQ=1.1)	–					–		–	• Weight-of-evidence suggests potential risks are unlikely
Mammals, Carnivore	Weasel	None	–				–					–		–	• HQs suggest no potential risk

Notes:
Invertivore = invertebrate-consuming biota
Birds = bird populations
Mammals = mammal populations
Representative Surrogate = representative surrogate species
Metals are indicated by standard abbreviations of chemical name
Plant and soil invertebrate surveys conducted by expert botanist and entomologist, respectively
AOI HQ = area of interest hazard quotient
> 1 = HQ greater than one
Food = HQ greater than one for food ingestion pathway only
Soil = HQ greater than one for incidental ingestion of soil pathway only
≈ Backgrnd = HQ less than/comparable to corresponding HQ for background area
> Backgrnd = HQ greater than corresponding HQ for background area
GS = grain size/coarseness
Compact = compaction
TOC = total organic carbon (indicator of organic content of soils)
Supp = supportive of eastside mixed conifer forest plant or soil invertebrate community
Mixed = mixed results regarding supportive of eastside mixed conifer forest plant or soil invertebrate community
NSupp = not supportive of eastside mixed conifer forest plant or soil invertebrate community

Table 2-1
Summary of Potential Constituents of Concern and Potential Cleanup Levels
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Media	Potential Constituent of Concern[a]	Potential Cleanup Level[i]	Basis
Surface Water and Groundwater at the Groundwater CPOC[h]	Aluminum (Total, µg/L)	144	Background concentration[d]
	Cadmium (Dissolved, µg/L)	0.07	Background concentration[d]
	Copper (Dissolved, µg/L)	1.5	NRWQC[b,c]
	Iron (Total, µg/L)	1,000	NRWQC[b]
	Zinc (Dissolved, µg/L)	17	SWQC[b]
Soil Direct Contact	Arsenic (mg/kg)	20	MTCA Method A[e]
	Cadmium (mg/kg)	80	MTCA Method B
	Copper (mg/kg)	10,571	Proposed Remediation Level[l]
	Lead (mg/kg)	400	Proposed Remediation Level[l]
	Diesel-Range Hydrocarbons (mg/kg)	3,300	MTCA Method B[m]
	Heavy-Oil Range Hydrocarbons (mg/kg)	4,300	MTCA Method B[m]
Soil Preliminary Screening Levels for Protection of Groundwater	Arsenic (mg/kg)	20	MTCA Method A[e]
	Cadmium (mg/kg)	1.8(BG-R)/3.3(BG-MC)	Background concentrations[f]
	Copper (mg/kg)	263	MTCA Method B[g]
	Zinc (mg/kg)	5,970	MTCA Method B[g]
	Gasoline-Range Hydrocarbons (mg/kg)	30/100	MTCA Method A[j]
	Diesel-Range Hydrocarbons (mg/kg)	2,000	MTCA Method A[k]
	Heavy-Oil Range Hydrocarbons (mg/kg)	2,000	MTCA Method A[k]

Notes:

CPOC = Conditional Point of Compliance
EPA = Environmental Protection Agency
mg/L = milligrams per liter
MTCA = Model Toxics Control Act (Chapter 173-340 WAC)
NRWQC = National Recommended Water Quality Criteria (EPA 2006)
PCOC = Potential constituent of concern
SWQC = State Surface Water Quality Criteria (WAC 173-201A)
µg/L = micrograms per liter
BG-R = background concentration - eastside riparian wetland habitat (ERM 2009)
BG-MC = background concentration - eastside mixed conifer forest (ERM 2009)

[a]Constituent identified as a PCOC if concentration exceeds the lowest potential ARAR.

[b]Intalco has previously expressed its views that certain state and federal regulations and guidance are not ARARs or TBCs. While reserving its concerns, the lowest potential surface water quality ARARs identified in the SFS (USDA Forest Service 2007b) are presented for this evaluation. Hardness-adjusted values for copper and zinc are based on a hardness of 12 mg/L $CaCO_3$, consistent with the SFS (USDA Forest Service 2007b).

[c]The copper concentration shown is based upon the 2006 NRWQC, as evaluation of the 2007 Copper NRWQC is ongoing.

[d]Surface water background values are calculated in the DRI Section 5.3 (Dames & Moore, 1999)

[e]The MTCA Method A soil cleanup level for unrestricted land use for arsenic is based on direct contact and protection of groundwater for drinking water use, adjusted for the State of Washington natural background concentration for soil (WAC 173-340-900 Table 740-1).

[f]The potential soil cleanup levels for cadmium are lower than the natural background concentration, the background soil concentrations shown are for the eastside riparian wetland reference area (B-R) and eastside mixed conifer reference area (B-MC), presented in the draft Terrestrial Ecological Evaluations Report (ERM 2009)

[g] MTCA Method B Groundwater protection value calculated with the fixed parameter, three-phase partitioning model (Equation 747-1) using default entries and most stringent potential groundwater ARAR (MCL, State MCL, or MTCA B groundwater cleanup levels). These values represent conservative screening values only.

[h]A groundwater CPOC in surface water as close as technically possible to the point or points where groundwater flows into surface water.

[i] Preliminary ecological indicator soil concentrations for the protection of terrestrial plants and animals are provided in Appendix I.

[j] The MTCA Method A cleanup level for unrestricted land use of 100 mg/kg for gasoline is for mixtures without benzene and with total toluene, ethylbenzene, and xylenes less than 1 percent of the gasoline mixture; for all other gasoline mixtures the cleanup level is 30 mg/kg.

[k]The MTCA Method A cleanup level for unrestricted land use based on the protection of groundwater.

[l] Calculated remediation levels for recreational user based on child. Appendix F: Draft Supplemental Human Health Risk Evaluation for the Tailings and Waste Rock Piles (URS 2009)

[m]Concentrations noted are based on use of MTCA spreadsheets provided by Ecology. The calculations are based on the highest detected concentrations, and fresh diesel and heavy fuel oil weight percentages provided by Ecology. Copies on file at URS.

Table 2-2
Potential Points of Compliance
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Media	Description of Potential Points of Compliance[1]
Surface Water	Under MTCA, the point of compliance for surface water cleanup levels is the point or points at which hazardous substances are released to surface waters, unless Ecology authorizes a mixing zone in accordance with WAC 173-201A. MTCA does not allow a mixing zone to demonstrate compliance for groundwater discharges to surface water (WAC 173-340-730[6]).
Groundwater	Although the standard point of compliance for groundwater cleanup under CERCLA and MTCA is generally throughout the contaminant plume, from the uppermost level of the saturated zone, extending vertically to the lowest most depth which could potentially be affected by the Site, it is recognized that remedial actions may involve areas where contamination is managed in place when it is not practicable to meet cleanup levels throughout the Site within a reasonable restoration time frame (WAC 173-340-720[8][b] and 55 FR 8753). Portions of the seeps and groundwater beneath the Site are not expected to meet potential chemical-specific ARARs in the short- or long-term under any of the remedial alternatives under consideration. It was determined in the DFFS and SFS that it is not practicable to meet potential groundwater ARARs throughout the Site within a reasonable restoration time frame. Therefore, a CPOC would be established for Site groundwater under any of the proposed remedial alternatives. Because Railroad Creek and Copper Creek abut the Site, a CPOC(s) that is located within surface water at the point or points where groundwater flows into surface water may be established if the conditions described in MTCA (WAC 173-340-720[8][d][i]) are met, including the requirement that the remedy applies all known, available, and reasonable methods of treatment (AKART). Institutional controls, including land use restrictions, would be required to protect human health and prevent potential future groundwater consumption in areas where groundwater concentrations remain above drinking water criteria.
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 ground surface to 15 feet below the ground surface. However, Ecology may approve containment actions (e.g., capping) in conjunction with institutional controls that prohibit or limit activities that could interfere with the long-term integrity of the containment system. For soil cleanup levels based on the protection of groundwater, the point of

[1] Points of compliance are locations at the Site where cleanup levels must be achieved.

Media	Description of Potential Points of Compliance[1]
	compliance is established in soils throughout the Site. For terrestrial receptors, a point of compliance for soils will be established based on risk to terrestrial ecological receptors. For sites with institutional controls to prevent excavation of deeper contaminated soils, a conditional point of compliance may be set at the biologically active soil zone. This zone is assumed to extend to a depth of six feet, unless it is demonstrated that an alternative depth is more appropriate for the Site.

Requirement	Citation	Description	Evaluation
Washington MTCA	RCW 70.105D; WAC 173-340-360(4), -440, -410, -720(9), -730(7), -740(6), -360(6), -370(7), -830.	The MTCA specifies requirements that affect the implementation of remedial action at a site. These regulations specify requirements for choosing technologies; establishing institutional controls; conducting compliance monitoring for groundwater, surface water, and soil; providing for a reasonable restoration time frame to meet the cleanup level; determining the appropriateness of monitored natural attenuation; and using an Ecology-accredited laboratory to analyze environmental samples.	These MTCA provisions are potentially applicable to remedial action selection and implementation.
Minimum Standards for Construction and Maintenance of Water Wells	RCW 18.104; WAC 173-160-101, -121, -161 to -241, -261 to -341, -381.	Well construction regulations establish minimum standards for water well construction and decommissioning.	These provisions are potentially applicable to wells constructed for groundwater withdrawal and monitoring and decommissioning of existing or future wells.
Regulation and Licensing of Well Contractors and Operators	RCW 180104; WAC 173-162-020, -030	These regulations apply to all water well contractors and operators who are providing well installation, maintenance, or abandonment services in Washington State.	Potentially applicable to contractors or operators who install wells at the Site.

Requirement	Citation	Description	Evaluation
Resource Conservation and Recovery Act; Dangerous Waste Act and Regulations	42 USC 6901; RCW 70.105; WAC 173-303- 016, -070, -071, -090 to 104, -170, -200, -630, -640, -646(4), (5) and (8)	The Washington State Dangerous waste regulations establish requirements for characterizing, managing, treating, and establishing a corrective action management unit for the disposition of remediation waste.	Potentially applicable to alternatives involving the active management of soils and tailings that are determined to be characteristic dangerous waste.
Resource Conservation and Recovery Act; Dangerous Waste Act and Regulations	42 USC 6901; RCW 70.105; WAC 173-303-016, -070, -071, -170, -200, -630, -646(4), (5) and (8), -060, -140, -141, -180, -190, -210, -220, and -240	The dangerous waste regulations establish criteria for the identification, designation, accumulation, management, consolidation, transportation and off-site disposal of dangerous waste.	These provisions are potentially applicable to the on-site accumulation, management and consolidation of designated dangerous waste. These regulations must be fully complied with for any off site disposal of waste determined to be characteristically hazardous.

Requirement	Citation	Description	Evaluation
Hydraulic Project Approval	RCW 75.20.100; WAC 220-110-040, -050, -070, -080, -120, -130, -150, -170, and -190	Construction activity below the ordinary high water mark that uses, diverts, obstructs or changes the natural flow or bed of any waters of the state requires a hydraulic project approval (HPA) from the Washington State Department of Fish and Wildlife.	Substantive provisions of this potential ARAR are potentially applicable to remedial alternatives that include diversion of or placement of a culvert in Railroad Creek or Copper Creek. The potential applicability will depend upon the activities associated with a specific remedial alternative.
Clean Water Act National Pollutant Discharge Elimination System Regulations	40 CFR 122.29, 122.41, 122.43 to 122.45, 122.48, 122.26	The CWA regulates the discharge of pollutants from point sources into waters of the United States. The NPDES regulations establish requirements for discharges of wastewater, including technology and effluent discharge limits, and for the discharge of storm water from construction activities greater than 5 acres.	These requirements are potentially applicable to alternatives involving treatment and discharge of groundwater, and portal drainage. The storm water provisions are potentially applicable to activities involving disturbance of greater than 5 acres.

Requirement	**Citation**	**Description**	**Evaluation**
Washington State Water Quality Standards for Surface Waters – Mixing Zone	RCW 90.48; WAC 173-201A-410	This Washington State regulation allows establishment of a mixing zone. The criteria for establishing the size and location of the mixing zone is described in Washington's Water Quality Standards regulations.	Establishment of a mixing zone is potentially applicable to remedial alternatives, which would require substantive compliance with NPDES permit requirements.
Construction of Wastewater Facilities	RCW 90.48; 173-240-110 to –150, -180	This regulation establishes requirements for Ecology to review plans, specifications, and engineering reports, review and approve proposed methods for operation and maintenance of industrial wastewater facilities, and approve construction modifications.	Substantive compliance with this requirement is potentially applicable to remedial alternatives involving construction of wastewater treatment systems and will be met through consultation with Ecology.
Clean Water Act Section 404	33 USC 1344(a) – (d); 33 CFR 230 and 330	Filling or construction that occurs in waters of the United States requires a Section 404 Permit from the US Army Corps of Engineers.	The substantive provisions of this requirement are potentially applicable to selected alternatives involving diversion, construction, and installation of culverts and riprap, dredging and filling of streams, creeks or wetlands. Substantive compliance would be met through consultation with the Army Corps of Engineers.

Requirement	Citation	Description	Evaluation
Federal Clean Water Act Water Quality Certification	33 USC 1341(a) and (d); WAC 173-225-010	Section 401 of the Federal Water Pollution Control Act (FWPCA) provides that applicants for a license or permit from the federal government relating to any activity which may result in any discharge into the navigable waters shall obtain a certification from the state that the water quality standards will be met. The 401 Certification is required before obtaining a section 404 permit equivalency.	No formal certification would be required for on-site work. Substantive compliance with this requirement would be potentially applicable to alternatives where substantive compliance with a federal permit equivalency (i.e., NPDES or Section 404 permit) would be required.
Temporary Modification of Water Quality Criteria and Other Requirements to Modify Water Quality Criteria	RCW 90.48; WAC 173-201A-410 through -450	Construction activity in or adjacent to surface waters that will unavoidably cause violations of the State of Washington's Surface Water Quality Criteria requires a Short-term Water Quality Modification. The regulations also have provisions for obtaining a variance, obtaining site-specific water quality criteria and applying for water offsets.	Substantive provisions of requirements allowing for short-term modification of potential chemical-specific ARARs in surface water would be potentially applicable to remedial alternatives involving dredging, filling, and construction in, or adjacent to, wetlands and streams on the Site. Substantive provisions of the regulations relating to obtaining a variance from SWQC, obtaining a site-specific water quality criteria and applying for

Requirement	Citation	Description	Evaluation
			offsets may be applicable to on-site activities impacting surface water.
Surface and Groundwater Removal	RCW 90.03.250, .340 and 90.44.050 to .060, .100	These laws specify requirements for withdrawing groundwater and surface water for beneficial use. A water rights permit is required for the removal of groundwater at a rate greater than 5,000 gallons per day. Any removal of surface water requires a water rights permit.	Substantive compliance with these requirements is potentially applicable to alternatives involving withdrawal of groundwater above the threshold amount, or withdrawal or diversion of surface water.
Criteria for the Classification of Solid Waste Disposal Facilities and Practices; Washington State Standards for Solid Waste Handling	40 CFR 257; RCW 70.95; WAC 173--350-400(3)(e)(i)(A through (H), -400(6)(a), -400(7)(a), and –710(5).	Subtitle D of RCRA establishes a framework for controlling the management of nonhazardous solid waste. The federal regulations establish guidelines under which states develop regulations for solid waste landfills. Washington State has established regulations that meet or exceed the federal solid waste disposal design criteria. This regulation specifies the requirements for minimizing liquids into the landfill by providing a cover, prohibiting placement of materials with free liquids, minimizing run-on and run-off and providing for a soil or alternative artificial liner covers, grading, and final topsoil cover. Variance from provisions in the regulations is also provided.	Tailings piles and waste rock piles are not landfills. Consolidation of tailings and soils on existing tailings does not constitute disposal. Limited provisions of these regulations, including the variance provisions, are potentially relevant and appropriate to remedial activities for the tailings and waste rock piles.

Requirement	Citation	Description	Evaluation
Maximum Environmental Noise Levels	WAC 173-60-030 to-050, -080	These regulations establish noise levels that cannot legally be exceeded. Permissible noise levels established by this regulation vary depending on the source of noise (residential, commercial, industrial), and receptor of the noise. The regulation also specifies the process for obtaining a variance, if necessary, from these requirements.	Potentially applicable during implementation of the remedial actions involving on site work.
General Regulations for Air Contaminant Sources	(RCW 70.94; WAC 173-400-040(8)).	The Washington Clean Air regulations require that owners and operators of fugitive dust source take reasonable precautions to prevent fugitive dust from becoming airborne and to maintain and operate the source to minimize emissions. Other provisions of the air regulations establish permitting and limits for emissions for sources that emit pollutants above threshold quantities.	Fugitive emissions requirements are potentially applicable activities involving soil and tailings management. Other potential air regulations may be potentially applicable to alternatives where equipment will be used. These requirements will be identified during the remedial design.

Requirement	Citation	Description	Evaluation
National Historic Preservation Act	16 USC 470; 36 CFR 800; 36 CFR 65 and 60	The National Historic Preservation Act (NHPA) requires federal agencies to assess the impact of proposed actions on historic or culturally important sites, structures, or objects within the site of the proposed projects. It further requires federal agencies to assess all sites, buildings, and objects on the site to determine if any qualify for inclusion in the National Register of Historic Places (NRHP) or as a National Historic Landmark. Criteria for evaluation are included in 36 CFR Part 60.4. If historic properties or landmarks are eligible or included in the NRHP, and exist within the areas where remedial activity will occur, the remedial activities must be designed to minimize the effect on such properties or landmarks.	These requirements are potentially applicable to the areas of the site (Railroad Creek drainage from Lucerne to the site, Holden Village town site, Holden mill and mine complex, the Talus slope near Tenmile Creek, Honeymoon Heights, and Winston home sites) some of which are being surveyed and may be considered for inclusion on the Federal Register of Historic Places. If remedial activities may impact sites, buildings or objects listed on the Federal Register of Historic Places, the remedial activities will be designed to minimize impacts.
Historic Site, Buildings and Antiquities Act	16 USC 461-471; 40 CFR 6.301(a)	This act requires that historic sites, buildings, and objects of national significance be preserved.	If sites, buildings or objects are identified for listing or listed on the Historic Site, Buildings and Antiquities Federal Register, then these requirements are potentially applicable if remedial activities will impact such areas.

Requirement	Citation	Description	Evaluation
Archaeological and Historic Preservation Act	16 USC 469	This act establishes procedure to provide for the preservation of historical and archeological data that might be destroyed through alteration of terrain as a result of a federally licensed activity or program. Presence or absence of such data on the site must be verified. If historic or archaeological artifacts are present in the area where the remedial activity will occur, the remedial activity must be designed to minimize adverse effects on the artifacts.	This requirement is potentially applicable if historical or archeological data are found in areas of the site potentially disturbed during remedy implementation.
Native American Graves Protection and Repatriation Act	25 USC 3001 et. seq; 43 CFR 10.1, 10.4, and 10.5	This act protects Native American burial sites and funerary objects. If Native American graves are discovered within the area where the remedial activity occurs, the US Department of Interior and the Indian tribe with ownership must be notified of the inadvertent discovery. And the activity must cease until a reasonable effort is taken to protect the discovered items.	This requirement is potentially applicable to land disturbing activities implemented during the remedial action if Native American burial sites or funerary objects are encountered.
Archaeological Resources Protection Act	16 USC 470aa; 43 CFR 7.1, 7.7 and 7.33;	This act and regulations specify the steps that must be taken to protect archaeological resources and sites that are on public and Native American lands and to preserve data uncovered. The presence of archeological sites should be identified before beginning any remedial activity.	This requirement is potentially applicable to land disturbing activities implemented during remedial action if archaeological resource or sites are encountered.

Requirement	Citation	Description	Evaluation
Fish and Wildlife Coordination Act	16 USC 661-667d	This act requires consultation with U.S. Fish and Wildlife Service and Washington Department of Fish and Game when waters of 10 acres or more will be impounded or diverted, or a channel deepened. Regulated projects will be evaluated for possible impacts to wildlife and identification of preventive or mitigation measures.	This requirement is potentially applicable to water diversion or dredging activities in Railroad Creek.
Fish and Wildlife Conservation Act	16 USC 2901; 50 CFR 83	The FWCA requires federal agencies to use their authority to conserve and promote conservation of non-game fish and wildlife. Non-game fish and wildlife are defined as fish and wildlife that are not taken for food or sport, that are not endangered or threatened and that are not domesticated.	This requirement is potentially applicable to areas that contain habitat for non-game fish and wildlife. Appropriate measures would be identified through consultation with USFWS and WAF&G.

Requirement	**Citation**	**Description**	**Evaluation**
Endangered Species Act	(16 USC 1531-1543, 50 CFR 402) 50 CFR 17	This act protects fish, wildlife and plants that are threatened or endangered (T/E) with extinction. It also protects habitat designated as critical to the conservation of the species. The act requires consultation with resource agencies for remedial actions that may affect these species.	This requirement is potentially applicable if federally–listed candidate species are present in the areas impacted during remedy implementation.
Wilderness Act	16 USC 1531-666; 36 CFR 293.1-.15	National Forest Wilderness Resources are to be managed to promote, perpetuate, and where necessary restore, the Wilderness character of the land and its specific values.	This requirement is potentially applicable to assessing the remedial alternatives at the Site. The potentially applicable requirements will be identified during remedial design in consultation with the USFS.
National Forest Management Act	16 USC 1600(6)	Specifically regarding forestland and resource management, Congress enacted the National Forest Management Act of 1976 (NFMA). NFMA requires the USDA Forest Service to manage the National Forest System lands according to land and resource management plans that provide for multiple-uses and sustained yield in accordance with MUSYA (16 U.S.C. 1604[e] and [g] [1]). In developing and maintaining these plans, NFMA calls for "integrated consideration of physical, biological, economic and other sciences." (16 U.S.C. 1604 [b]).	This requirement is potentially applicable to assessing the remedial alternatives at the Site. The potentially applicable requirements will be identified during remedial design in consultation with the USFS.

Requirement	Citation	Description	Evaluation
Washington State Shoreline Management Act and Federal Coastal Zone Management Act	(16 USC 1451-1464; RCW 90.58; WAC 173-27-060 15 CFR 923-930)	The Shoreline Management Act requires a permit for any development or activity valued at $2500 or more that is located on the water or shoreline area. "Shorelines" are lakes, including reservoirs, of 20 acres or greater; streams with a mean annual flow of 20 cubic feet per second or greater; marine waters; plus an area landward for 200 feet measured on a horizontal plane from the ordinary high water mark; and all associated marshes, bogs, swamps, and river deltas. Floodplains and floodways incorporated into local shoreline master programs are also included. Federal agency action that is reasonably likely to affect use of shorelines must be consistent with approved coastal zone management plan to the maximum extent practicable subject to limitations set forth in the Coastal Zone Management Act. Federal agencies are not required to obtain permits for shoreline development, but must conduct a Coastal Zone Consistency Determination which includes a project description, a brief assessment of the impacts, and a statement that the project complies with the Coastal Zone Management Program.	Railroad Creek, except portions running through federal lands, and Lake Chelan are identified as shorelines subject to the Shoreline Management Act. State Shoreline Management Act, which includes demonstrating consistency with the federal CZMA requirements are potentially applicable to remedial actions involving work in and within 200 feet of Railroad Creek and Lake Chelan, except portions running through federal lands. The CZMA requirements are potentially applicable to remedial activities impacting Railroad Creek which runs through federal lands. The substantive provisions of the CZMA will met though consultation with the USFS and EPA.

Appendix A
Agencies' 11 March 2008 Letter Regarding Modification of the 1998 AOC

United States Department of Agriculture
Office of the General Counsel

Pacific Region - Portland Office
1220 S.W. Third Avenue, Room 1734
Portland, Oregon 97204-2823

Telephone: 503-326-7264
Facsimile: 503-326-3807
E-Mail: james.alexander@usda.gov

March 11, 2008

Theodore L. Garrett
Covington & Burling
P.O. Box 7566
Washington, DC 20044-7566

RE: Holden Mine - Modification of AOC Work and Proposed Plan Deferral

Dear Ted:

As contemplated by paragraph 41 of the 1998 Holden Mine Site (Site) Administrative Order on Consent (AOC), Intalco proposed additional Work described as “Tasks and Proposed Schedules for Evaluation of Alternative Remedial Components” (“additional Work”). David Jackson e-mailed the most recent form of Intalco’s proposal for additional Work to Norman Day on March 6, 2008. This most recent form reflects mutually agreed-upon revisions from our February 13, 2008, meeting. As the lead agency for the Site, the Forest Service approves Intalco’s request for additional Work, with modifications. This approval is on behalf of the Forest Service, EPA, and the Washington Department of Ecology (collectively “the Agencies”). The Agencies’ managers propose to discuss their expectations with respect to this approval at a management meeting to be held at the EPA’s Seattle office on March 26, 2008, at a mutually agreed time. Kimberly Bown (or designee), Jim Pendowski, and Dan Opalski will represent the Agencies at this meeting. If you prefer, we could arrange this meeting as a conference call.

The required additional Work, as modified, is enclosed. Please provide written confirmation, by March 17, 2008, that Intalco will perform the additional Work, as modified, under the AOC. This additional Work is hereby incorporated into the AOC and is subject to all terms of the AOC. Modification to Intalco’s proposal consists of: edits consistent with discussions at the February 13, 2008, meeting and the follow-up conference call on February 26, 2008; changes to text regarding work schedules; and supplying completion dates for field work.

The Agencies will defer issuing the proposed plan, as it currently exists, for public comment at this time. The Agencies retain the option to issue the proposed plan at any time. The Agencies expects Intalco to conduct the additional Work in a manner that the Agencies believe is timely and satisfactory.

Contamination at the Holden Mine has continued unabated during the 10 years since Intalco agreed to complete the remedial investigation and feasibility study (RI/FS) required to select a remedial action. The existing administrative record supports the remedy identified in the Agencies' proposed plan, as it currently exists. While the alternative remedial components proposed by Intalco are not supported by the existing record, the Agencies agree that the additional Work has the potential to supplement the record to support one or more of these components. However, time is of the essence and the Agencies insist that Intalco complete the additional Work expeditiously.

The enclosed documentation of the additional Work establishes a required schedule for Intalco to complete draft work plans, final work plans, and field work. The work plans must require specific deliverables summarizing and analyzing the data collected. The work plans must include a schedule for those deliverables, with Intalco to provide the last of those deliverables no later than October 31, 2008. The Agencies' goal is to issue a proposed plan for public comment by December 19, 2008.

The Agencies understand that Intalco may elect not to perform evaluations for particular components at this time, such as the west area groundwater and seeps. In that case, the Agencies would retain the respective component in the proposed plan (Alternative 11), as it currently exists. If Intalco still wished later consideration of the component in question, Intalco must request post-ROD evaluation (e.g., in remedial design or through an ESD process).

Intalco has not paid the Agencies' oversight costs under the AOC for at least three years. Even under Intalco's unduly narrow reading of the AOC, Intalco is required to pay the Agencies' oversight costs related to the development and implementation of the additional Work. Accordingly, the Agencies expect Intalco to pay, when due, any Agency bills for Agency expenses related to this additional Work. This includes the Forest Service bill transmitted February 15, 2008, and any future Agency bills through the issuance of the Record of Decision. Please confirm Intalco's intent in this regard. It would be anomalous for Intalco and the Agencies to be working in a cooperative fashion, while at the same time the Agencies are assessing stipulated penalties for Intalco's refusal to pay the Agencies' costs associated with doing so. Note well, an Agency's acceptance of Intalco's partial payment of costs does not represent that Agency's forbearance as to recovery of the unpaid portion of those costs. The individual Agencies are addressing, or will address, unpaid costs through further communications with Intalco.

The Agencies look forward to working with Intalco to complete the additional Work in an expeditious fashion.

Sincerely,

MARCUS R. WAH
Associate Regional Attorney

/s/ James E. Alexander
James E. Alexander
Attorney

Enclosures

cc via email:

Dave Jackson, David E. Jackson & Associates, Inc.
Rik Langendoen, URS
Jennifer Barrett, ERM
Rick Roeder, WA-DOE
Andy Fitz, WA-ATG
David Einan, EPA
Jennifer MacDonald, EPA
Norm Day, FS
Fred Phillips, DOJ
Mike Bailey, Hart Crowser, Inc.
Rose Longoria, Yakama Nation
Ray Givens, Givens Law Firm (representing the Yakama Nation)
Jim Hansen, USFWS
Paul and Carol Hinderlie and Tom Ahlstrom, Co-Directors, Holden Village
Paul Haines, Holden Village
Tom Newlon, Stoel Rives (representing Holden Village, Inc.)

JEA/mg

Additional Tasks and Schedules For Evaluation of Alternative Remedial Components
Holden Mine Site, Chelan County, Washington
03-11-08

Remedial Component	Tasks to be Performed	Schedule
1. Proposed Groundwater Collection Adjacent to Tailings	**Railroad Creek Relocation** 1. Provide information addressing items in Agency Handout 1 from the February 13, 2008, meeting relating to selection of Railroad Creek Relocation. 2. The water treatment system location information needs identified in attached Agency Handout 7 (items 1-4, 6, & 7) will also be addressed under this task. **3.** Additional field investigations of hydrogeology and soil properties relevant to channel relocation will be performed (e.g. backhoe pits and nested wells) in conjunction with field investigations to the east of TP-3 described below **Groundwater Collection East of TP-3** 1. Provide information addressing items in Agency Handout 1 (attached) from the February 13, 2008, meeting relating to selection of a collection pond or barrier wall to the East of TP-3. 2. Field investigations of hydrogeology, geotechnical conditions and groundwater quality to the east of TP-3 relating to selection of collection method - collection pond or barrier wall. 3. If a collection pond is favored based on field investigation, perform additional analyses to assess the capture zone. 4. If barrier walls are favored based on field investigations, perform analyses to evaluate location, depth (partially penetrating vs. fully penetrating), and capture zone of barrier wall system.	1. Draft Work Plan to Agencies: April 4, 2008 2. Technical meeting or conference call to address comments on Draft Plan: April 24, 2008 3. Finalize Work Plan: May 1, 2008 4. Assumed Agency Approval: May 8, 2008 5. Field Work Completed: July 11, 2008

Additional Tasks and Schedules For Evaluation of Alternative Remedial Components
Holden Mine Site, Chelan County, Washington
03-11-08

Remedial Component	Tasks to be Performed	Schedule
2. Groundwater and Seeps in Lower West Area (LWA)	**West Area Groundwater Collection** 1. Provide information addressing items in Agency Handout 2 (attached) from the February 13, 2008, meeting relating to selection of the UWA barrier wall in place of a LWA barrier wall, or information to assess the location and depth (partially vs. fully penetrating) of a barrier wall in the LWA.	1. Draft Work Plan to Agencies: April 18, 2008 2. Technical Meeting on Draft Plan: May 14 & 15, 2008 (Combined with meetings for remedial components 4, 5, 6, & 8 below.) 3. Finalize Work Plan: June 20, 2008 4. Assumed Agency Approval: June 27, 2008 5. Field Work Completed: July 31, 2008
3. Portal Drainage Flow Retention	**Feasibility of Bulkhead Installation** 1. Underground investigations during RD/RA, addressing items in Agency Handout 3 (attached).	No Action at this time.

Additional Tasks and Schedules For Evaluation of Alternative Remedial Components
Holden Mine Site, Chelan County, Washington
03-11-08

Remedial Component	Tasks to be Performed	Schedule
4. Mill Building and Former Surface Water Retention Area Soils	**Cover for Mill Building Soils** 1. The information identified in Agency Handout 4 to support leaving certain soils above cleanup levels in place within the Mill Building and closing them with a cover that is protective of human health and environmental receptors will be developed during RD/RA. This work will include additional sampling to determine specific areas for removal or closure in place. **Cover for Former Surface Water Retention Area** 1. Provide information addressing items in Agency Handout 4 (attached) from the February 13, 2008, meeting relating to selection of an in-place cover for the former surface water retention area. 2. 2008 field work to include sampling of soils within retention basin and documentation of physical constraints for removal or cover actions and potential access routes and methods. 3. Documentation of ecological evaluation (to be performed under Remedial Component 8 below), engineering issues.	1. Draft Work Plan to Agencies: May 2, 2008 2. Technical Meeting on Draft Plan: May 14 & 15, 2008 (Combined with meetings for remedial components 5, 6, & 8 below.) 3. Finalize Work Plan: May 30, 2008 4. Assumed Agency Approval: June 6, 2008 5. Field Work Completed: July 31, 2008

Additional Tasks and Schedules For Evaluation of Alternative Remedial Components
Holden Mine Site, Chelan County, Washington
03-11-08

Remedial Component	Tasks to be Performed	Schedule
5. Tailings Pile Closure	**Tailings Pile Closure Evaluations** 1. Provide information addressing items in Agency Handout 5 (attached) from the February 13, 2008, meeting relating to selection of a tailings pile closure approach that is different than the presumptive cover, regrading and setback approaches assumed under Alternative 11. 2. Updated terrestrial ecological evaluation (to be performed under Remedial Component 8 below) and human health evaluation of the tailings piles will be performed. 3. The proposed areas and extent of slope regrading will be evaluated based on slope stability and compatibility with the proposed cover.	1. Technical meetings on ecological and engineering evaluation approaches: March 26 & 27, 2008. 2. Draft Work Plan appendix for engineering field work to Agencies: April 4, 2008 3. Draft Work Plan to Agencies: April 18, 2008 4. Technical meeting or conference call on engineering field work appendix: April 24, 2008 (Combined with conference call or meeting for remedial component 1, above.) 5. Agency approval of engineering field work: May 8, 2008 6. Technical Meeting on Draft Work Plan: May 14 & 15, 2008 7. Finalize Work Plan: June 20, 2008 8. Assumed Agency Approval: June 27, 2008 9. Field Work Completed: July 31, 2008

Additional Tasks and Schedules For Evaluation of Alternative Remedial Components
Holden Mine Site, Chelan County, Washington
03-11-08

Remedial Component	Tasks to be Performed	Schedule
6. Waste Rock Closure	**Waste Rock Relocation, Grading, Closure Evaluations** 1. Provide information addressing items in Agency Handout 6 relating to selection of waste rock actions that are different than the relocation and cover approaches assumed under Alternative 11. 2. Additional engineering evaluations of waste rock slope stability, volumes, access for removal, removal methods, and other engineering considerations for removal/regrading of waste rock piles will be performed, including limited additional field investigations (test pits on east/west waste rock piles). 3. Updated terrestrial ecological evaluation (to be performed under Remedial Component 8 below) and human health evaluation of the waste rock piles will be performed. 4. Additional engineering evaluations of waste rock and tailings pile cover considerations will be performed.	1. Technical meetings on Ecological and Engineering Evaluation Approaches: March 26 & 27, 2008. 2. Draft Work Plan to Agencies: April 18, 2008 3. Technical Meeting on Draft Plan: May 14 & 15, 2008 4. Finalize Work Plan: June 20, 2008 5. Assumed Agency Approval: June 27, 2008 6. Field Work Completed: July 31, 2008
7. Water Treatment System Performance	**Water Treatment Performance and Lined vs. Unlined Water Treatment Settling Ponds** 1. Provide information addressing items in Agency Handout 7 (items 4 & 5) and Agency Handout 8 (attached) related to treatment system performance and compliance with ARARs for treatment ponds. 2. Documentation of proposed monitoring and acceptability of unlined ponds within regulatory framework. Based on discussions during the February 13, 2008, meeting, Intalco anticipates that the information needs can be addressed for remedy component selection without the need for bench-scale testing prior to RD/RA.	1. Draft Work Plan to Agencies: May 22, 2008 2. Conference Call on Draft Plan: June 10, 2008 3. Finalize Work Plan: July 10, 2008 4. Assumed Agency Approval: July 17, 2008

Additional Tasks and Schedules For Evaluation of Alternative Remedial Components
Holden Mine Site, Chelan County, Washington
03-11-08

Remedial Component	Tasks to be Performed	Schedule
	3. Evaluation and documentation of reaction kinetics, mixing and aeration approach, and ability to expand, modify, or augment, as needed, a treatment system located immediately east of TP-3.	
8. Remedial Components 4, 5 and 6 and Other Soil Areas	**Expanded Ecological Risk Assessment** 1. Additional soil sampling and preparation of an updated terrestrial ecological risk assessment to establish soil cleanup levels for the Site that are protective of terrestrial receptors. This will include the LWA, areas north of Railroad Creek, and in support of evaluation of remedial components 4, 5 and 6 above. A combined ecological risk assessment report will be prepared for the Site. The ecological evaluations will develop recommended soil cleanup levels and evaluate potential approaches or cover types that would be protective of ecological receptors for areas where soils, tailings or waste rock may be left in place.	1. Technical meetings on Ecological Evaluation Approach: March 26 & 27, 2008. 2. Draft Work Plan to Agencies: April 18, 2008 3. Technical Meeting on Draft Plan: May 14 & 15, 2008 4. Finalize Work Plan: June 20, 2008 5. Assumed Agency Approval: June 27, 2008 6. Field Work Completed: July 31, 2008

Information Needed for Possible Inclusion of Alternative Remedy Components in the Proposed Plan

Agencies' Handout 1

(February 13, 2008 Meeting)

1. Proposed Groundwater Collection Adjacent to Tailings

Proposed Plan Component: Install groundwater containment (barrier wall) and collect groundwater for treatment as proposed for Alternative 11.

Potential Alternative Remedy Component: Consider relocating Railroad Creek to the north and use the former creek channel to contain, collect, and convey groundwater to treatment system downstream of TP-3. By relying on collection of groundwater in the former creek channel and in a pond east of TP-3, the goal would be to hydraulically prevent transport of groundwater above cleanup levels downgradient into Railroad Creek.

Information Needed to Select Alternative: Questions that need to be addressed to show stream relocation is equally effective and equally protective as Alternative 11.

1. Hydrologic analyses of the new channel gradient to show geomorphic stability and that the channel will support habitat;

2. Elimination of ferricrete and flocculent formation in new creek channel;

3. Assessment of impacts on riparian corridor function (old growth, wildlife migration);

4. Assessment of impacts on Holden Village (both the Village proper and the new drain field);

5. Analyses that show the proposed alternative would accomplish containment (hydraulic isolation) of the contaminated plume. Intalco would need to demonstrate the following:
   - How gaining conditions would be maintained in the old channel concurrent with losing conditions in the new channel;
   - How the system would respond to seasonal and storm-related changes in hydrologic conditions; and
   - System efficiency in collection of both shallow and deep groundwater.

6. Examples (case studies) of stream relocation that enabled effective use of the former channel for collection of contaminated groundwater, as part of cleanup at other sites;

7. Additional materials needed (e.g., riprap);

8. Impacts on road system; and

9. Ability to accommodate potential future expansion/modification of the treatment system.

Required Performance at Point of Compliance: Seeps and groundwater base flow must satisfy ARARs at the conditional point of compliance within 5 years. Groundwater head measurements in new monitoring wells on both sides of Railroad Creek must show flow into former stream channel and collection pond east of TP-3 prevents any future release of groundwater that is above proposed cleanup levels, to enable use of the Waste Management Area concept to support a conditional point of compliance.

Surface water quality must meet ARARs throughout Railroad Creek and in the wetlands downgradient of the treatment facility following remedy implementation. Groundwater monitoring downgradient of the tailings piles and downgradient of the treatment system, after implementation, would need to show that water quality does not exceed surface water protection criteria at the required points of compliance.

Selection of the stream relocation option would depend on information produced by Intalco prior to the completion of the public comment period (or if later, the ROD could be amended). Implementation would be based on remedial design and would be confirmed by monitoring after implementation.

Failure to demonstrate that surface water quality criteria are being met at the required points of compliance and that hydraulic controls are performing as designed, could trigger treatment system and/or collection system improvements, and/or installation of a groundwater containment barrier wall as described for Alternative 11.

Information Needed for Possible Inclusion of Alternative Remedy Components in the Proposed Plan

Agencies' Handout 2

(February 13, 2008 Meeting)

2. Groundwater and Seeps in Lower West Area (LWA)

Proposed Plan Component: Install groundwater containment (barrier wall) and collect groundwater for treatment in the LWA as proposed for Alternative 11.

Potential Alternative Remedy Component: Intalco has proposed installing an Upper West Area (UWA) groundwater containment (barrier wall) to collect groundwater for treatment; thereafter, the LWA groundwater would be cleaned up through natural attenuation. As discussed in the SFS, there is insufficient information to support this approach.

Information Needed to Select Alternative: Analyses to support using UWA barrier wall and natural attenuation in the LWA would need to include:

1. The amount of groundwater that enters or leaves the creek as base flow has not been directly measured. Intalco has not quantified the influence of the former creek channel or commented on the flow net analysis for the LWA presented by Hart Crowser (2005).

2. An assessment of site-specific distribution of metals between dissolved metals in groundwater and metals sorbed onto soils, and the degree to which partitioning is likely to be reversible for anticipated conditions at the Site. This should be supported by case studies that address information from other sites where similar concentrations of constituents of concern have been stabilized or depleted as a result of hydrologic changes.

3. Evaluation of the implications of Intalco's estimates of the range in groundwater pore volume flush rate, using published partition coefficients, to predict rates of natural attenuation.

4. Downward migration of metals in the LWA has not been addressed as part of estimating the rate of natural attenuation.

5. Quantitative analysis to back up the estimate provided in DFFS of a 75 percent metals load reduction over 5 years following the UWA barrier wall and collection

system, that addresses deficiencies in that already prepared by SRK (URS 2005). This should include an evaluation of *in situ* constituents that impact fate and transport: pH, redox potential, organic carbon content, alkalinity, etc. to estimate partitioning, stability of remaining metals, available attenuation capacity, etc. The analysis should identify which parameters have not been quantified for the Site, a quantification of those parameters, and analysis of how this affects estimates of the rate of natural attenuation.

Required Performance at Point of Compliance: Seeps and groundwater base flow must satisfy ARARs at the conditional point of compliance within 5 years. Surface water quality must meet ARARs throughout Railroad Creek and in the wetlands following remedy implementation.

Selection of the upper barrier wall option would depend on information produced by Intalco prior to the completion of the public comment period (or if later, the ROD could be amended). Implementation would be based on remedial design and would be confirmed by monitoring after implementation. Failure to meet criteria following implementation would trigger construction of a barrier wall along the creek.

Information Needed for Possible Inclusion of Alternative Remedy Components in the Proposed Plan

Agencies' Handout 3

(February 13, 2008 Meeting)

3. Portal Drainage

Proposed Plan Component: Install in-mine bulkheads for equalization of portal flow; so all flow would be collected for conveyance to treatment, as described for Alternative 11.

Potential Alternative Remedy Component: Above-ground retention basins may be adequate to provide flow equalization, to improve treatment plant effectiveness, but would not protect surface water in the event that subsidence of the underground workings causes a large surge of mine water to be released from the mine.

Information Needed to Select Alternative: The ROD could be modified in the event that further investigation during remedial design shows it is not practicable to construct hydraulic bulkheads.

Required Performance at Point of Compliance: Groundwater discharge from the mine must meet surface water protection criteria where it is discharged into Railroad Creek. Treatment, including necessary hydraulic controls, must be provided as part of the remedy.

Information Needed for Possible Inclusion of Alternative Remedy Components in the Proposed Plan

Agencies' Handout 4

(February 13, 2008 Meeting)

4. Cleanup of Soils above Screening Values in the Mill Building and Ventilator Portal Detention Area

Proposed Plan Component: Excavate soils above cleanup levels at locations, such as the mill building and ventilator portal detention area, and consolidate to a permanent on-site containment area, as described for Alternative 11. Remove as much of the remaining former mill building structure, as necessary, to safely access and sample milling wastes and soils within and beneath the mill building.

Potential Alternative Remedy Component: Consider leaving soils above cleanup levels in place by closing them with a cap that meets ARARs, e.g., the default requirements specified in WAC 173-350-400(3)(e)(ii). Alternatively, Intalco would need to show that any other approach that involves leaving the soils above cleanup levels in place would be protective of ecological receptors [in conformance with WAC 173-340-7493] and, if outside the area(s) of groundwater containment, would not cause any groundwater or surface water quality exceedances [WAC 173-340-740(1)(d)] and satisfy all other ARARs. Other approaches such as leaving concrete foundations in place, covering soils in place, or a combination of soil removal and covering of soils may be considered for areas in the mill building and the former ventilator portal surface water detention area, if determined to meet ARARs. Any Hazardous Waste identified must be removed.

Information Needed to Select Alternative: Intalco would need to describe the proposed alternative cleanup approach, and present engineering and ecological risk analyses to show the approach would satisfy ARARs. This includes:

1. Additional sampling and analysis to characterize soil materials in these areas (e.g., mill building and ventilator portal detention areas).

2. Conduct studies to determine bioavailibility of metals in the soils to terrestrial receptors.

3. Conduct a terrestrial ecological risk evaluation that complies with EPA (1997) guidance[1] and WAC 173-340-7493 to determine whether soils need to be removed or capped in place.

4. Monitor seeps and groundwater downgradient of the ventilator portal surface water detention area (and the mill, if groundwater containment is not provided).

Required Performance at Point of Compliance: The remaining soils or final cover/cap shall be protective as demonstrated by a terrestrial ecological evaluation that complies with EPA (1997) guidance and WAC 173-340-7493. At the ventilator surface water detention area (and at the mill, if groundwater containment is not provided), seep and groundwater base flow must satisfy ARARs at the point of compliance, assumed to be the groundwater-surface water interface, within 5 years. If ARARs are not met, remove soils that are above cleanup levels.

[1] Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment. U.S. Environmental Protection Agency. EPA 540-R-97-006. 1997.

Information Needed for Possible Inclusion of Alternative Remedy Components in the Proposed Plan

Agencies' Handout 5

(February 13, 2008 Meeting)

5. Tailings Pile Closure

Proposed Plan Component: Regrade all tailings pile slopes to provide stability as described in Alternative 11. During regrading, the toe of the tailings piles would be set back from Railroad and Copper Creeks to prevent risk of future flood, scour, or other instability from causing a massive release of tailings into the creek(s). The tailings piles would be closed in accordance with the default provisions of WAC 173-350-400 and the Forest Plan Standards and Guidelines.[2] Revegetate the tailings piles. Alternatively, the Proposed Plan allows for modifying the cap from the default provisions of WAC 173-350-400(3)(e)(ii), provided this is based on satisfying the performance requirements specified in WAC 173-350-400(3)(e)(i) and other ARARs.

Potential Alternative Component: The Proposed Plan includes provisions for modifying the tailings pile cap in accordance with ARARs. There is no alternative to regrading the slopes of all three tailings piles to assure stability and enable placement of a cover as required by ARARs. Selection of a remedy could consider an alternative that includes setting back only the portion of the tailings where Copper Creeks is in close proximity to both TP-1 and TP-2, along with channel improvements, and relocation of Railroad Creek to prevent potential future instability from releasing tailings into the creek(s).

Information Needed to Select Alternative:

1. Selection of a final tailings pile cover would need to be based on engineering and ecological risk analyses that show the closure would satisfy the requirements specified in WAC 173-350-400 and the Forest Plan Standards and Guidelines.

2. Selection of an alternative cap in accordance with WAC 173-350-400(3)(e)(i) would need to be based in part on a terrestrial ecologic evaluation that complies with EPA guidance and WAC 173-340-7493.

3. Design of final tailings pile slopes would need to satisfy requirements of WAC 173-350-400(3)(g) and the Forest Plan Standards and Guidelines.

---

[2] The Forest Plan Standards and Guidelines refer to 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).

4. Selection of a regrading plan that does not include a set back from Railroad Creek and all along Copper Creek would need to be based on an analysis of geomorphic channel stability that shows the proposed approach will prevent future instability and release of tailings.

Required Performance at Point of Compliance: As provided in Alternative 11, the final tailings pile cover shall be protective of terrestrial ecologic receptors and shall satisfy the default or performance requirements specified in state landfill standards WAC 173-350-400 and the Forest Plan Standards and Guidelines. The remedy must protect Railroad and Copper Creeks from the risk of tailings releases due to erosion, scour and other forms of instability.

Information Needed for Possible Inclusion of Alternative Remedy Components in the Proposed Plan

Agencies' Handout 6

(February 13, 2008 Meeting)

6. Waste Rock Pile Closure

Proposed Plan Component: Honeymoon Heights Waste Rock Piles, which are located within Riparian Reserves, will be excavated and consolidated onto the Main West (or East) Waste Rock Pile. Close the Main East and West Waste Rock Piles and other remaining waste rock piles by regrading and capping them in accordance with state landfill standards (WAC 173-350-400) and the Forest Plan Standards and Guidelines to protect human and terrestrial ecological receptors and reduce impacts to groundwater and surface water. The cap would consist of 2 feet of soil and a geomembrane (the presumptive cover prescribed by state regulations), unless analyses indicate an alternative cover would satisfy performance standards in the regulations [WAC 173-350-400(3)(e)(i)] and the Forest Plan Standards and Guidelines. Revegetate remaining waste rock piles and exposed soils at the site(s) of the relocated waste rock piles.

Potential Alternative Remedy Component: Based on outcome of the studies identified below, consider modifying the extent of removal, and extent of regrading and capping/cover for the Honeymoon Heights Waste Rock Piles, if shown to be protective (terrestrial and aquatic receptors) and to satisfy the performance standards (WAC 173-350-400). Close Main East and West Waste Rock Piles by regrading and capping them in accordance with state landfill standards (WAC 173-350-400) and the Forest Plan Standards and Guidelines.

Information Needed to Select Alternative Component:

1. Prepare map displaying an overlay of Riparian Reserves and the Honeymoon Heights Waste Rock Piles.

2. Sample and characterize material in waste rock piles.

3. Conduct studies to determine bioavailibility of metals in the waste rock piles to terrestrial receptors.

4. Conduct terrestrial ecologic risk evaluation that complies with EPA (1997) guidance and WAC 173-340-7493 for all waste rock piles.

5. Conduct an engineering evaluation to determine practicability (and trade-offs) of safely accessing and relocating the Honeymoon Heights Waste Rock Piles.

6. Perform slope stability analysis on remaining waste rock piles in conformance with state landfill requirements (WAC 173-350-400) and the Forest Plan Standards and Guidelines.

Required Performance at Point of Compliance: The final waste rock pile covers shall be protective as demonstrated by a terrestrial ecologic evaluation that complies with EPA (1997) guidance and WAC 173-340-7493 and shall satisfy the performance requirements specified in WAC 173-350-400(3)(e)(i) and the Forest Plan Standards and Guidelines. Final determination of the extent of Honeymoon Heights Waste Rock Piles relocation and final closure requirements for the remaining waste rock piles will depend on information produced by Intalco prior to the completion of the public comment period (or if later, the ROD could be amended).

Information Needed for Possible Inclusion of Alternative Remedy Components in the Proposed Plan

Agencies' Handout 7

(February 13, 2008 Meeting)

7. Treatment System Ponds

Proposed Plan Component: Install one treatment system, with lined ponds, on the north side of Railroad Creek downstream of Tailings Pile 3.

Alternative Remedy Components: Consider installing two treatment plants (one near the current lagoon area and one downstream from Tailings Pile 3 on the south side of a relocated Railroad Creek).

Information Needed to Select Alternative: Questions that need to be addressed:

1. Impacts on riparian corridor function (old growth, wildlife migration);
2. Impacts on Holden Village;
3. Impacts on road system;
4. Ability to accommodate potential expansion/modification of the groundwater collection and/or treatment systems;
5. Ability to satisfy ARARs (e.g., the Ecology Permit Writer's Handbook);
6. Stream channel stability and flood protection; and
7. Wetlands impacts.

Required Performance at Point of Compliance: Seepage from the ponds shall not degrade groundwater quality or reduce the rate of surface water quality improvement. Water quality impacts due to seepage from the ponds shall be monitored within groundwater immediately adjacent to and downgradient of the ponds. The ponds will need to be lined and/or other changes made to the system if ARARs are not met at the point of compliance following implementation.

Information Needed for Possible Inclusion of Alternative Remedy Components in the Proposed Plan

Agencies' Handout 8

(February 13, 2008 Meeting)

8. Treatment System Performance

Proposed Plan Component: Implement single treatment facility as proposed for Alternative 11.

Potential Alternative Remedy Component: Consider implementing two treatment facilities, incorporating conventional low-energy technologies for alkalinity adjustment and settling.

Information Needed to Select Alternative: Questions that need to be addressed to show alternative treatment systems are effective and equally protective as Alternative 11.

1. Case study information for multiple sites indicating that the proposed systems produce effluent of similar quality to that expected from Alternative 11, within the constraints of the Holden Mine Site (e.g., available hydraulic elevation gradient east of TP-3); and

2. Ability to be expanded/modified/augmented based on actual performance.

Required Performance at Point of Compliance: Treated effluent must satisfy water quality criteria at discharge from outfall. The treatment system would need to be modified if ARARs are not met following remedy implementation. Mixing zone, if any, must satisfy WAC 173-201 A-400.

Appendix B
Draft Honeymoon Heights
Focused Drainage Analysis
(URS, 2009c)

(Submitted under Separate Cover)

Appendix C
Draft Geotechnical Technical Memorandum (URS, 2009b)

(Submitted under Separate Cover)

Appendix D
Draft Proposed Railroad Creek Realignment Technical Memorandum (URS, 2009a)

(Submitted under Separate Cover)

Appendix E
Draft Hydrogeology Technical Memorandum (URS, 2009d)

(Submitted under Separate Cover)

Appendix F
Draft Supplemental Human Health Evaluation for the Tailings and Waste Rock Piles (URS, 2009e)

(Submitted under Separate Cover)

Appendix G
Draft Terrestrial Ecological Evaluations Report (ERM, 2009a)

(Submitted under Separate Cover)

Appendix H
Water Treatment System Performance Evaluations Report (ERM, 2009b)

(Submitted under Separate Cover)

Appendix I
Preliminary Ecological Indicator Soil Concentrations

Draft Memorandum

Environmental Resources Management

2525 Natomas Park Drive
Suite 350
Sacramento, CA 95833
(916) 924-9378
(916) 920-9378 (fax)

ERM®

To: Ms. Jennifer Barrett, ERM

From: Mr. Mark Shibata; Ms. Sandra Mulhearn; Mr. Mark Bowland and Ms. Sarah Piper, ERM

Date: 5 August 2009

Subject: Preliminary AOI-Specific Ecological Indicator Soil Concentrations for the Holden Mine Site

---

At the request of the Agencies, preliminary ecological indicator soil concentrations (EISCs) for terrestrial ecological receptors at Holden areas of interest (AOIs) are presented in the attached Tables I-1 through I-8. The preliminary AOI-specific EISCs presented in Tables I-1 through I-8 are either the hazard quotient (HQ)-based soil concentrations or the background area EISCs, whichever was greater. Preliminary background area EISCs are presented in Tables I-9 and I-10.

HQ-Based Soil Concentration. In the draft terrestrial ecological evaluation (TEE), HQs were calculated using:

- Soil concentration (field measurements);
- Plant tissue burdens for conifers, shrubs, grasses (field measurements);
- Soil invertebrate tissue burdens (field measurements);
- Wildlife exposure factors (e.g., food ingestion rate) (from Model Toxics Control Act [MTCA]); and
- Toxicity reference values (TRV) (from MTCA).

For representative surrogate wildlife receptors[1], the HQ was defined as:

$$HQ = \frac{AUF \bullet \{(FIR \bullet C_{food} \bullet RGAF_{food}) + (SIR \bullet C_{soil} \bullet RGAF_{soil})\}}{TRV}$$

---

[1] Representative surrogate receptors evaluated in the TEE include:

- Blue grouse (herbivorous bird);
- American robin (invertebrate-consuming bird);
- Northern goshawk (carnivorous bird);
- Long-tailed vole (herbivorous small mammal);
- Snowshoe hare (herbivorous mammal);
- Mule deer (herbivorous large mammal);
- Trowbridge's shrew (invertebrate-consuming mammal); and
- Weasel (carnivorous mammal).

where:

AUF	=	area use factor is equal to the AOI area/home range and is an estimate of the percent of time the receptor spends at the AOI (unitless, ranging from 0 to 100 percent)
FIR	=	food ingestion rate ($kg_{food}/kg_{body\ weight}$-day, dry weight [DW])
C_{food}	=	constituent exposure point concentration in food (mg/kg_{food}, DW)
C_{soil}	=	constituent exposure point concentration in soil (mg/kg_{soil}, DW)
RGAF	=	gut absorption factor percent of concentration in food or soil that is absorbed across the gastrointestinal tract (unitless, ranging from 0 to 100 percent) [assumed to be 100 percent absorption across gastrointestinal tract]
SIR	=	incidental soil ingestion rate ($kg_{soil}/kg_{body\ weight}$-day, DW)
TRV	=	toxicity reference value ($mg/kg_{body\ weight}$-day, DW)

For representative surrogate wildlife receptors, preliminary HQ-based soil concentrations ($HQBC_{soil}$) were "back-calculated" by setting the HQ equal to one (HQ = 1) and solving for the soil concentration[2]:

$$HQBC_{soil}\ (mg/kg_{soil}) = \frac{(TRV/AUF) - (FIR \bullet C_{food})}{SIR}$$

The back-calculated HQ-based soil concentrations used the same data as the "forward-calculated" HQs, with the exception that the soil concentration (not the HQ) was the parameter of interest. Because TRVs for plants and soil invertebrates are in units of soil concentration (mg/kg_{soil}), the $HQBC_{soil}$s are the TRVs.

2 For practical purposes, the goalseek function was applied to the TEE worksheets to solve for $HQBC_{soil}$.

Background Area EISCs. Background soil concentrations were calculated and presented in the draft TEE (ERM 2009) for the eastside mixed conifer forest background area (BGMC) and eastside riparian wetland habitat background area (BGR) using the approach described in MTCA (WAC [Washington Administrative Code] 173-340-709[3]):

- For normally distributed background data, the background concentration is defined as the 80th percentile or four times the true 50th percentile, whichever is lower.
- For lognormally distributed background data, the background concentration is defined as the 90th percentile or four times the true 50th percentile, whichever is lower.

Preliminary HQ-based soil concentrations were also calculated for both BGMC and BGR using methods described in the previous section.

For the purposes of establishing preliminary AOI-specific EISCs, the preliminary background area EISC is the background soil concentration or the HQ-based background soil concentration, whichever was greater. Preliminary background area EISCs that are based on the HQ-based soil concentrations are presented in bold text in Tables I-9 and I-10.

AOI-Specific EISCs. Preliminary AOI-specific EISCs (in units of mg/kg_{soil}) are provided on an AOI-by-AOI basis for:

- Plants
- Soil invertebrates
- Herbivorous mammals[3]
- Invertebrate-consuming mammals (Trowbridge's shrew)
- Carnivorous mammals (weasel)
- Herbivorous birds[4]
- Invertebrate-consuming birds (American robin)
- Carnivorous birds (northern goshawk)

---

3 Lowest EISC for conifer-/shrub-/grass-consuming vole, conifer-/shrub-/grass-consuming snowshoe hare, and conifer-/shrub-/grass-consuming mule deer.

4 Lowest EISC for conifer-/shrub-/grass-consuming blue grouse.

The preliminary AOI-specific EISCs that are exceed by the AOI exposure point concentrations for soil are presented in bold text in Tables I-1 through I-8. Note that alternative TRVs are currently being considered for several potential constituents of concern, including copper and thallium. Revised AOI-specific EISCs for these metals will be provided to the Agencies when they are available.

Tables

Table I-1a

Preliminary EISCs - Tailings Pile 1
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)									
		Barium	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Molybdenum**	**Silver**	**Thallium**	**Zinc**
Plants - 0-1 ft bgs	--	**500**	4.0	42	**100**	**50**	0.93	**8.8**	**2.0**	1.0	**136**
Plants - 0-6 ft bgs	--	500	**4.0**	42	**100**	**50**	0.93	**8.8**	**2.0**	**1.0**	**136**
Soil Invertebrates	--	3000	20	42	**50**	500	0.93	200	50	NA	200
Birds											
Herbivorous Bird	Plant Materials	2419	3255	799	9760	1829	147	5703	319	NA	18744
American Robin	Soil Invertebrates	911	914	223	2635	521	42	1623	87	NA	4149
Northern Goshawk	Small Mammals	6873	815	1297	16632	4149	300	14739	852	NA	54358
Mammals											
Herbivorous Mammal	Plant Materials	933	1848	3679	3787	2463	275	50	721	**0.36**	66349
Trowbridge's Shrew	Soil Invertebrates	9075	3162	7722	7344	4394	636	487	1268	8.4	136099
Weasel	Small Mammals	814	31	502	593	295	54	73	143	1.1	15222
Surface Soil (0-1 ft) EPC		541	0.73	11	297	96	0.35	30	3.0	0.82	161
Subsurface Soil (0-6 ft) EPC		460	37	10	2355	86	0.38	33	4.2	1.0	4563

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration
bgs = below ground surface
EPC = exposure point concentration
HQ = hazard quotient
TEE = terrestrial ecological evaluation

AOI EISC (mg/kg$_{soil}$ [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.

Background area EISC (mg/kg$_{soil}$ [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)						
		Barium	Cadmium	Copper	Lead	Molybdenum	Silver	Zinc
Plants - 0-1 ft bgs	--	**500**	4.0	**100**	50	**8.8**	**2.0**	**136**
Plants - 0-6 ft bgs	--	500	**4.0**	**100**	**50**	**8.8**	**2.0**	**136**
Soil Invertebrates	--	3000	20	**50**	500	200	50	**200**
Birds								
Herbivorous Bird	Plant Materials	2702	3263	9742	1823	5702	320	20407
American Robin	Soil Invertebrates	911	914	2635	521	1623	87	4149
Northern Goshawk	Small Mammals	6873	815	16632	4149	14739	852	54358
Mammals								
Herbivorous Mammal	Plant Materials	1627	1875	3787	2443	47	726	66349
Trowbridge's Shrew	Soil Invertebrates	9075	3162	7344	4394	487	1268	136099
Weasel	Small Mammals	814	31	593	295	73	143	15222
Surface Soil (0-1 ft) EPC		581	1.6	187	50	21	2.5	273
Subsurface Soil (0-6 ft) EPC		407	61	1653	115	21	3.8	4492

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration

bgs = below ground surface

EPC = exposure point concentration

HQ = hazard quotient

TEE = terrestrial ecological evaluation

AOI EISC (mg/kg_{soil} [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.

Background area EISC (mg/kg_{soil} [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Table I-1c

Preliminary EISCs - Tailings Pile 3

Draft Alternative 13M Evaluation Report

Holden Mine Site, Chelan County, WA

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)				
		Copper	Lead	Molybdenum	Silver	Zinc
Plants - 0-1 ft bgs	--	**100**	**50**	**8.8**	**2.0**	**136**
Plants - 0-6 ft bgs	--	**100**	**50**	**8.8**	**2.0**	**136**
Soil Invertebrates	--	**50**	500	200	50	**200**
Birds						
Herbivorous Bird	Plant Materials	9812	1821	5731	321	20309
American Robin	Soil Invertebrates	2850	521	1623	88	4149
Northern Goshawk	Small Mammals	16632	4149	14739	852	54358
Mammals						
Herbivorous Mammal	Plant Materials	3787	2434	154	727	66349
Trowbridge's Shrew	Soil Invertebrates	9568	4394	487	1278	136099
Weasel	Small Mammals	593	295	73	143	15222
Surface Soil (0-1 ft) EPC		161	77	23	2.8	393
Subsurface Soil (0-6 ft) EPC		451	67	20	4.0	1761

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration

bgs = below ground surface

EPC = exposure point concentration

HQ = hazard quotient

TEE = terrestrial ecological evaluation

AOI EISC (mg/kg_{soil} [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.

Background area EISC (mg/kg_{soil} [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Table I-2
Preliminary EISCs - Area of Windblown Tailings
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)		
		Copper	Molybdenum	Zinc
Plants - 0-1 ft bgs	--	**100**	**8.8**	**136**
Plants - 0-6 ft bgs	--	**100**	**8.8**	**136**
Soil Invertebrates	--	**50**	200	200
Birds				
Herbivorous Bird	Plant Materials	7810	4488	16397
American Robin	Soil Invertebrates	2635	1632	4149
Northern Goshawk	Small Mammals	4771	4299	14553
Mammals				
Herbivorous Mammal	Plant Materials	3787	105	66349
Trowbridge's Shrew	Soil Invertebrates	7344	588	136099
Weasel	Small Mammals	593	73	15222
Surface Soil (0-1 ft) EPC		128	18	145
Subsurface Soil (0-6 ft) EPC		118	19	138

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration

bgs = below ground surface

EPC = exposure point concentration

HQ = hazard quotient

TEE = terrestrial ecological evaluation

AOI EISC (mg/kg$_{soil}$ [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.

Background area EISC (mg/kg$_{soil}$ [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Table I-3a
Preliminary EISCs - East Waste Rock Pile
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)									
		Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Molybdenum	Silver	Zinc
Plants - 0-1 ft bgs	--	**10**	**500**	**4.0**	**42**	**100**	**50**	**0.93**	**8.8**	**2.0**	**136**
Plants - 0-6 ft bgs	--	**10**	**500**	**4.0**	**42**	**100**	**50**	0.93	**8.8**	**2.0**	**136**
Soil Invertebrates	--	60	3000	20	**42**	**50**	500	**0.93**	200	50	**200**
Birds											
Herbivorous Bird	Plant Materials	16766	15796	15248	3796	46885	8602	686	26908	1530	99256
American Robin	Soil Invertebrates	1023	967	930	233	2870	526	42	1642	94	6093
Northern Goshawk	Small Mammals	40676	32075	4017	6296	78144	21110	1401	68782	3977	261125
Mammals											
Herbivorous Mammal	Plant Materials	4390	3957	1873	3682	3787	2467	275	234	723	66349
Trowbridge's Shrew	Soil Invertebrates	7778	9667	3333	7822	9778	4444	636	687	1338	156289
Weasel	Small Mammals	3079	3137	126	2021	2505	1452	208	281	553	63874
Surface Soil (0-1 ft) EPC		20	626	5.6	120	2449	318	1.2	19	4.6	1154
Subsurface Soil (0-6 ft) EPC		30	533	4.7	81	1714	260	0.59	21	3.6	950

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration
bgs = below ground surface
EPC = exposure point concentration
HQ = hazard quotient
TEE = terrestrial ecological evaluation

AOI EISC (mg/kg_{soil} [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.
Background area EISC (mg/kg_{soil} [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Table I-3b
Preliminary EISCs - West Waste Rock Pile
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)							
		Arsenic	Cadmium	Chromium	Copper	Lead	Molybdenum	Silver	Zinc
Plants - 0-1 ft bgs	--	10	**4.0**	**42**	**100**	**50**	**8.8**	**2.0**	**136**
Plants - 0-6 ft bgs	--	**10**	**4.0**	**42**	**100**	**50**	**8.8**	**2.0**	**136**
Soil Invertebrates	--	60	20	**42**	**50**	500	200	50	**200**
Birds									
Herbivorous Bird	Plant Materials	16702	15250	3796	46937	8602	26908	1530	98545
American Robin	Soil Invertebrates	1023	930	233	2870	526	1642	94	6093
Northern Goshawk	Small Mammals	40679	4017	6294	78144	21105	68782	3977	261119
Mammals									
Herbivorous Mammal	Plant Materials	4390	1879	3682	3788	2467	234	723	66349
Trowbridge's Shrew	Soil Invertebrates	7778	3333	7822	9778	4444	687	1338	156289
Weasel	Small Mammals	3081	126	2022	2503	1452	281	553	63838
Surface Soil (0-1 ft) EPC		10	13	63	1590	176	25	3.0	1940
Subsurface Soil (0-6 ft) EPC		20	10	48	1022	249	15	3.5	1351

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration
bgs = below ground surface
EPC = exposure point concentration
HQ = hazard quotient
TEE = terrestrial ecological evaluation

AOI EISC (mg/kg_{soil} [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.
Background area EISC (mg/kg_{soil} [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)							
		Arsenic	**Copper**	**Lead**	**Mercury**	**Molybdenum**	**Silver**	**Thallium**	**Zinc**
Plants - 0-1 ft bgs	--	**10**	**100**	**50**	**0.93**	**8.8**	**2.0**	**1.0**	**136**
Plants - 0-6 ft bgs	--	**10**	**100**	**50**	**0.93**	**8.8**	**2.0**	**1.0**	**136**
Soil Invertebrates	--	60	**50**	**500**	**0.93**	200	50	NA	**200**
Birds									
Herbivorous Bird	Plant Materials	16697	46718	8602	686	26908	1530	NA	99213
American Robin	Soil Invertebrates	1023	2870	**526**	42	1642	94	NA	6093
Northern Goshawk	Small Mammals	40676	78144	21110	1401	68782	3977	NA	261125
Mammals									
Herbivorous Mammal	Plant Materials	4390	3787	2466	275	233	723	**0.36**	66349
Trowbridge's Shrew	Soil Invertebrates	7778	9778	4444	636	687	1338	16	156289
Weasel	Small Mammals	3079	2505	**1452**	208	281	553	4.3	63858
Surface Soil (0-1 ft) EPC		30	1446	1905	3.4	22	8.2	1.5	522
Subsurface Soil (0-6 ft) EPC		30	1446	1905	3.4	22	8.2	1.5	522

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration
bgs = below ground surface
EPC = exposure point concentration
HQ = hazard quotient
TEE = terrestrial ecological evaluation

AOI EISC (mg/kg_{soil} [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.

Background area EISC (mg/kg_{soil} [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)								
		Arsenic	Cadmium	Copper	Lead	Mercury	Molybdenum	Selenium	Silver	Zinc
Plants - 0-1 ft bgs	--	**16**	**4.0**	**110**	**50**	**0.43**	**2.9**	**1.4**	**2.0**	**177**
Plants - 0-6 ft bgs	--	**16**	**4.0**	**110**	**50**	**0.43**	**2.9**	**1.4**	**2.0**	**177**
Soil Invertebrates	--	60	20	**110**	500	**0.43**	200	70	50	**200**
Birds										
Herbivorous Bird	Plant Materials	2822	2514	7810	1436	115	4520	122	249	16397
American Robin	Soil Invertebrates	878	825	2412	514	42	1631	39	92	2822
Northern Goshawk	Small Mammals	768	64	**1342**	242	26	1265	17	73	3143
Mammals										
Herbivorous Mammal	Plant Materials	4401	305	3787	2468	275	222.5	44	723	66349
Trowbridge's Shrew	Soil Invertebrates	6268	2240	5022	4323	636	577	81	1315	122319
Weasel	Small Mammals	804	31	**593**	295	54	73	4.9	143	15222
Surface Soil (0-1 ft) EPC		20	5.3	1679	77	1.9	17	2.4	3.3	1007
Subsurface Soil (0-6 ft) EPC		20	5.3	1679	77	1.9	17	2.4	3.3	1007

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration
bgs = below ground surface
EPC = exposure point concentration
HQ = hazard quotient
TEE = terrestrial ecological evaluation

AOI EISC (mg/kg_{soil} [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.
Background area EISC (mg/kg_{soil} [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)									
		Arsenic	**Cadmium**	**Copper**	**Lead**	**Mercury**	**Molybdenum**	**Selenium**	**Silver**	**Thallium**	**Zinc**
Plants - 0-1 ft bgs	--	**16**	**4.0**	**110**	**50**	**0.43**	**2.9**	**1.4**	**2.0**	**1.0**	**177**
Plants - 0-6 ft bgs	--	**16**	**4.0**	**110**	**50**	**0.43**	**2.9**	**1.4**	**2.0**	1.0	**177**
Soil Invertebrates	--	60	**20**	**110**	**500**	**0.43**	200	70	50	NA	**200**
Birds											
Herbivorous Bird	Plant Materials	11174	10154	31046	5719	457	17850	498	1016	NA	62874
American Robin	Soil Invertebrates	782	825	**2412**	**514**	42	1623	33	92	NA	2822
Northern Goshawk	Small Mammals	27223	2641	52041	13831	934	45855	1237	2652	NA	173356
Mammals											
Herbivorous Mammal	Plant Materials	4390	1840	**3787**	2430	275	**2.9**	32	719	**0.13**	66349
Trowbridge's Shrew	Soil Invertebrates	5270	2240	**5022**	4323	636	488	21	1315	8.4	122319
Weasel	Small Mammals	2058	**82**	**1640**	914	139	187	23	369	2.9	41943
Surface Soil (0-1 ft) EPC		23	107.8	6552	654	1.0	51	7.0	11	1.4	2153
Subsurface Soil (0-6 ft) EPC		20	130	6231	644	1.1	53	10	11	1.0	17314

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration
bgs = below ground surface
EPC = exposure point concentration
HQ = hazard quotient
TEE = terrestrial ecological evaluation

AOI EISC (mg/kg$_{soil}$ [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.
Background area EISC (mg/kg$_{soil}$ [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Table I-6b

Preliminary EISCs - Lower West Area-West

Draft Alternative 13M Evaluation Report

Holden Mine Site, Chelan County, WA

Receptor	Food Source	Ecological Indicator Soil Concentrations (AOI EISCs)
		Arsenic
Plants - 0-1 ft bgs	--	**16**
Plants - 0-6 ft bgs	--	**16**
Soil Invertebrates	--	60
Birds		
Herbivorous Bird	Plant Materials	11183
American Robin	Soil Invertebrates	782
Northern Goshawk	Small Mammals	27223
Mammals		
Herbivorous Mammal	Plant Materials	4415
Trowbridge's Shrew	Soil Invertebrates	5270
Weasel	Small Mammals	2058
Surface Soil (0-1 ft) EPC		25
Subsurface Soil (0-6 ft) EPC		26

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration

bgs = below ground surface

EPC = exposure point concentration

HQ = hazard quotient

TEE = terrestrial ecological evaluation

AOI EISC (mg/kg_{soil} [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.

Background area EISC (mg/kg_{soil} [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)		
		Copper	Lead	Zinc
Birds				
Herbivorous Bird	Plant Materials	21204	3875	42871
American Robin	Soil Invertebrates	2635	521	4149
Northern Goshawk	Small Mammals	35434	9252	117533
Mammals				
Herbivorous Mammal	Plant Materials	3787	2395	66349
Trowbridge's Shrew	Soil Invertebrates	7344	4394	136099
Weasel	Small Mammals	1093	583	28009
Surface Soil (0-1 ft) EPC		260	52	225
Subsurface Soil (0-6 ft) EPC		260	52	225

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration
bgs = below ground surface
EPC = exposure point concentration
HQ = hazard quotient
TEE = terrestrial ecological evaluation

AOI EISC (mg/kg$_{soil}$ [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.

Background area EISC (mg/kg$_{soil}$ [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Table I-8
Preliminary EISCs - Ballfield/Wilderness Boundary Area
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Receptor	Food Source	Preliminary AOI-Specific Ecological Indicator Soil Concentrations (AOI EISCs)	
		Copper	**Zinc**
Plants - 0-1 ft bgs	--	100	**136**
Plants - 0-6 ft bgs	--	100	**136**
Soil Invertebrates	--	**50**	200
Birds			
Herbivorous Bird	Plant Materials	35013	73085
American Robin	Soil Invertebrates	2635	6071
Northern Goshawk	Small Mammals	58264	194264
Mammals			
Herbivorous Mammal	Plant Materials	3852	66349
Trowbridge's Shrew	Soil Invertebrates	7344	156059
Weasel	Small Mammals	1847	47181
Surface Soil (0-1 ft) EPC		72	155
Subsurface Soil (0-6 ft) EPC		72	155

Notes:

AOI EISC = area-of-interest-specific ecological indicator soil concentration
bgs = below ground surface
EPC = exposure point concentration
HQ = hazard quotient
TEE = terrestrial ecological evaluation

AOI EISC (mg/kg_{soil} [dw]) is the HQ-based soil concentration or the background area EISC, whichever is greater.

Background area EISC (mg/kg_{soil} [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.

Bolded values = AOI EISC < AOI EPC

NA = not available -- due to lack of toxicity reference value

Table I-9
Preliminary EISCs - Background Eastside Mixed Conifer Forest
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Receptor	Food Source	Preliminary Background Area-Specific Ecological Indicator Soil Concentrations (BG EISCs)											
		Arsenic	**Barium**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Molybdenum**	**Selenium**	**Silver**	**Thallium**	**Zinc**
Plants - 0-1 ft bgs	--	**10**	**500**	**4.0**	**42**	**100**	**50**	0.93	8.8	12	**2.0**	**1.0**	136
Plants - 0-6 ft bgs	--	**10**	**500**	**4.0**	**42**	**100**	**50**	0.93	8.8	12	**2.0**	**1.0**	136
Soil Invertebrates	--	**60**	**3000**	**20**	**42**	**50**	**500**	0.93	**200**	**70**	**50**	**NA**	**200**
Birds													
Herbivorous Bird	Plant Materials	**2819**	**1790**	**2471**	**603**	**7810**	**1417**	**115**	**4350**	**77**	**236**	NA	**16397**
American Robin	Soil Invertebrates	**994**	**911**	**914**	**223**	**2635**	**521**	**42**	**1623**	12	**87**	NA	**4149**
Northern Goshawk	Small Mammals	**768**	**590**	**64**	**100**	**1342**	**242**	**26**	**1265**	**17**	**73**	NA	**3143**
Mammals													
Herbivorous Mammal	Plant Materials	**4390**	**933**	**106**	**3598**	**3787**	**2395**	**273**	8.8	12	**673**	0.36	**66349**
Trowbridge's Shrew	Soil Invertebrates	**7476**	**9075**	**3162**	**7722**	**7344**	**4394**	**636**	**487**	12	**1268**	**6.4**	**136099**
Weasel	Small Mammals	**804**	**814**	**31**	**502**	**593**	**295**	**54**	**73**	12	**143**	**1.1**	**15222**
Background Soil EPC		4.8	164	3.3	24	45	14	0.93	8.8	12	0.65	0.36	136

Notes:

BG EISC = background area-specific ecological indicator soil concentration
bgs = below ground surface
EPC = exposure point concentration
HQ = hazard quotient
TEE = terrestrial ecological evaluation

Background area EISC (mg/kg$_{soil}$ [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.
Bolded values = Background EISC is HQ-based

NA = not available -- due to lack of toxicity reference value

Table I-10
Preliminary EISCs - Background Eastside Riparian Wetland
Draft Alternative 13M Evaluation Report
Holden Mine Site, Chelan County, WA

Receptor	Food Source	Preliminary Background Area-Specific Ecological Indicator Soil Concentrations (BG EISCs)											
		Arsenic	**Barium**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Molybdenum**	**Selenium**	**Silver**	**Thallium**	**Zinc**
Plants - 0-1 ft bgs	--	16	**500**	**4.0**	**42**	110	**50**	0.43	2.9	1.4	**2.0**	**1.0**	177
Plants - 0-6 ft bgs	--	16	**500**	**4.0**	**42**	110	**50**	0.43	2.9	1.4	**2.0**	**1.0**	177
Soil Invertebrates	--	**60**	**3000**	**20**	**42**	110	**500**	0.43	**200**	**70**	**50**	**NA**	**200**
Birds													
Herbivorous Bird	Plant Materials	**2819**	**1790**	**2471**	**603**	**7810**	**1417**	**115**	**4350**	**77**	**236**	NA	**16397**
American Robin	Soil Invertebrates	**782**	**825**	**825**	**227**	**2412**	**514**	**42**	**1623**	**23**	**92**	NA	**2822**
Northern Goshawk	Small Mammals	**768**	**590**	**64**	**100**	**1342**	**242**	**26**	**1265**	**17**	**73**	NA	**3143**
Mammals													
Herbivorous Mammal	Plant Materials	**4390**	**933**	**106**	**3598**	**3787**	**2395**	**273**	2.9	1.4	**673**	0.13	**66349**
Trowbridge's Shrew	Soil Invertebrates	**5270**	**8183**	**2240**	**7767**	**5022**	**4323**	**636**	**488**	1.4	**1315**	**6.4**	**122319**
Weasel	Small Mammals	**804**	**814**	**31**	**502**	**593**	**295**	**54**	**73**	**4.9**	**143**	**1.1**	**15222**
Background Soil EPC		16	133	1.8	38	110	25	0.43	2.9	1.4	0.60	0.13	177

Notes:

BG EISC = background area-specific ecological indicator soil concentration
bgs = below ground surface
EPC = exposure point concentration
HQ = hazard quotient
TEE = terrestrial ecological evaluation

Background area EISC (mg/kg_{soil} [dw]) is the background soil concentration (see draft TEE) or the HQ-based background soil concentration, whichever is greater.
Bolded values = Background EISC is HQ-based

NA = not available -- due to lack of toxicity reference value