Project Number 5681

CAPTAIN JACK SUPERFUND SITE RECORD OF DECISION

CDPHE PROJECT: HMWMD-RP-06

EPA ID: COD981551427

September 2008

Prepared for:

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and

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List of Acronyms and Abbreviations

µg/L	micrograms per liter
ABA	Absolute Bioavailability
AMD	Acid Mine Drainage
amsl	above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirement
AST	Above ground Storage Tank
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BMP	Best Management Practice
BOD	Biological Oxygen Demand
$CaCO_3$	Calcium Carbonate
CCR	Code of Colorado Regulations
CDI	Chronic Daily Intake
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CJM	Captain Jack Mill
cm	centimeter
CO_2	Carbon Dioxide
COCs	Chemicals of Concern
COD	Chemical Oxygen Demand
COPC	Contaminant of Potential Concern
CSF	Slope Factor
CSFi	Inhalation Cancer Slope Factor
CSFo	Oral Cancer Slope Factor
CSM	Conceptual Site Model
cy	cubic yards
CWA	Clean Water Act
DMG	Colorado Division of Minerals and Geology
E&E	Ecology and Environment, Inc.
EPA	U.S. Environmental Protection Agency
EPC	Exposure Point Concentration
EPDM	Ethylene Propylene Diene Terpolymer
ER	Electrical Resistivity
ERA	Ecological Risk Assessment
FR	Federal Register
FS	Feasibility Study
GCL	Geocomposite Clay Liner

List of Acronyms and Abbreviations (continued)

gpm	gallons per minute
GPS	Global Positioning System
HDPE	High-Density Polyethylene
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HMWMD	Hazardous Materials and Waste Management Division
HP	Horsepower
HQ	Hazard Quotient
IEUBK	Integrated Exposure Uptake Biokinetic
INL	Idaho National Laboratory
IRIS	Integrated Risk Information System
kg	kilogram
LHD	Load-Haul-Dump
LWOG	Lefthand Watershed Oversight Group
m	meter
NaOh	Sodium Hydroxide
MCL	maximum contaminant level
mg	milligram
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MSHA	Mine Safety and Health Administration
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRHP	National Register of Historic Places
O&M	Operating and Maintenance
ORNL	Oak Ridge National Laboratory
OSE	Office of State Engineers
OSWER	Office of Solid Waste and Emergency Response
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCOC	Preliminary Contaminant of Concern
POC	Point of Compliance
PRG	Preliminary Remediation Goal
PRP	Potential Responsible Party
RAGS A	Risk Assessment Guidance for Superfund Volume I, Part A, Human Health Evaluation Manual
RAO	Remedial Action Objective
RBA	Relative Bioavailability
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose

List of Acronyms and Abbreviations (continued)

RfDi	Inhalation Reference Dose
RfDo	Oral Reference Dost
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	Reporting Limit
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SCM	Site Conceptual Model
SF	Slope Factor
SI	Site Investigation
Site	CJM Superfund Site
SOPs	Standard Operating Procedures
SVOC	Semivolatile Organic Compound
TAL	Target Analytical List
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TEM	Time-Domainal Electromagnetics
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
TVS	Table Value Standard
UCL95	95% Upper Confidence Limit
UOS	URS Operating Systems
URF	unit risk factor
URS	URS Consultants
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
Walsh	Walsh Environmental Scientists and Engineers, LLC
WQCC	Water Quality Control Commission
XRF	X-Ray Fluorescence

CAPTAIN JACK SUPERFUND SITE

CDPHE PROJECT: HMWMD-RP-06

EPA ID: COD981551427

PART ONE: THE DECLARATION

1 Site Name and Location

The Captain Jack Mill (CJM) Superfund Site is located near Ward, Colorado, within the Left Hand Creek Watershed. The National Superfund Database Identification Number is COD981551427.

2 Statement of Basis and Purpose

This Record of Decision (ROD) document presents the "Selected Remedy" for the CJM Superfund Site (the Site or CJM Site). The Selected Remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 United States Code §9601 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300, as amended.

This decision is based on the Administrative Record for the Site, which has been developed in accordance with Section 113(k) of CERCLA, 42 United States Code §9613(k). The Administrative Record file is available for review at the Colorado Department of Public Health and Environment (CDPHE) office in Denver, Colorado, and at the U.S. Environmental Protection Agency (EPA Region 8) Records Center in Denver, Colorado. The Administrative Record Index (Appendix A) identifies each of the items comprising the Administrative Record upon which the selection of the Remedial Action is based.

The remedy was developed by CDPHE and EPA. These agencies then jointly proposed a preferred remedy to the public in the proposed plan. Upon consideration of public responses, CDPHE and EPA now approve the Selected Remedy.

3

Assessment of the Site

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

4 Description of the Selected Remedy

CDPHE and EPA will address the site contamination as one operable unit. The site-specific media have been divided into two categories to address the sources of contamination. The major elements of remedial activities involve:

- Surface Contamination Sources;
- Subsurface Contamination Sources; and
- Operational Monitoring

Surface Contamination Sources: The Remedial Investigation/ Feasibility Study (RI/FS) identified three main mine and mill areas of contamination: the Big Five Tunnel, Captain Jack Mill area, and White Raven Mine. Approximately 85,000 cubic yards (cy) of contaminated waste rock, tailings, and soils were identified, which includes approximately 9,000 cy of the highest contaminant-concentration materials considered principal threat waste. Material considered to be contaminated contains concentrations that exceed 85 milligrams per kilogram (mg/kg) of arsenic, site specific values ranging from 380 to 860 mg/kg of lead, and/or 5.2 mg/kg of thallium.

Subsurface Contamination Sources: Up to 50 gallons per minute of metals-contaminated water is draining from the Big Five adit and eventually flows into Left Hand Creek. The source of the metals-contaminated water is the mineralized and oxidizing subsurface conditions present within the Big Five adit and mine workings. Samples from water seeping from the fractures within the Big Five tunnel and water discharging from the tunnel indicated strongly acidic water, with elevated cadmium and copper levels. Dissolved metal concentrations have the following ranges:

- Cadmium (4.26 to 7.2 micrograms per liter [µg/L]);
- Copper (888 to 2,540 µg/L);
- Iron (5,710 to 26,100 µg/L); and
- Manganese (3,230 to 6,650 µg/L).

The components of the Selected Remedy are described in detail in Section 19 of this ROD.

The major components of the Selected Remedy are briefly summarized below:

1. Surface Contamination Remediation:

Alternative 2C was selected because the contaminated surface material will be contained in on-site consolidation cell(s). The contaminated waste materials are located primarily at the Big Five to CJM area, CJM, White Raven, and White Raven to Sawmill areas. It should be noted that excavation of contaminated material will be limited to the vertical and horizontal extents defined within the volume calculations presented in the FS (Walsh 2008b). Contaminated material - which will remain in place after reaching the design excavation depth – will be treated to reduce mobility, backfilled with clean fill and covered with a vegetated soil cap.

The on-site consolidation cell will potentially be located at the CJM site along the escarped slope bordering the former tailings ponds on the northeast. The contaminated material currently in the former tailings ponds will not be excavated since it will become part of the consolidation cell. Waste material from all five areas of contamination at the Site will be placed in the consolidation cell and compacted.

The cap for the consolidation cell will consist of 6 inches of topsoil on top of 12 inches of select fill on top of a geosynthetic clay liner. Before the clay liner is placed, caustic material will be mixed into the top 6 inches of the waste material to neutralize the waste and minimize leaching of acidic material. The liner will provide a barrier between the waste material and the upper cap layers and prevent clean water from infiltrating into the underlying waste material. Vegetation on top of the cover will require annual maintenance. This may require reseeding several times within the first few years until a self-supporting vegetative cover is established. A crushed-rock apron or cap layer also will be considered to keep rodents from burrowing into the cap.

Capping and erosion-protection materials are expected to be available within a 3- to 4-acre borrow area on or near the Site. The specific location for the borrow area will be fully evaluated during the design phase, including evaluation of areas adjacent to the CJM If on- or near-site borrow locations do not contain sufficient volumes of needed material, the balance of capping material may need to be imported.

Surface water will be diverted around the consolidation cell and capped areas of the Site. Surface water controls will include swales and rip-rap-lined channels to provide erosion protection and control run-on/run-off.

The remedy will require various site improvements. Because the Site access is via a single-lane vehicle road, road improvements will be required. There will need to be excavation around existing structures to remove contaminated material, provide access for construction of the consolidation cell and capping, and improve site drainage. Related work will include design and oversight, mobilization of personnel and equipment, site grading, installation of drainage systems and erosion control, and demobilization. Access controls will be needed during construction which will include fencing, signage, and restrictions to vehicles and people moving through the site. The construction contractor will need to communicate closely with onsite residents to minimize heath and safety issues while implementing the work.

2. Subsurface Contamination Remediation:

Alternative 3B was selected because the remedy will undertake restoration of the ground and surface waters by treating mine water "in-situ". The principal subsurface sources are the acid-generating materials associated with the underground mine-workings and tunnel(s) of the Big Five mine. The "in-situ" remedial objective is to submerge (to the extent safely practicable) source materials in order to minimize contact with oxygen, and to implement active neutralization of impounded mine-pool waters in order to treat continuing long-term acid water inflows. If needed, a second phase of remedial operations will be to design and install an ex-situ bioreactor for further treatment of mine-discharge waters.

In-Situ Mine-Pool Treatment

A bulkhead will be installed in the tunnel at a location approximately 470 to 675 feet from the Big Five adit portal. In order to be able to draw down and sample water behind the bulkhead, it will contain stainless steel through-piping and valves. The annular space between the plug and the mine tunnel will be grouted to seal off the AMD when the valves are closed. Implementing the bulkhead will require additional studies during the design phase including surveys, geotechnical evaluations, hydrostatic and hydrodynamic loading, and other engineering design aspects.

Mine-pool mitigation will be implemented "upstream" of the bulkhead. The mine pool treatment options are anticipated to include a neutralization loop with an injection and extraction well drilled into the tunnel reservoir approximately 2,400 feet up-gradient from the tunnel bulkhead. In addition, a secondary treatment access point – where, if necessary, additional neutralization could be added — may be installed at another mid-point location upstream of the bulkhead, west of the Peak to Peak highway. Current assumptions are that the injection and extraction wells will be approximately 450 feet deep, and will introduce a caustic agent such as sodium hydroxide (NaOH). Ongoing operational adjustments to the dosing rate are anticipated to adequately buffer the flooded workings.

If emerging science and remedial technology developments associated with sulfide-reduction bioreactor-processes warrant it, consideration may be given to implementing carbon-loading within the mine-pool.

Ex-situ Mine-Water Treatment

If a second phase of mine-water treatment is necessary, water from behind the bulkhead valve will be routed out of the Big Five adit and into a biochemical reactor(s). The biochemical reactor(s) may be located on top of the Big Five pile or below the pile in the area that is now the on-site pond. The size of the bioreactor(s) will depend on a variety of design factors, including the substrate chosen (i.e., solid or liquid substrate). Additional neutralization may be required prior to entry into the bioreactors and could be accomplished through gravity drip systems within the discharge piping and/or neutralization ponds.

Design considerations for successive biochemical reactors at the CJM Site may require detailed bench and/or pilot-scale studies to address specific factors such as organic-carbon types, flow permeability and hydraulics, and sludge characteristics and disposal.

To avoid vandalism, freezing, and other safety and operational issues, the reactor-cells could either be built below grade and covered with a layer of large boulders (for a solid substrate biochemical reactor), or housed in a "greenhouse-type" building to minimize climate fluctuations and better control hydrogen sulfide gas (for a liquid substrate biochemical reactor). If a liquid substrate biochemical reactor is selected, a detailed hydrogen sulfide monitoring and control plan would need to be developed as part of the design phase.

Ongoing sludge management will be required, although sludge volumes and management will be much less intensive as neutralization and resulting precipitates would be occurring within the tunnel itself. It's anticipated that two sulfide sludge cells will complement the biochemical reactors, and they would likely be installed in parallel to allow for rotating maintenance. Sludge generated by this process would likely be disposed of as solid waste; however, treatability studies will confirm whether this process is the proper method. Regular off-site sludge disposal is anticipated.

3. Operational Monitoring

In-Situ Mine-Pool Reservoir. The remedial actions addressing the underground mine-pool require a comprehensive monitoring system because:

- there is limited information regarding the extent of mine-workings and the hydraulic characteristics of bedrock fracture systems throughout the reservoir zone of the Big Five tunnel;
- mine-pool mitigation involves carefully controlled neutralization, hydraulic controls and "containment" of the treatment zone and mine-pool; and
- in-situ treatment of mine-pool systems is innovative with limited prior project applications; therefore careful tracking of both geochemistry and spatial movement of ground-waters is warranted.

System(s) for mine-pool operational monitoring will require:

- direct-measurements of the mine-pool reservoir, including bore-holes/wells for placement of pressure transducers and geochemical sensors;
- subsurface spatial-monitoring utilizing geophysics-methods to track mine-pool chemistry and groundwater movement;
- surface seep observation and monitoring; and
- electronic data-collection and storage to minimize on-site sampling and laboratory analysis.

Ex-Situ Bioreactor. For the bioreactor system(s) outside of the adit-portal, a monitoring system will be required for operational controls of the various geo- and biochemical treatment processes.

Surface-Water Monitoring of Left Hand Creek. While the mine pool is neutralized inside the Big Five tunnel, surface water monitoring will be conducted to assess the water quality of Left Hand Creek. If, after two years of mine pool neutralization, the mine pool treatment appears to have stabilized and the downstream Remedial Action Objectives (RAOs) are not being met for surface water, the second phase of this remedy will be implemented. If treatment has not yet stabilized, additional monitoring will be conducted to ascertain the effectiveness of the in-situ mine pool neutralization prior to implementation of the second phase. If downstream RAOs are being met for surface water, the second phase of this remedy will not be implemented.

5 Statutory Determinations

The Selected Remedy meets the requirements of CERCLA §121, and the regulatory requirements of the NCP. This remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the Remedial Action, is cost-effective, and utilizes permanent solutions to the maximum extent practicable.

The Selected Remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduce the toxicity, mobility, or volume of hazardous substances through treatment).

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

6 ROD Data Certification Checklist

The following information is included in the Decision Summary (Part 2) of this ROD, while additional information can be found in the Administrative Record file for this site:

1. Chemicals of concern (COCs) and their respective concentrations (Section 12.8);
2. Baseline risk represented by the COCs (Section 14);
3. Remediation goals (i.e., cleanup levels) established for the COCs and the basis for the levels (Section 16);
4. How source materials constituting principal threats are addressed;
5. Current and reasonably anticipated future land use assumptions, and current and potential future beneficial uses of the Site used in the Baseline Human Health Risk Assessment (HHRA) and this ROD (Sections 13 and 14);
6. Potential land use that will be available at the Site as a result of the Selected Remedy (Section 13);
7. Estimated capital, lifetime operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (Appendix B); and
8. Key factor(s) that led to selecting the remedy (Section 19).

7

Authorizing Signature, Concurrence Page, Record of Decision

This ROD documents the Selected Remedy for surface and subsurface contamination sources at the CJM Superfund Site. CDPHE and EPA jointly selected this remedy. The following authorized official at CDPHE approves the Selected Remedy as described in this ROD.

Sept 29, 2008

Martha Rudolph
Director of Environmental Programs   Date

Colorado Department of Public Health and the Environment

The following authorized official at the US Environmental Protection Agency Region 8 approves of the Selected Remedy for the CJM Site as described in this ROD.

9/29/08

for Carol L. Campbell   Date
Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

CAPTAIN JACK SUPERFUND SITE

CDPHE PROJECT: HMWMD-RP-06

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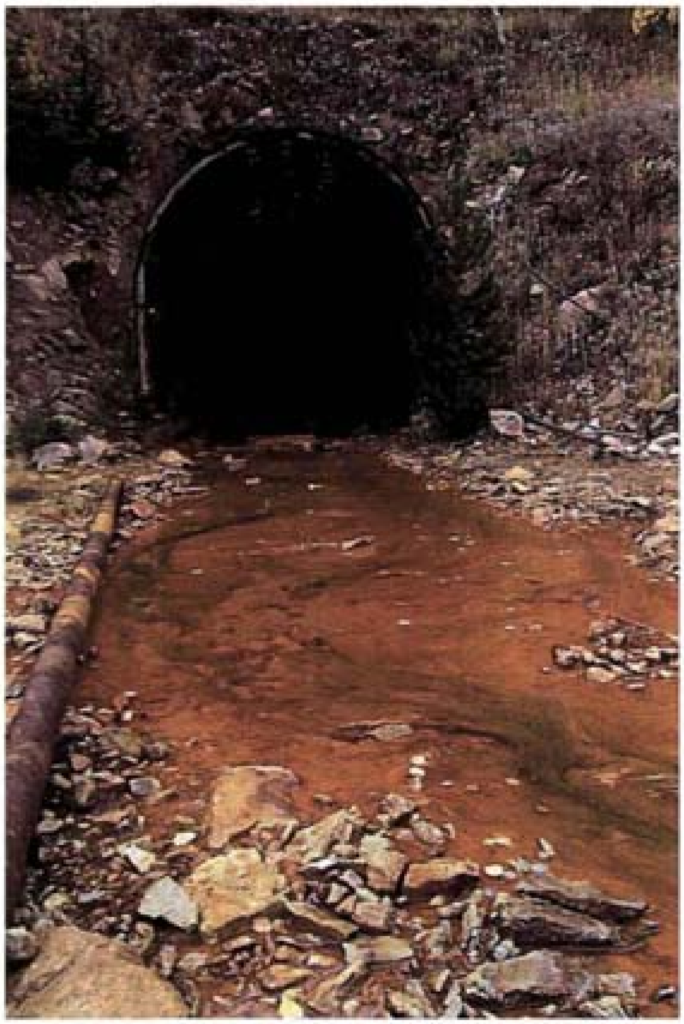


PART TWO: THE DECISION SUMMARY

8 Site Name, Location, and Description

The Captain Jack Superfund Site is located near the Town of Ward, Colorado, within the Left Hand Creek Watershed (Figure 8-1). The Site is located in the southeastern quarter of Section 12, Township 1 North, Range 73 West, and the northwestern quarter of Section 18, Township 1 North, Range 72 West, Boulder County, Colorado. Elevations at the Site range from 8,550 to 9,040 feet above mean sea level (amsl). The National Superfund Database Identification Number for the Site is COD981551427. The CJM Site is a State-lead site, with CDPHE as lead agency for the remedial activities and EPA supporting. Potential Responsible Party(ies) (PRP(s)) for the Site have not been identified and did not participate in the RI/FS.

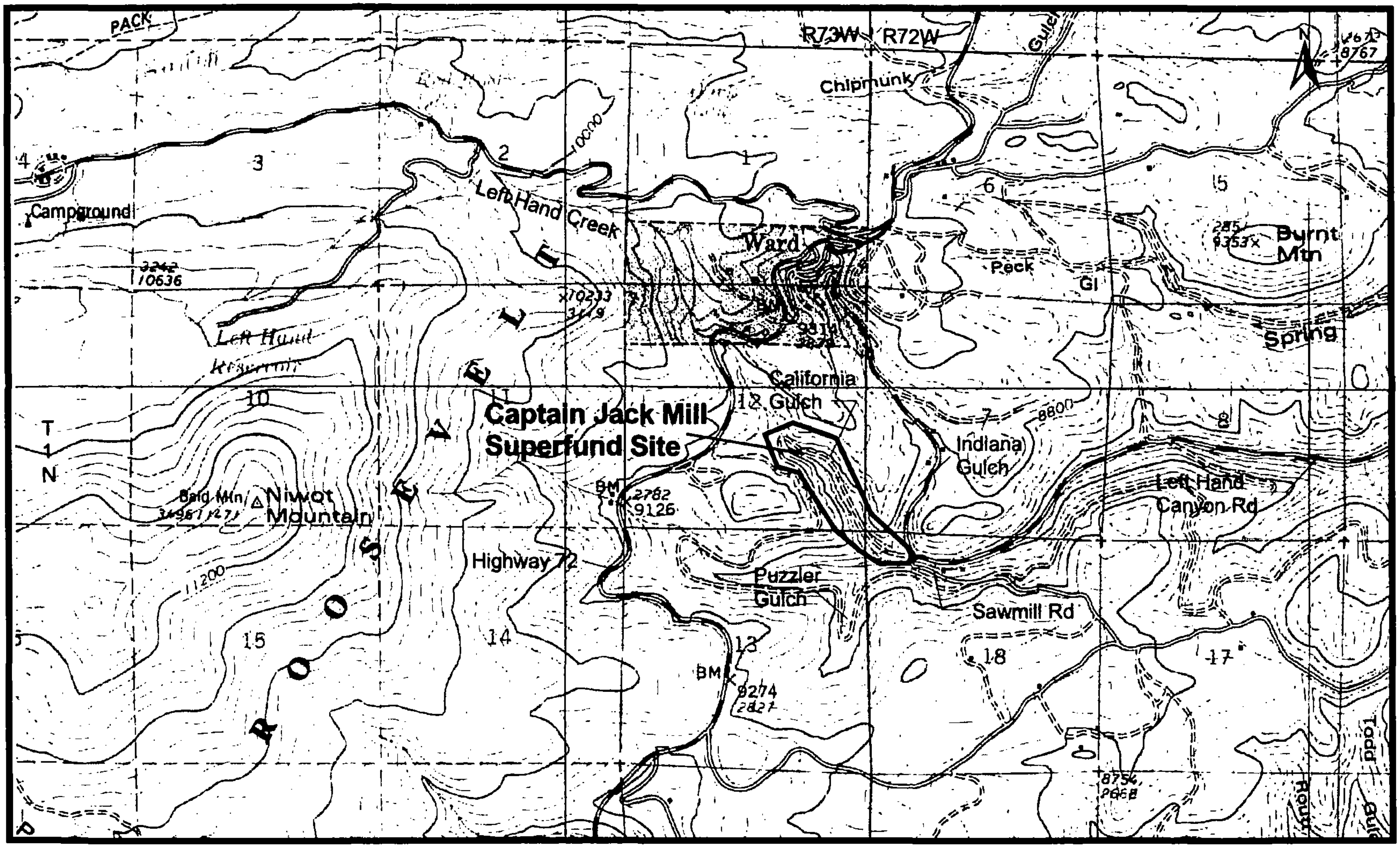
Left Hand Creek flows through the Site from northwest to southeast. The Left Hand Ditch Water District distributes water from Left Hand Creek to approximately 6,318 downstream connections from a diversion structure located approximately 15 miles downstream of the Site (LWOG 2004). The Left Hand Ditch Company stores some of their water in Left Hand Reservoir, located approximately 3 miles upstream of the Site. Most of the Site property is in private ownership with property boundaries coinciding with mining claims. The principal mining areas associated with the Site are described below.

Five areas of investigation are present at the Site and are depicted on Figures 8-2 through 8-6 and briefly discussed below:

Big Five Area

The Big Five area consists of underground mine workings and associated sulfide source materials, which cause releases of acid mine drainage (AMD) into and through the:

- Big Five adit tunnel and associated mine-workings;
- Big Five Mine dump;
- Big Five settling pond;



Source: USGS 1:24,000 Topographic Map
Compiled from maps dated 1957-1972;
Revised from aerial photographs dated 1975-1976, and 1978;
UTM Zone 13, NAD 27.

0 1 Mile
Scale

Figure 8-1

Location Map - Captain Jack Mill Superfund Site

Walsh
Environmental Scientists and Engineers, LLC

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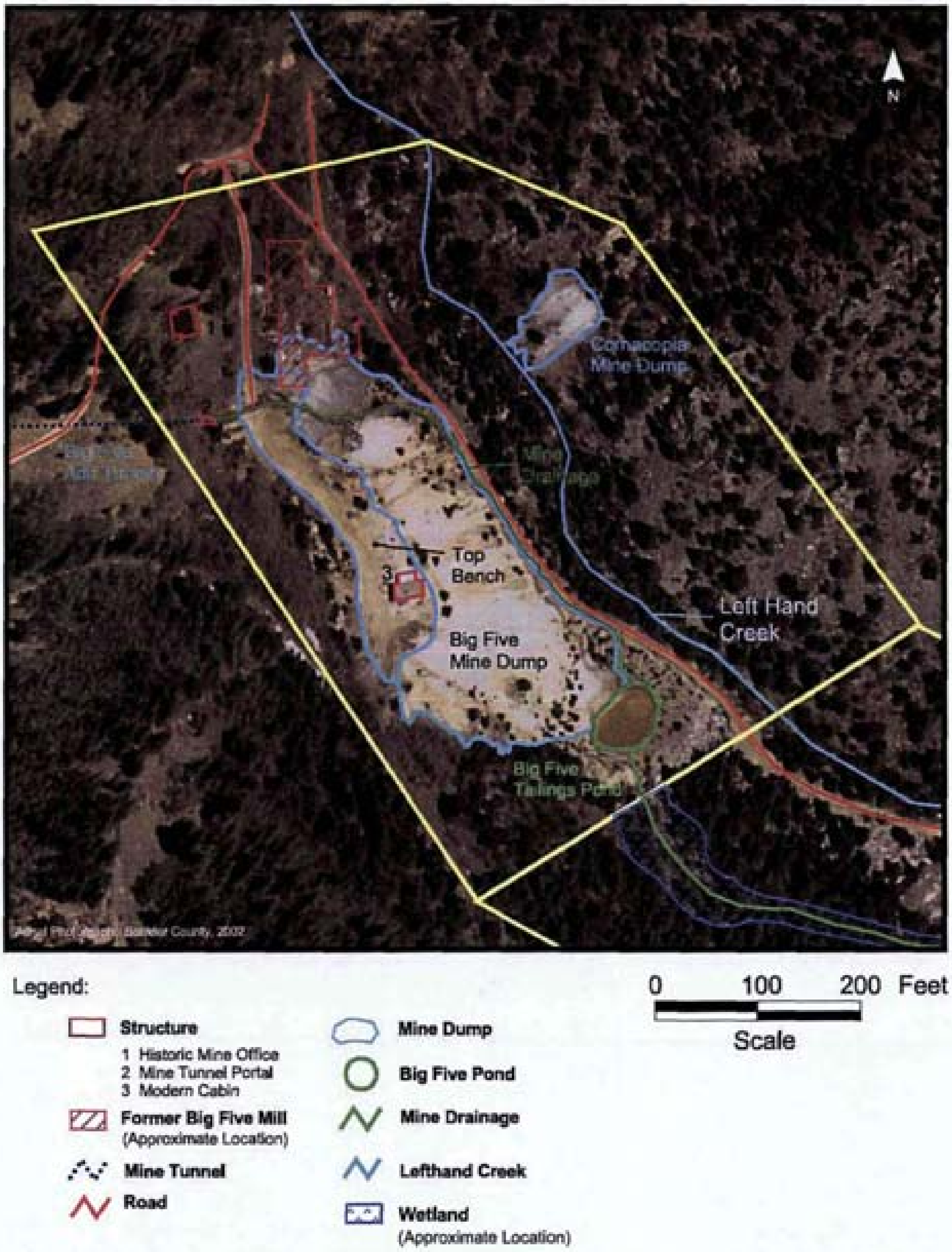
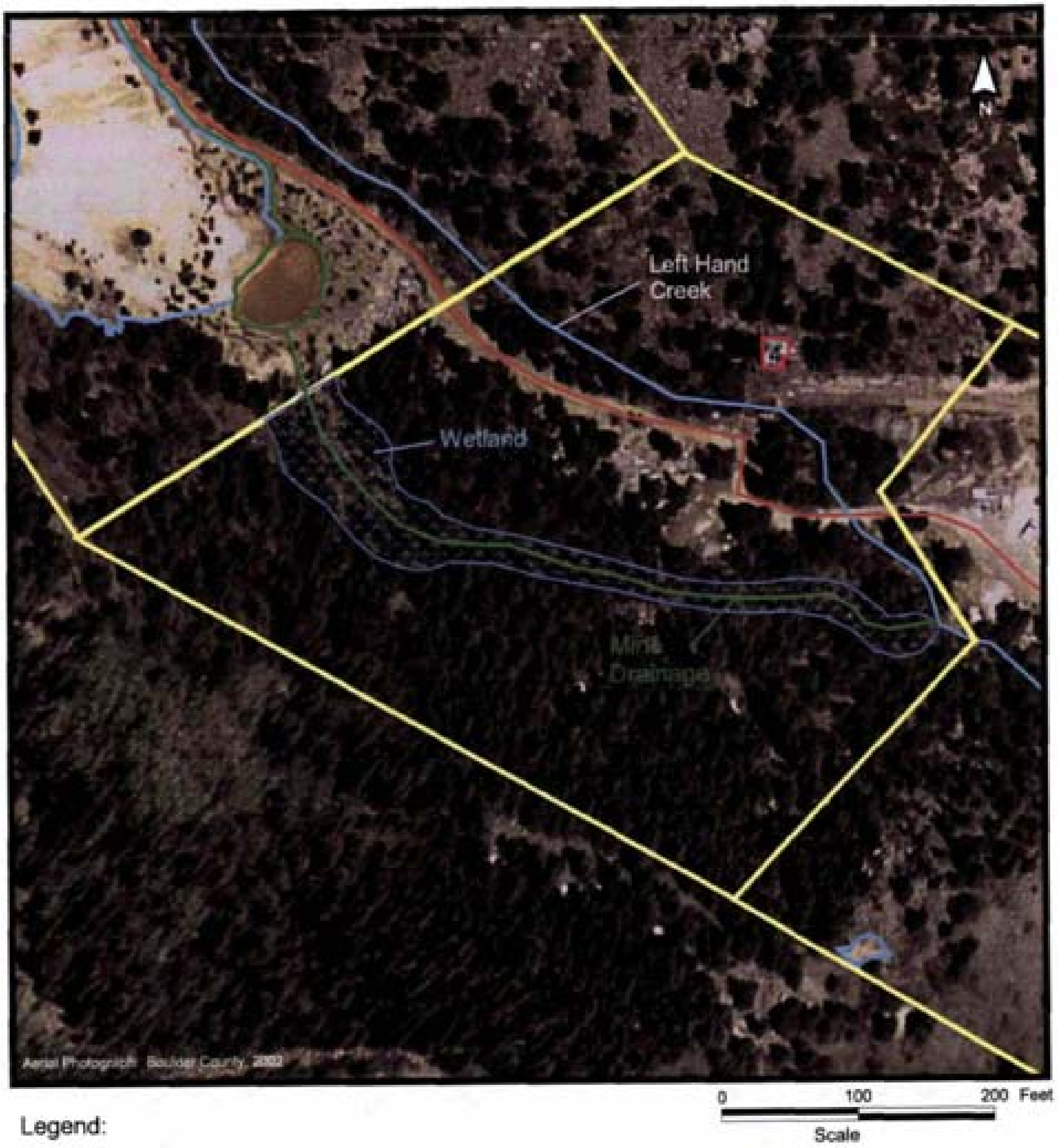


Figure 8-2
Site Features - Big Five Area of Investigation
Captain Jack Mill Superfund Site

Walsh



Legend:

- Structure
  4 Daily Residence
- Wetland
  (Approximate Location)
- Road
- Mine Dump
- Big Five Pond
- Mine Drainage
- Lefthand Creek

Figure 8-3
Site Features - Big Five to Captain Jack Area of Investigation
Captain Jack Mill Superfund Site

Walsh
Environmental Scientists and Engineers, LLC

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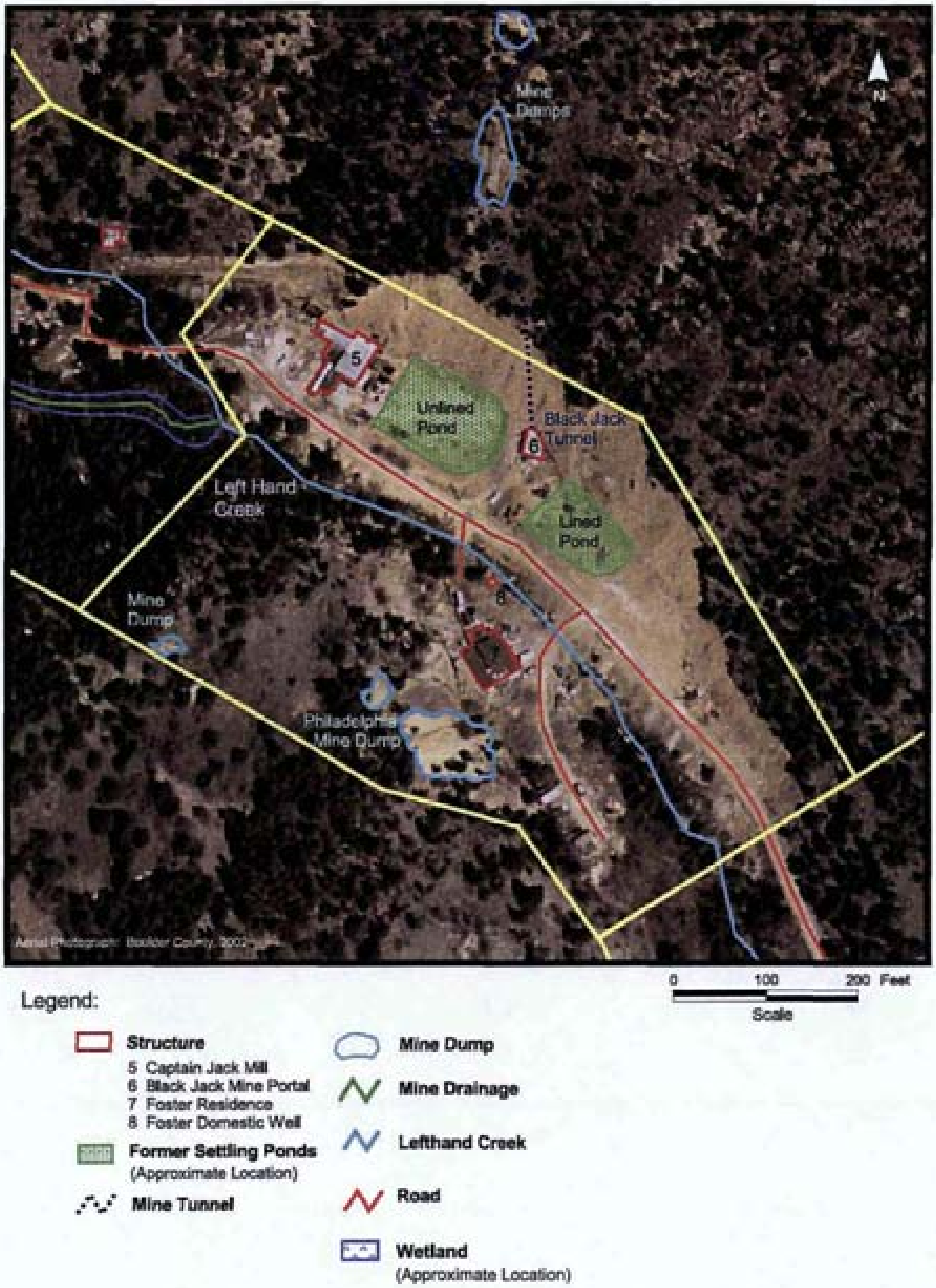

Figure 8-4
Site Features - Captain Jack Mill Area of Investigation
Captain Jack Mill Superfund Site

Walsh
Environmental Scientists and Engineers, LLC

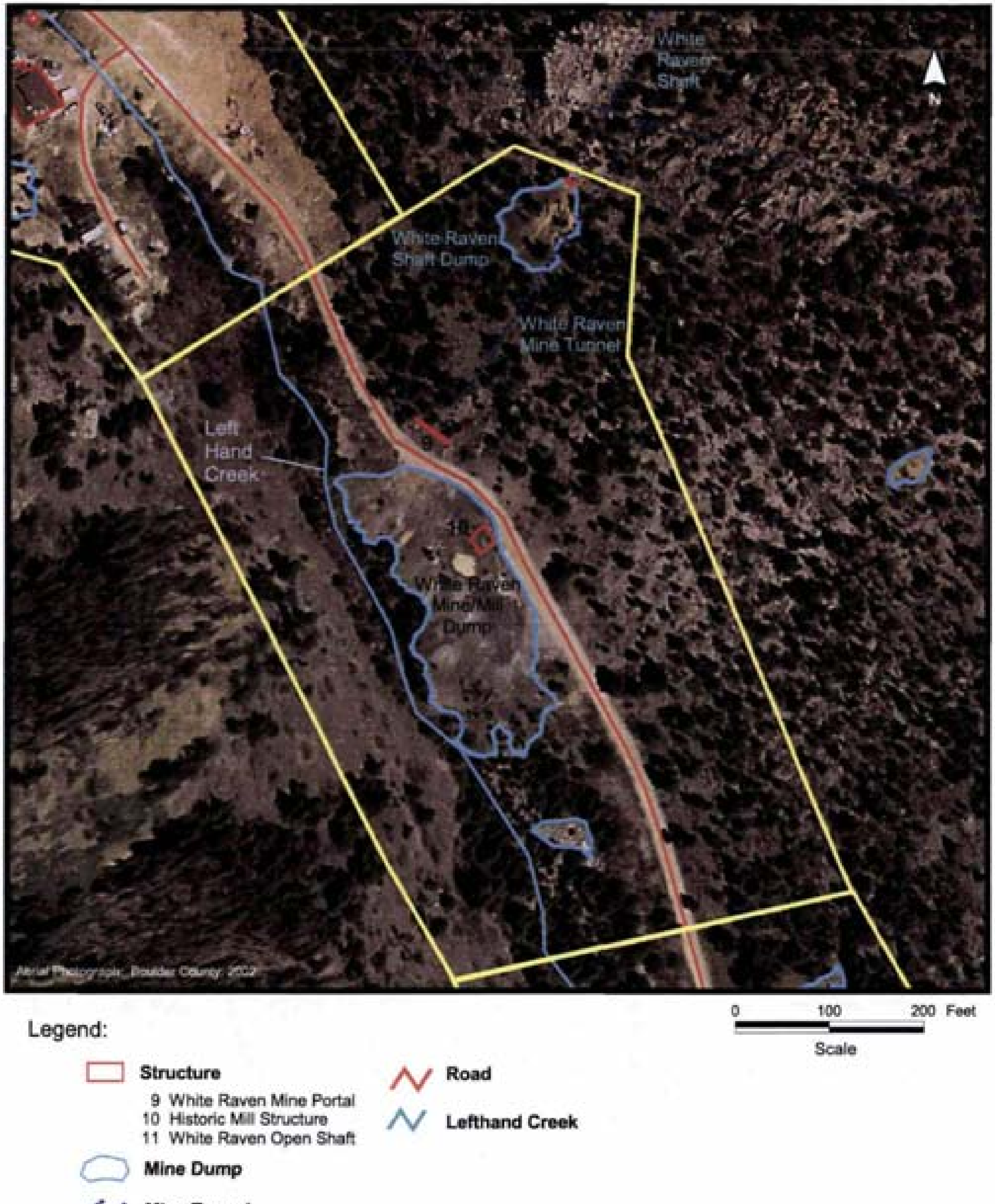

Figure 8-5
Site Features - White Raven Area of Investigation
Captain Jack Mill Superfund Site

Walsh
Environmental Scientists and Engineers, LLC

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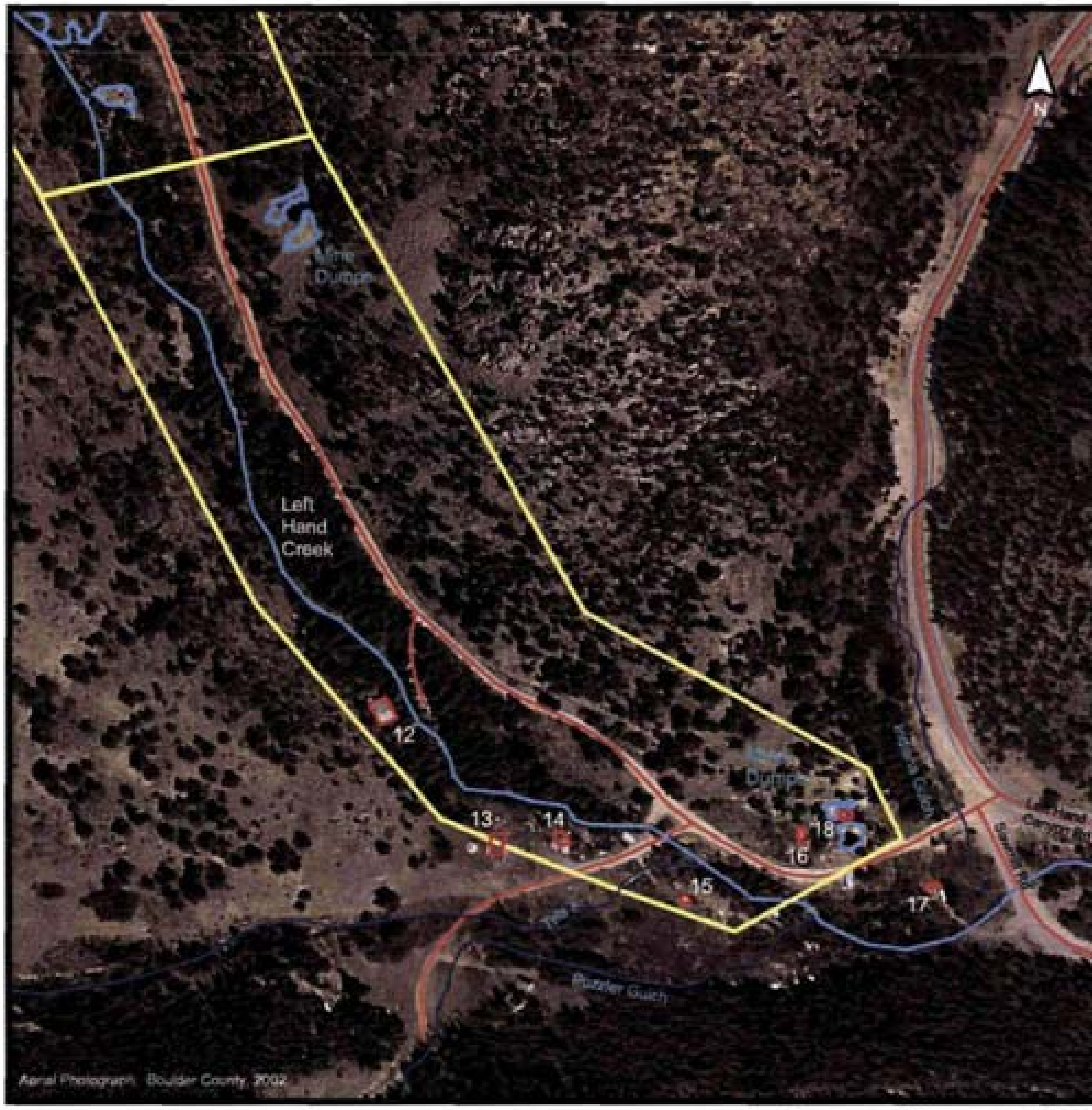


Legend:

Structure	Mine Dump
12 Private Residence	Lefthand Creek
13 Private Residence	Tributaries
14 Private Residence	Road
15 Unknown	
16 Mobile Home (Bus)	
17 Mobile Home (Bus)	
18 Mine Structure Debris	

Figure 8-6
Site Features - White Raven to Sawmill Segment Area of Investigation
Captain Jack Mill Superfund Site

Walsh
Environmental Scientists and Engineers, LLC

R:/projects/captainjack_GIS/captainjack_ch2_ch3.apr

- (the former) Big Five Mill; and
- Cornucopia Mine/dump.

AMD flows from the adit across and down the mine dump to an undersized settling pond, through an on-site wetland, and eventually discharges to Left Hand Creek. Figure 8-7 depicts the approximate locations of the primary mine tunnels at the Site.

The underground workings of the Big Five tunnel that extend underground a considerable distance west of the Peak-to-Peak highway are included in the CJM Site. Areas outside of the CJM Site may still be impacted by the Selected Remedy for access, treatment and monitoring of the underground workings.

The mine dump is an approximately 100-foot-high waste rock pile. A historic mine building is located near the waste rock dump, and a plywood structure connected to a camping trailer is present on the dump. The Big Five adit tunnel was driven approximately 10,000 feet to access claims to the west and north (Big Five 1901). Reconnaissance of the adit tunnel indicated a roof fall area at approximately 340 to 440 feet from the portal, with an existing runaround that bypasses the collapse. At approximately 860 feet from the portal, a second collapse had been present, impounding water to the full height of the adit roof. An EPA emergency removal action removed this blockage in 2007. Reconnaissance conducted beyond the 860-foot-in collapse area indicated that there was open tunnel located approximately 150 feet farther from the portal leading to what is presumed to be the California shaft area. Beyond this area, the tunnel was partially filled with broken ore on the floor and access beyond was not possible without extensive work.

Big Five to Captain Jack Area

The Big Five to Captain Jack area includes the wetland below the Big Five pond and the segment of Left Hand Creek that receives AMD from the Big Five area. The wetland is situated south of the Big Five pond and was probably formed, at least in part, by drainage and seepage from the pond. Sediments metal-hydroxide precipitates from mine-waters passing through the pond have accumulated in the wetland.

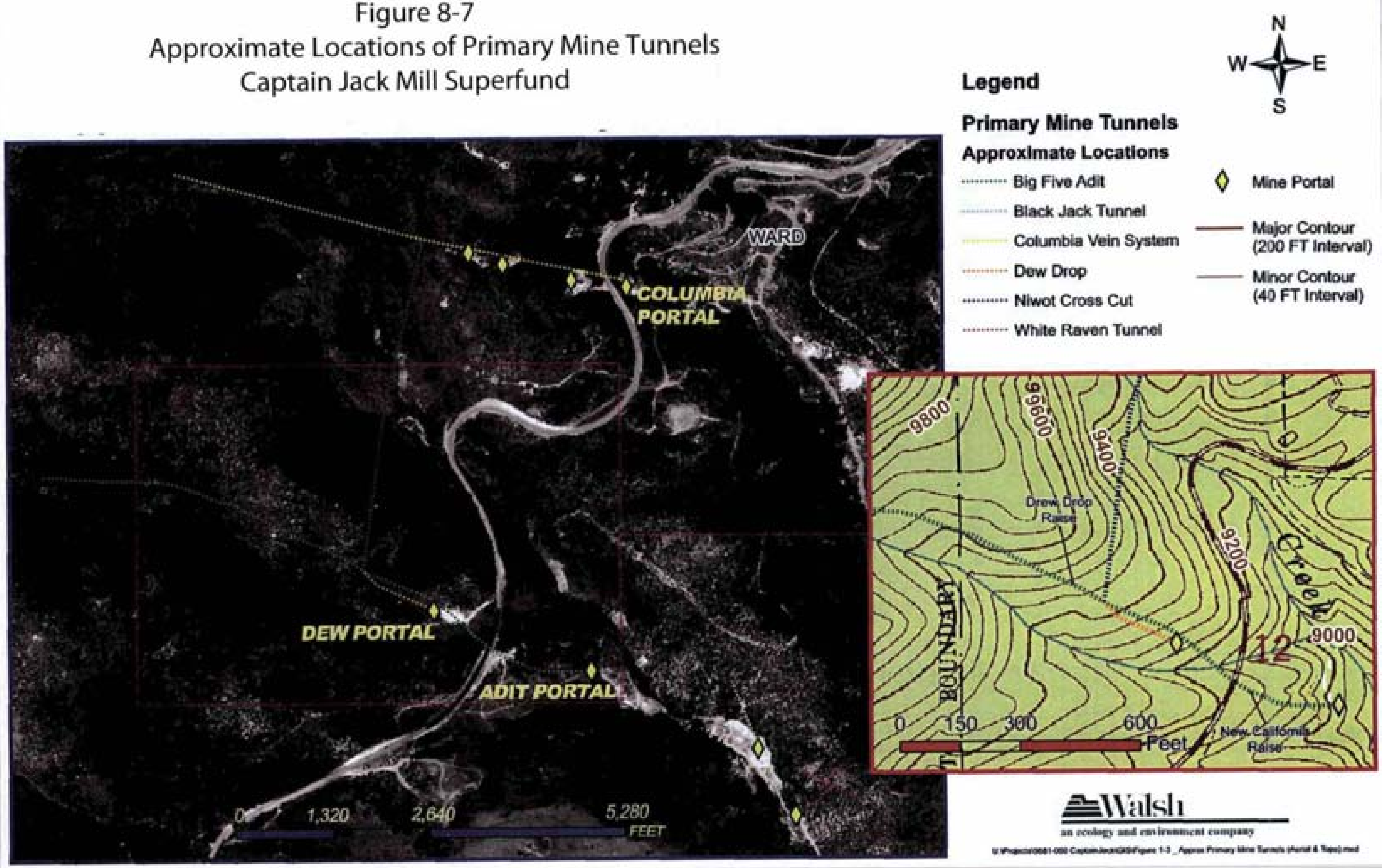
CJM Area

The CJM area includes the Captain Jack mine, an unlined tailings settling pond, a lined tailings settling pond, the Foster residence, the Black Jack Mine adit, the Philadelphia Mine and dump, and at least two other mine dumps on the hillsides. The mill facility is currently inactive.

White Raven Area

The White Raven area consists of the White Raven Mine adit, shaft, and mine/mill dump. The White Raven portal is set into a concrete wall on the north side of the site road. The tunnel was driven approximately 400 feet toward the northwest. The current condition of the White Raven

Figure 8-7
Approximate Locations of Primary Mine Tunnels
Captain Jack Mill Superfund



mine workings is not known at this time; however, no drainage has been observed from the portal. The White Raven Mine/Mill dump occupies a relatively large area adjacent to Left Hand Creek.

White Raven to Sawmill Area

This area primarily represents the nearest downstream receptors. A few residents have been identified in this area. A riparian wetland has also been mapped along Left Hand Creek below the Site. Two mine dumps including the Conqueror Mill site are present in this area and were inspected and sampled during the RI.

9 Site History and Enforcement Activities

9.1 History of Site Activities

The CJM Site history has been discussed in detail in the Screening Site Investigation and expanded Site Investigation (SI) documents (URS 1994; URS Operating Systems [UOS] 1998). A summary of some key historic and investigative events is listed below:

1861: Mining in the Ward District began (Cobb 1988).

1896: Construction of the adit tunnel (also known as the Big Five) began (Murray 1934).

1898: A mill began operations adjacent to the adit tunnel (Murray 1934).

1900: The Big Five Consolidated Company was organized from five existing companies: Dew Drop Mining Company, Adit Mining Company, Niwot Mining Company, Columbia Mines Company, and Timberline Mines Company. Mining operations and construction of the adit tunnel were underway (Big Five 1901).

1902: The Big Five Consolidated Company ceased mining operations (Murray 1934).

1913: The White Raven Mine was operating (Worchester 1920).

1917: The Black Jack Mine obtained patent approval and began operations (UOS 1998).

1933: The Ward Big Five Company had been recently organized and milling operations resumed near the adit tunnel. The adit tunnel was utilized to transport ore from the Adit and Columbia Vein Systems (Murray 1934).

1940: Sometime during the 1940s, Bernard Teets and Associates reopened the Big Five Mine (Cobb 1988).

1974: Prior to 1974, Boulder County removed more than 25,000 cy of sand and gravel from the north slope of the CJM area. Captain Jack Ltd. Company formed to pursue mining operations (UOS 1998). The Foster residence was built in 1974 (Colorado Division of Mines 1975).

1975: The CJM buildings and tailings ponds were constructed (Colorado Division of Mines 1975).

1981: The Captain Jack Ltd. Company began operations of a flotation mill as indicated on the Colorado Mined Land Reclamation Division permit (UOS 1998).

1982: Sometime around 1982, the Captain Jack Ltd. Company cleaned out the Big Five adit tunnel and covered the mine dump with hundreds of tons of waste rock (UOS 1998).

1984: The CJM property was sold to Colorado Consolidated Metal Corporation (UOS 1998).

1985: The CJM was granted inactive status (UOS 1998).

1986: VanDyke Minerals, Inc. acquired the CJM properties. The Colorado Mined Land Reclamation Division issued a Cease and Desist Order on May 22, 1986 for noncompliance and negligence in filing yearly fees. The Mine Safety and Health Administration (MSHA) reported the CJM Site to EPA on September 16, 1986. EPA's Technical Assistance team and Emergency Response Cleanup Services team responded, collected samples, and removed some of the wastes (UOS 1998).

1987: VanDyke Minerals, Inc. filed for bankruptcy in Illinois (UOS 1998).

1988: Ecology and Environment, Inc. (E&E) and EPA performed a Preliminary Assessment (PA) for the CJM Site (E&E 1988).

1992: Mr. Paul Danio purchased the CJM and began operations in August 1992. URS began the three-day Screening SI sampling activities on August 24, 1992. On October 21, 1992, the Colorado Division of Minerals and Geology (DMG) responded to complaints and observed tailings discharges to Left Hand Creek from milling operations. The mill was shut down and DMG obtained an injunction to prevent further milling operations (UOS 1998).

1993: DMG inspected the CJM and found several drums scattered around the Site, poor chemical reagent storage, and unknown contents and conditions of the outdoor explosives magazine. EPA subsequently stabilized the Site (UOS 1998).

1997: UOS conducted sampling activities on July 25 and 26, 1997, for the expanded SI (UOS 1998).

2003: The CJM Site was listed on the EPA National Priorities List (NPL) on September 29, 2003.

2003: EPA and CDPHE entered into a Cooperative Agreement for the Site to be under State-lead management.

2004: CDPHE and Walsh Environmental Scientists and Engineers, LLC (Walsh) entered into a contract for completion of an RI/FS for the CJM Superfund Site.

2004: Ameriquest Mortgage Company foreclosed on and took possession of the Foster property at the CJM Site.

2004: EPA conducted an emergency removal of miscellaneous hazardous wastes from the CJM Site including a large amount of household waste, debris, paint containers, and a variety of chemical wastes that were discovered during the initial phase of the RI field investigation.

2005: The Lefthand Watershed Oversight Group (LWOG) identified the Big Five tunnel as the only "high-priority" site along Left Hand Creek among 16 studied sites due to metals loading, including aluminum, manganese, zinc, copper, and lead, plus low pH.

2007: EPA Emergency Removal to rehabilitate the tunnel and remove impounded mine water.

2008: The RI and Risk Assessment were completed (Walsh 2008a).

2008: The FS was completed (Walsh 2008b).

2008: The Proposed Plan was completed (CDPHE July 2008).

9.2 Enforcement Activities

As presented in the Section 9.1, on October 21, 1992, the Colorado DMG responded to complaints and observed tailings discharges to Left Hand Creek from milling operations. The mill was shut down and DMG obtained an injunction to prevent further milling operations (UOS 1998).

9.3 History of CERCLA Enforcement Activities

The CJM Site has been the subject of inspections, assessments, evaluations and removals by State and Federal agencies since the late 1980's. EPA conducted its first preliminary assessment in 1988. A sampling event took place in 1992 and a subsequent Site Inspection was completed in March of 1994. The Site was investigated for listing on the NPL in the summer of 2002 and placed on the NPL in August of 2003. CJM is a State-lead Site. To date, EPA has not identified potentially responsible parties for the Site.

10 Community Participation

10.1 Community Meetings

Two community meetings were held on June 27, 2005 and May 18, 2006 to update the public on the status of the Site activities and present the findings of the RI, Risk Assessment, and FS. These meetings took place at the Tahosa Rocky Mountain High Adventure Boy Scout Camp located approximately 2.5 miles north of Ward, Colorado. These meetings included a Site tour for interested community members and a PowerPoint presentation, followed by an open house forum for questions and answers. Both meetings were well attended by community members, groups, and other various stakeholders.

10.2 Public Meeting for the Proposed Plan

A public meeting was held on July 2, 2008 to present the proposed plan to the public. The meeting was at the Municipal Dojo Room in Ward, Colorado and was well attended by community members, groups, and other various stakeholders. A court reporter was present and an official transcript of the meeting is included in the Administrative Record for the Site (Appendix C). Along with a presentation of the Proposed Plan, risk assessment findings of the Agency for Toxic Substances and Disease Registry (ATSDR) Health Consultation were presented at the meeting. Agencies accepted the public's questions and comments at the meeting.

The RI/FS (including the Risk Assessment) and Proposed Plan for the Site were made available to the public on June 16, 2008. These documents are currently located in the Administrative Record file for the Site. The notice of the availability of these documents was published in the Denver Post newspaper and the Boulder Daily Camera newspaper on June 15, 2008, and in the Nederland Mountain Ear newspaper on June 12, 2008. A public comment period was held from June 16, 2008 to August 5, 2008. CDPHE and EPA responses to the comments received during this period are included in the Responsiveness Summary, which is part of this ROD (Section 23).

11 Scope and Role of Response Action

11.1 Past Interim Response Actions

The following interim response actions were completed on the CJM Site:

- Circa 1993, the Colorado DMG found several drums scattered around the Site, poor chemical reagent storage, and unknown contents and conditions of the outdoor explosive magazine. The EPA Region 8 Emergency Response Program completed a drum and chemical removal at the Site. No other information is available regarding this action.

- Circa 2000 and 2004, EPA conducted two emergency removals of miscellaneous hazardous wastes from the CJM Site including a large amount of household waste, debris, paint containers, and a variety of chemical wastes that were discovered during site discovery and during the initial phase of the RI field investigation. No other information is available regarding these actions.

- In 2007, EPA conducted an emergency removal to remove a blockage located approximately 340 to 440 feet within the Big Five adit tunnel and rehabilitate the tunnel. New steel sets were placed through the first 900 feet of the tunnel. The first collapse area was temporarily stabilized, the second collapse was removed and the impounded water was pumped out and treated prior to discharge. In addition, the tunnel was "mucked out" for a short distance behind these steel sets at the second collapse area. The second collapse appeared to be within a bypass section of the tunnel. A point previously considered the "possible collapsed draw point," at 790 feet from the mouth of the adit, was actually the former adit heading that had caved.

For this reason, in order to access the tunnel workings beyond the second collapse, it was necessary to work in a second bypass that traveled south of the original tunnel and reconnected with it just beyond the collapse. The tunnel was accessible for approximately the first 150 feet. After this point, the stabilized tunnel entered a mined area consisting of a stope and approximately 30 feet of broken ore on the floor of the tunnel. Beyond the stoped area was inaccessible without substantial additional and costly work to the tunnel.

11.2 Role of this ROD

The entire Site is addressed as one operable unit. The main objective for response action at this Site is to achieve the RAOs outlined in Section 16 of this ROD. Specifically, this remedy aims at providing source control in the form of consolidation, capping, and treatment to reduce exposure to arsenic, lead, and thallium from incidental ingestion and/or inhalation of surface material and to control and reduce runon and runoff from contaminated surface material. Furthermore, this remedy aims to undertake restoration of the ground- and surface- water by treating mine water "in-situ". This will.reduce the in-stream metals concentrations in Left Hand Creek by containing and treating the underground AMD currently flowing from the Big Five adit.

The planned Remedial Action is a final action for the Site and is expected to successfully achieve the RAOs. Using a mix of different remedial technologies, this response will permanently reduce the toxicity, mobility, and volume of those source materials that constitute the principal threat wastes at the Site and meet applicable or relevant and appropriate requirements (ARARs). The site-specific media impacted are soils, tailings, waste rock, sediment, groundwater, and surface water. CDPHE and EPA have selected a combination of technologies to address the contamination in the various media.

As part of the listing process, Boulder County assisted in the evaluation of the site. The Lefthand Watershed Task Force was appointed by Boulder County to evaluate the entire Left Hand Creek Watershed. Upon their recommendation and approval, the Captain Jack Mill was identified as the only area in the watershed to be evaluated and addressed using federal monies as a CERCLA site on the National Priorities List. Investigation of the contamination of the Captain Jack Mill site was limited to the area upstream of the Sawmill Road intersection on Left Hand Road and downstream of the Peak to Peak Highway (CO 72).

12 Site Characteristics

The following provides a site overview, including discussions of the Conceptual Site Model (CSM), nature and extent of contamination, geology, hydrogeology, sampling strategy at the CJM Site, sources of contamination, and COC. Additional detailed information regarding site characterization can be found in the RI Report (Walsh 2008a).

12.1 Overview of the Site

As stated in Section 8, the CJM Superfund Site is located near Ward, Colorado (Figure 8-1) within the Left Hand Creek Watershed. Left Hand Creek flows through the Site from northwest to southeast and joins with tributaries from Puzzler Gulch and Indiana Gulch near the intersection of Left Hand Canyon and Sawmill roads. A riparian wetland is present in this area. Beyond that point, the Left Hand Creek continues in a northeasterly and easterly direction.

The Left Hand Creek Watershed covers portions of two distinct physiographic regions: the Southern Rocky Mountain province and the Colorado Piedmont section of the Great Plains province (Worcester 1960). Foothills separate these distinct topographical features. Glaciation, stream erosion and deposition, wind erosion, and atmospheric weathering formed (and continue to alter) the watershed topography. Pre-Cambrian metamorphic and granitic rocks dominate the geology of the mountainous portions of the Left Hand Creek Watershed.

Most of the CJM Site property is privately owned. Many of the property boundaries coincide with mining claims. For the purposes of the RI/FS, the CJM Site was organized into five areas of investigation as described in Section 8 (Figures 8-2 through 8-6). Adjoining properties are owned by both private entities and the U.S. Department of Agriculture (USDA) Forest Service.

12.2 Site Features

12.2.1 Site Geology

The CJM Site is situated in an area that has been glaciated. Surficial material consists of glacial moraine and outwash deposits (E&E 1988). It is not known how much glacial material exists above bedrock at the Site. Bedrock in the area is described as granite, granodiorite, and/or granitic gneiss. Tertiary dikes have been mapped near the northeast and southwest ridges above the CJM Site (Worchester 1920). The Big Five tunnel adit and mine-workings are associated with a near-vertical mineralized vein (and associated fractures) containing various metal-sulfides (including the historic economic-grades of gold ore) extending west from the Big Five portal over 7,000 feet towards the mountaintops west of the Peak-to-Peak highway (CO 72). The Site is considered to be in the southern part of the historic Ward Mining District.

12.2.2 Site Hydrogeology

Fractured granite country rock serves as an aquifer in the area. Water wells are common in the fractured granite. According to the Colorado State Engineer's records, there are more than 220 wells listed for domestic or household use within a 4-mile radius of the Site. Residents of Ward receive their domestic water from three separate springs located approximately 5 miles west of town. These springs are located upgradient and outside of the 4-mile radius of the CJM Site (URS 1994).

Surface water runoff from Ward appears segregated from the Site by the ridge between the Town and the Site until it meets at the confluence with Left Hand Creek at Puzzler Gulch. However, subsurface mine waters from the Ward Mining District presumably is draining through the Niwot Cross Cut on the Columbia vein just west of Ward to the Big Five adit.

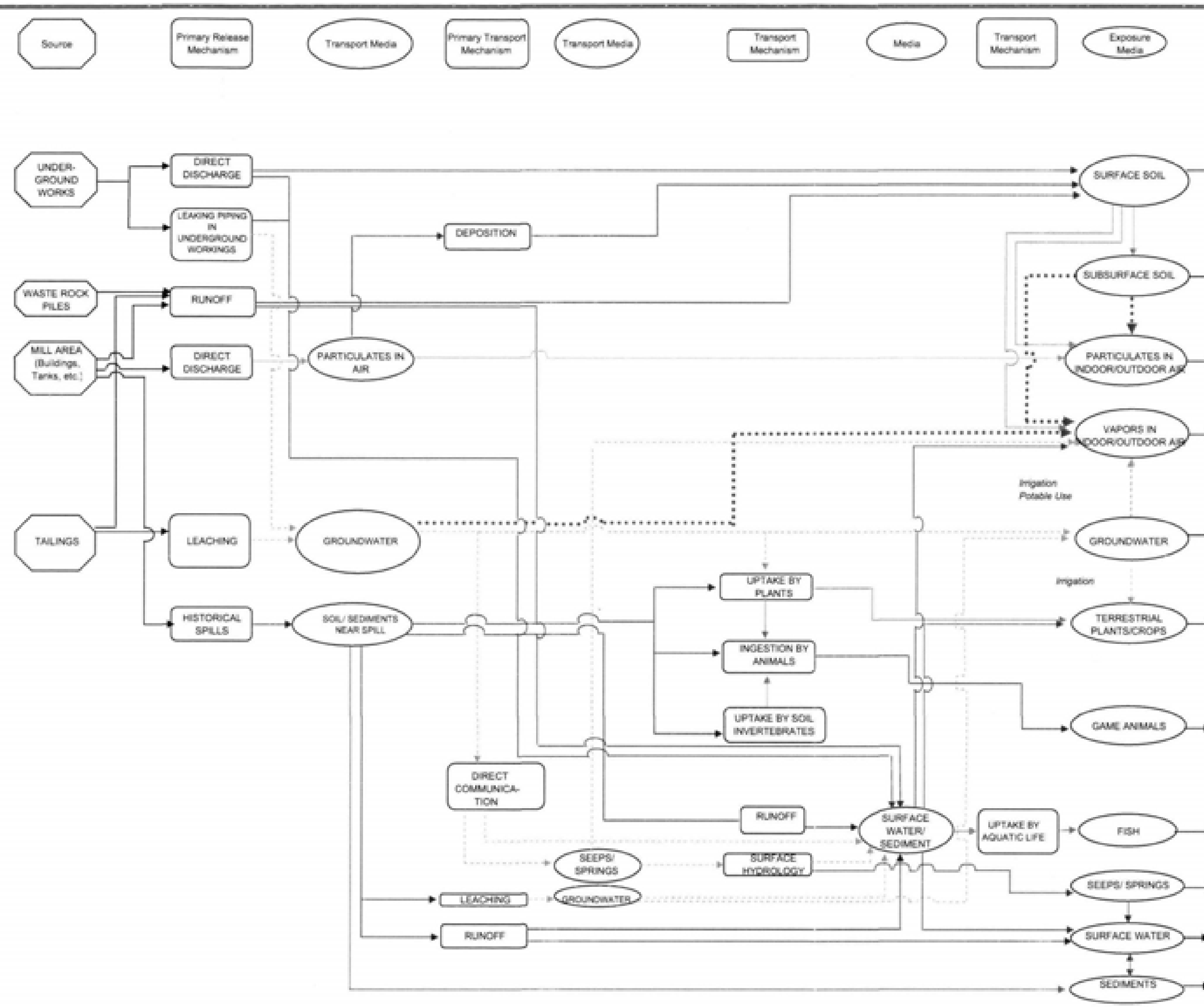
Recharge to the surficial and bedrock aquifers is primarily from snowmelt and rainfall infiltration. The greatest amount of recharge occurs in late spring and early summer during the snowmelt season. During late summer and fall, intense rainstorms are major recharge sources.

12.2.3 Areas of Archaeological and Historic Importance

A cultural resource inventory and historic evaluation of the CJM Site determined that neither the Big Five adit tunnel, Captain Jack Mine and Mill, or White Raven Mine are eligible for listing in the National Register of Historic Places (NRHP). The Conqueror Mill (located in the White Raven to Sawmill Area at the southern boundary of the Site) is recommended as eligible for listing in the NRHP, and immediate and long-term preservation actions were recommended in the RI Report (Walsh 2008a).

12.3 Conceptual Site Model (CSM)

The CSM for human health and ecological risk is shown on Figures 12-1 and 12-2, respectively. Sources of contamination include underground mine works, waste rock piles, mill areas, and

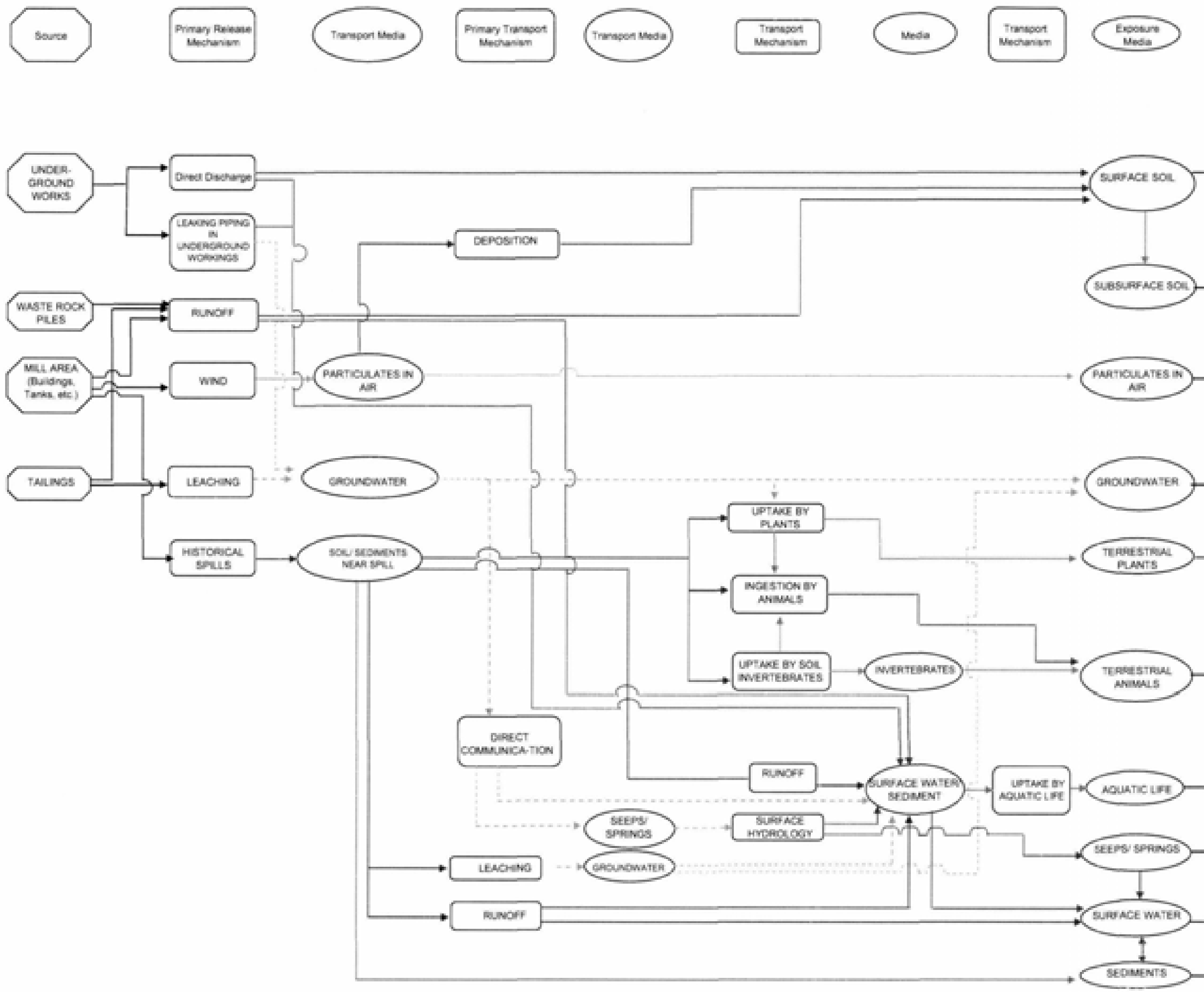


RECEPTORS

EXPOSURE ROUTE	Current and Future Residents	Current and Future Recreationalists	Future Construction Workers
INGESTION	C	C	C
DERMAL CONTACT	C	C	C
INGESTION	NS	I	C
DERMAL CONTACT	NS	I	C
INHALATION	C	NS	NS
INHALATION	I	I	I
POTABLE USE	C	I	I
DERMAL CONTACT DURING IRRIGATION	C	I	I
INGESTION	C	NS	I
INGESTION	NS	NS	I
INGESTION	C	C	I
INGESTION	C	NS	NS
DERMAL CONTACT	C	NS	NS
INGESTION	C	C	NS
DERMAL CONTACT	C	C	NS
INGESTION	C	C	NS
DERMAL CONTACT	C	C	NS

Figure 12-1. Human Health Conceptual Site Model
Captain Jack Mine Site

LEGEND
I - PATHWAY NOT COMPLETE; MISSING PATHWAY COMPONENT
NS - PATHWAY EXISTS; PREDICTED TO BE NOT SIGNIFICANT
NA - NOT APPLICABLE, DOES NOT APPLY TO RECEPTOR/MEDIA COMBINATION
C - COMPLETE
NQ - NOT QUANTIFIABLE, RECOGNIZED TO EXIST



RECEPTORS

EXPOSURE ROUTE	Terrestrial Plants (Primary Producers)	Terrestrial Invertebrates (Multiple Feeding Guilds)	Pine Grosbeak (Avian Herbivore)	Mountain Chickadee (Avian Insectivore)	Red Tailed Hawk (Avian Carnivore)	Montane Vole (Mammalian Herbivore)	Deer Mouse (Mammalian Omnivore)	Long-Tailed Weasel (Mammalian Carnivore)	American Dipper (Avian Insectivore)	Aquatic Life
INGESTION	NA	NQ	C	C	C	C	C	C	NA	I
DIRECT CONTACT	C	C	NQ	NQ	NQ	NQ	NQ	NQ	NA	I
INGESTION	NA	NQ	I	I	I	C	I	I	NA	I
DIRECT CONTACT	C	C	I	I	I	NQ	I	I	NA	I
INHALATION	NA	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NA
INGESTION	I	I	I	I	I	I	I	I	I	I
DIRECT CONTACT	I	I	I	I	I	I	I	I	I	I
INGESTION	NA	NQ	C	NA	NA	C	C	NA	NA	I
INGESTION	NA	NQ	NA	C	C	NA	C	C	NA	NQ
INGESTION	NA	NQ	NA	C	NA	NA	NA	C	C	NQ
INGESTION	NA	NQ	C	C	C	C	C	C	C	NQ
DIRECT CONTACT	C	C	NQ	NQ	NQ	NQ	NQ	NQ	NQ	C
INGESTION	NA	NA	C	C	C	C	C	C	C	NQ
DIRECT CONTACT	NA	NA	NQ	NQ	NQ	NQ	NQ	NQ	NQ	C
INGESTION	NA	NA	NS	C	NS	NS	NS	C	C	NQ
DIRECT CONTACT	NA	NA	NQ	NQ	NQ	NQ	NQ	NQ	NQ	C

Figure 12-2 Ecological Conceptual Site Model
Captain Jack Mine Site

LEGEND
I - PATHWAY NOT COMPLETE; MISSING PATHWAY COMPONENT
NS - PATHWAY EXISTS; PREDICTED TO BE NOT SIGNIFICANT
NA - NOT APPLICABLE. DOES NOT APPLY TO RECEPTOR/MEDIA COMBINATION
C - COMPLETE
NQ - NOT QUANTIFIABLE, RECOGNIZED TO EXIST

mine tailings. Primary release mechanisms from these sources include direct discharge of contaminants into surface soils and water, leakage from the piping of underground mine workings, surface water runoff, wind erosion, leaching, and historical spills. Transport media include air particulates, groundwater and surface water, and soils and sediments. Exposure routes include inhalation, ingestion, and direct contact. Risk assessments and planned remedial actions were based on the exposure observations described below.

The significant exposure media pathways for current and future residents of the CJM Site were judged to be: potable use of mine water; ingestion and/or dermal contact with surface and subsurface soils; inhalation of particulates in indoor and outdoor air; potable use and/or dermal contact with groundwater; ingestion of terrestrial plants, crops, or fish; incidental ingestion, dermal contact, and/or potable use of surface water; and ingestion and/or dermal contact with sediments. Residents were deemed the most at-risk user group. Current and future recreationalists and future construction workers were judged to be at risk for ingestion and/or dermal contact with surface soils, subsurface soils, sediments, and surface water and for ingestion of fish.

Ecological receptors were considered impacted by contaminants at the Site. Terrestrial plants and invertebrates, avian populations, and aquatic life were all judged to be significantly impacted by various exposure media. Terrestrial plant and invertebrate exposure routes of significance included direct contact with surface and subsurface soils, seeps, and springs. All avian and mammalian receptors, including the pine grosbeak, mountain chickadee, red tailed hawk, montane vole, deer mouse, long-tailed weasel, and American dipper were judged to be significantly impacted by ingestion of surface soils (excluding the American dipper), surface water, seeps and springs, and terrestrial plants and animals. Other avian and mammalian exposure routes of concern included ingestion of subsurface soils (montane vole) and aquatic life (mountain chickadee, long-tailed weasel, and American dipper). Direct contact with seeps, springs, surface water, and sediments were significant exposure routes for aquatic life. Groundwater and air particulates were incomplete and non-quantifiable pathways for ecological receptors.

Additional discussion regarding risk at the Site is included in Section 14 of this ROD.

12.4 Sampling Strategy

The objectives of the Captain Jack RI were to determine the nature and extent of contamination associated with former mining and milling operations, estimate potential risks to human health and ecological receptors, and provide information for the FS to evaluate remedial alternatives on a technical and cost basis. The investigation activities were designed to provide sufficient data to support the development of risk management decisions and remedy selection.

The approach included the collection of surface water, groundwater, soils, sediment, and biological samples from background (upstream) areas, suspected source areas, and potential receptor areas. In addition, surface water and sediment samples were collected seasonally to evaluate changes over time. Mapping of sample locations, site features, residential properties, domestic water well locations, and ecologically sensitive areas allowed for evaluation of the spatial distribution of contaminants with respect to potential exposure pathways. Topographic mapping was also performed to aid in the estimation of mine dump volumes, runoff pathways, and remedial construction options and/or constraints.

12.4.1 On-Site Sampling Areas

The five areas of investigation were designed to relate stream segments to potential source areas. These areas were previously discussed and include, from upstream to downstream end, the Big Five Area, the Big Five to CJM Area, the CJM Area, the White Raven Area, and the White Raven to Sawmill Area. Background samples including soils, sediment, plant tissue, groundwater, and surface water were collected from the upstream segment of the Big Five Area, which was the most upstream/upgradient segment of the Site and was judged to be uninfluenced by Site mining activities. The Big Five Area was also sampled to evaluate the impacts of mining activities from the Big Five Mine.

Sampling activities in the Big Five to Captain Jack study area focused on evaluating impacts of the Big Five settling pond discharge to the wetland. Sampling activities in the CJM study area focused on evaluating impacts associated with former mining and milling operations. The White Raven study area includes the White Raven Mine/Mill dump, White Raven shaft dump, and the segment of Left Hand Creek that may have been impacted by these potential source areas. The White Raven to Sawmill study area was primarily considered a downstream receptor area, and the focus of sampling efforts in this area was to evaluate what the cumulative effects of upstream sources may have had on the general quality of surface water, groundwater, and sediments above the confluences of Indiana Gulch and Puzzler Gulch. All sample site locations and site-specific details can be found in the RI Report (Walsh 2008a).

Surface Water

Surface water samples were collected from 11 sample locations during the months of September, November, February, May, and July to assess water quality on a seasonal basis. Samples were analyzed for total and dissolved Target Analytical List (TAL) metals, alkalinity, hardness, and sulfate. Wet chemistry samples were collected to evaluate compliance with surface water standards at an upstream and downstream location. The Wet Chemistry Group includes ammonia, chloride, fecal coliform, nitrite, nitrate, phosphorous, phosphate, sulfate, sulfide, total alkalinity, total organic carbon, total dissolved solids (TDS), and total suspended solids (TSS). Grab samples were collected in a downstream to upstream sequence. Samples were generally collected at locations downstream of mine adit drainages, waste rock dumps, and mining areas. One sample was collected from both the upstream and downstream ends of the wetland located in the Big Five to CJM area. Stream flow measurements were made at seven sites co-located with surface water sample locations along Left Hand Creek, the Big Five AMD channel, and a small intermittent tributary. Mine tunnel surface water field parameters were measured using the same methods and procedures as described above for stream surface water samples. Samples were collected from the Big Five adit portal and settling pond.

Groundwater

Groundwater monitoring occurred at 12 locations along the length of the Site. Monitoring wells were installed in a linear array adjacent to Left Hand Creek, and water level elevations were surveyed in both the monitoring wells and the adjacent streambed to help assess the discharge/recharge relationship between surface water and groundwater. Unconfined water levels varied from approximately 4 feet below ground surface (bgs) to approximately 24 feet bgs. It was inferred that alluvial groundwater flow was sub-parallel to surface water flow with a losing reach of the creek between the Big Five Mine and the CJM. Alluvial lithology consisted of coarse sands and gravels with minor amounts of fine sands and clay and many cobbles and boulders. Wells were developed, and a single round of samples was collected according to Standard Operating Procedures (SOPs) in October 2005. Samples were analyzed for dissolved TAL metals and cyanide.

Waste Rock and Soils

Soil sampling focused on characterizing surface soils (i.e., soil, rock, sand, etc.) from the perspectives of potential surface exposure and leaching potential to confirm the presence of contaminants that were previously detected and to define the lateral and vertical extents of contamination. Prior to sampling, field x-ray fluorescence (XRF) screening for metals on mine dumps and exposed waste rock was conducted at 108 sample locations. Surface soils (0 to 2 inches) samples were collected from 119 sample locations, and soil-boring samples were collected from 18 locations. Soil boring ranged from depths of 2 to 15 feet and were limited to the Big Five to CJM, CJM, and White Raven areas. Laboratory sample analyses of surface soils and boring samples included TAL metals, USGS Field Leach Test TAL metals, acid base accounting, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs).

Sediment

Sediment samples were collected as grab samples from the streambed at 31 locations. Attempts were made to select deposition pools with significant sediment accumulations. Sediment sample locations in Left Hand Creek represent upstream, downstream, and potential source area locations. Sediment samples were initially collected during the September assessment, and thereafter coincident with the surface water sampling program. Samples were not collected at all locations during each sampling event.

Sediment samples were collected from outside the Big Five adit, along the drainage pathway, from the settling pond, along the channel, from Left Hand Creek, and upstream and downstream of various drainage confluences and waste rock dumps. Additionally, a sediment sample was collected in the Big Five adit tunnel during the underground investigation.

Biology

Site vegetation was mapped and described in terms of sensitive habitat (riparian areas and wetlands). Vegetation tissue was sampled from eight locations to gather metal content data. Sampling of fauna conducted for the RI included attempts to collect benthic invertebrates and fish from Left Hand Creek at three locations above, adjacent, and below the Site. These data were used to estimate the potential direct impacts of metals on these organisms, as well as to approximate exposure of key receptors to metals in food chain pathways.

Vegetation tissue samples were collected in September 2004 and were co-located with sediment sample locations. Plant tissue samples were comprised of woody (secondary growth) tissue along with attached current year's leaf growth. Tissue samples were preferentially collected from willows (*Salix* spp.) and other members of the willow family (cottonwoods, *Populus*) within each sample site due to their known propensity for metals uptake, secondary growth production, and use by large herbivores as browse. A qualitative description of the plant community composition, including a list of dominant species and a visual estimate of percent cover of each, was recorded for each sample site.

Benthic invertebrate sampling was attempted at four locations along Left Hand Creek on three separate occasions; however, all were unsuccessful because no significant samples could be obtained.

Fish sampling was performed by the Colorado Division of Wildlife in October 2004 at the Captain Jack site. Three reaches of Left Hand Creek were selected for electro-shock sampling. One small brook trout was recovered from the downstream station, which was located upstream of the confluence of Left Hand Creek and Puzzler Gulch in the White Raven to Sawmill Area. The second station was located at the lower portion of the White Raven Area; no fish were recovered in this reach. The upstream station was located upstream of the Big Five Mine site. Twenty large and small brook trout were collected at this station. The entire body of each fish collected was analyzed for whole body concentrations of TAL metals.

12.4.2 Off-Site Sampling Areas

Although no off-site monitoring was conducted during the RI, the LWOG and the University of Colorado have collected surface water and sediment samples at several locations within, upstream, and downstream of the CJM study area since November 2003. The LWOG sample locations are described in the RI Report (Walsh 2008a). Flow velocities were also measured using a lithium tracer injection/synoptic sample technique developed by the USGS. LWOG produced a Watershed Management Plan (Wood et al. 2005) in August 2005. The plan identified the Big Five Mine as a loading source to Left Hand Creek due to low pH and high concentrations of zinc, copper, and lead. The White Raven Mine was also identified as a loading source due to low pH and high concentrations of zinc and copper. LWOG findings were included in conjunction with the data compiled for the RI.

12.5 Known or Suspected Sources of Contamination

The primary source of contamination to Left Hand Creek from the Site is the AMD emanating from mine workings, predominantly from the Big Five adit. Secondary sources are non-point and include runoff and leaching from uncovered waste rock and tailings adjacent to the creek at the Big Five Mine and Mill, CJM, Black Jack Mine, and White Raven Mine and Mill. The developed remedial action alternatives for surface and subsurface contamination address both the primary and secondary sources of contamination.

12.6 Nature and Extent of Contamination

Surface water, groundwater, soils, sediment, and biological samples were collected from the suspected source areas and potential receptor areas as part of the RI. Contamination at the Site includes primarily heavy metals, resulting from historical mining and milling, which impact soils and surface water. Contaminants of concern associated with the former mining and milling operations include antimony, arsenic, cadmium, copper, lead, manganese, thallium, and zinc. Concentrations of these contaminants are significantly above background levels for the area. The primary concerns in soils are the toxic metals (i.e., lead, arsenic, and thallium) that are contained in mine wastes and mill tailings and that subsequently discharge to Left Hand Creek. Residential properties (both permanent and transient) may be in direct contact with some of these wastes. Potential health hazards exist through direct contact, waterborne, or food-chain exposure to the high concentrations of toxic metals. Approximately ten full- or part-time community residents may be exposed to hazardous materials at the Site. An additional 15,000 residents are serviced by the Left Hand Water District, which intercepts and diverts Left Hand Creek water downstream from the Site for use as drinking water.

Organic contaminants have been detected but were only investigated at a limited number of locations. These contaminants, including PCBs, polycyclic aromatic hydrocarbons (PAHs), and petroleum compounds, were detected infrequently. They appear to be the result of incidental small spills or rubbish burning at the Site and not a major release from mining or milling operations.

12.6.1 Mine Portals and Surface Water

Mine tunnels and shafts intersect water-bearing fractures in the mineralized country rock, draining the overlying topography. This draining lowers the groundwater table and releases significant amounts of metals in the form of AMD to the surface streams. Surface water samples were collected and analyzed along mine adit drainages and the reach of Left Hand Creek between the Big Five Mine and Puzzler Gulch. Surface water quality exceeded drinking water standards for copper, cadmium, and manganese. The copper and cadmium standard concentrations were exceeded only in samples from the Big Five adit AMD, while the manganese standard was exceeded in multiple samples along the reach of Left Hand Creek flowing through the Site. Surface water aquatic life standards were exceeded in Left Hand Creek for cadmium, copper, and zinc.

12.6.2 Groundwater

No human health standards were exceeded in any of the three domestic wells sampled during the RI. All of these wells were shallow, hand-dug wells in alluvium along Left Hand Creek and did not appear to be constructed in accordance with State Engineer requirements. They could be considered susceptible to future contamination.

Primary drinking water standards for cadmium and secondary drinking water standards for zinc were exceeded in two monitoring wells downgradient of the Captain Jack tailings pond. Secondary drinking water standards were exceeded for manganese in monitoring wells along Left Hand Creek adjacent to the Big Five, the Captain Jack Mill, and the White Raven areas.

12.6.3 Waste Rock and Soils

The Big Five Mine veins consisted of quartz, pyrite, and an oxidized zone that contained considerable free gold and silver. The ore from this mine was primarily gold-sulfide; thus, the Big Five Mine is the source of most of the Site's COCs and AMD. The White Raven Mine was typified by brecciation, vugs, and shoots. Mineral complexes from these two mines, as well as the other various site mines, created COCs that vary given the very different mineral complexes between the Big Five and White Raven areas. COCs segregation is apparent in surface soils of the mill areas corresponding to mineral variations.

Major waste rock dumps are located at the Big Five and White Raven mines. Smaller surficial rock dumps are located at the Cornucopia, Philadelphia, and Sawmill mines, as well as on the CJM Site and incidental workings in California Gulch. The horizontal extents of mine dumps were surveyed by global positioning system (GPS) and then generated in AutoCAD. Existing site elevations and other pertinent information were taken from the topographic survey provided in AutoCAD format. Table 12-1 shows the areas and volumes of contaminated soils by area of investigation. Detailed maps showing specific contaminated soil areas can be found in the RI/FS reports (Walsh 2008a, 2008b).

The data used to generate the horizontal extents of contaminated areas and/or waste piles were compiled from surface soils and XRF sample results and through visual observations of the extents of the disturbed areas. In addition, subsurface soil sample results were used where available. Subsurface data points were only available in the Captain Jack Mill and White Raven areas in which the depth of contamination averaged approximately 3.25 feet bgs. In all other areas where the depth was not sampled, a depth of soil contamination of 6 inches was approximated, taking into account the recommended human health exposure depth and the practicality of implementing the remedial action with available construction equipment. The horizontal extents shown in the RI/FS reports (Walsh 2008a, Walsh 2008b) coupled with the 3.25- and 0.5-foot vertical extents of contamination extrapolated and assumed at areas of the Site will constitute the extents of excavation in the remedial action alternatives.

Table 12-1. Area and Volumes of Contaminated Soil at the Site

Area of Investigation	Description	Area [sq. feet]	Area [acres]	Volume [cubic yards]
Big Five Area	Primary Waste Pile	75,000	1.72	35,000-100,000
	Ancillary Waste Pile	5,000	0.11	100
	Contaminated Material	28,000	0.64	520
Big Five to CJM Area	Contaminated Material	34,000	0.78	620
CJM Area	Ancillary Waste Piles	11,200	0.26	200
	Contaminated Material	144,000	3.31	17,500
White Raven Area	Primary Waste Pile	35,000	0.80	7,000
	Ancillary Waste Pile	8,000	0.18	150
	Contaminated Material	128,000	2.94	15,500
White Raven to Sawmill Area	Waste Piles	4,500	0.10	80
	Contaminated Material	14,000	0.32	260
	TOTAL	486,700	11.16	77,000-142,000

12.6.4 Areas of Investigation

Big Five Area

The Big Five adit drainage resulting from exposed sulfidic and metal-enriched mine waste and underground mine workings is the major source of AMD and subsequent metals contamination to Left Hand Creek. Of the three mine adits that were investigated, including Big Five, Black Jack, and White Raven, only the Big Five adit showed evidence of AMD with degraded water quality. Surface water samples were collected from the mine discharge at the portal, the mine settling pond, and the confluence of the mine drainage channel with Left Hand Creek. Metals concentrations in the mine discharge exceeded drinking water supply standards for cadmium, copper, iron, lead, manganese, and sulfate, and exceeded aquatic life standards for cadmium, copper, iron, lead, manganese, nickel, silver, and zinc. Despite the elevated concentrations, the drainage was considered a point source effluent and not a stream to which aquatic life standards would apply. Samples collected at the adit discharge and the settling pond had iron staining and the low pH indicative of AMD.

Big Five to CJM Area

Mine drainage samples collected downstream of the Big Five settling pond, after drainage flowed through the wetlands, showed significant decreases in iron concentrations. The wetlands below the mine pond showed evidence of filtering iron discharge from the Big Five adit portal. Visual observation of sediments along the mine drainage channel between the Big Five settling pond and the confluence with Left Hand Creek showed evidence of iron oxide precipitation. Cadmium, copper, and zinc concentrations were elevated downstream of the confluence of the Big Five AMD with the creek and exceeded aquatic life standards. These contaminants were below aquatic life standards in Left Hand Creek upstream of the confluence, which indicates that metal loading from the Big Five Mine has a negative impact on downstream water quality.

CJM Area

No drainage was observed from the Black Jack Mine during any of the field visits to the Site. Samples collected from the Black Jack Mine Adit did not indicate any signs of AMD. Water quality results exceeded drinking water standards for metals concentrations including antimony, barium and lead; however, the mine water is not a drinking water source, does not appear to drain to Left Hand Creek, and has no apparent exposure pathway to humans.

The CJM building and surrounding area was inspected to determine if materials were present that would require special disposal or that might be relevant to the on-going investigation. Key observations are summarized below. Additional details can be found in the RI Report (Walsh 2008a).

- A relatively large amount of household waste, debris, paint containers, chemical wastes, and other materials were present in and around the mill building.
- Some ore processing equipment was present in and around the building, including an ore bin, ball mill, flotation tanks, boiler, filter press, pumps, motors, and above-ground storage tanks (ASTs). The ASTs appeared to be empty.
- Various waste materials inside the building were in contact with storm-water, which entered through holes in the roof of the building and drained through walls to a floor drain. Standing water was present in the drain, which may be connected to a sand trap, sump, or septic system or may drain directly to the adjacent creek.

In 2004, the EPA conducted an Emergency Removal of material in the mill building. Remaining material on the floor of the mill building may have elevated concentrations of contaminants, which potentially pose chronic risks to human health and the environment.

White Raven Area

No AMD was observed from the White Raven portal during the RI investigation. Water samples collected from the White Raven adit contained concentrations that exceeded drinking water standards for metals concentrations, including antimony, barium, lead and mercury; however, the groundwater in this mine is not a drinking water source, does not appear to drain to Left Hand Creek, and has no apparent exposure pathway to humans.

White Raven Area to Sawmill Area

Surface water sampling in the White Raven to Sawmill area resulted in a drinking water supply standard exceedance for manganese. Chronic aquatic life standards were exceeded for cadmium, copper, and zinc. Sediment sampling results indicated Preliminary Remediation Goal (PRG) exceedances of arsenic, lead, manganese, and thallium.

12.7 Chemicals of Concern (COCs)

As discussion in Section 12.6, COCs associated with the former mining and milling operations at the Site were determined to be the metals antimony, arsenic, cadmium, copper, lead, manganese, thallium, and zinc. Concentrations of these chemicals are significantly above background levels for the area and pose a risk to human health and the environment. Three metals of specific concern are lead, arsenic, and thallium, which pose significant human health risks and are contained in the mine wastes and mill tailings of the Big Five, Captain Jack/Black Jack, and White Raven Mine areas. Other metals are primarily a concern in surface water and pose risks to aquatic life.

12.8 Characteristics and Concentrations of COCs

The following describes the characteristics of the COCs identified at the CJM Site, as summarized in Table 12-2. The concentration ranges for the COCs described below are presented in Table 12-3. The concentrations shown are for surface water (total and dissolved), groundwater (dissolved), surface and subsurface soils, sediment, and plant and fish tissue. Additional information regarding detection limits; minimum, maximum, and mean values; and sample- and site-specific data can be found in the RI report (Walsh 2008a).

12.8.1 Antimony

Antimony in the soil ranges from below detection limits to 5,570 mg/kg. Only trace amounts have been found in the surface water. Antimony can cause lung diseases, heart problems, and gastrointestinal problems at high concentrations. Long-term exposure has shown to cause fertility problems in laboratory animals.

12.8.2 Arsenic

Arsenic in the soil ranges from below detection limits to 34,862 mg/kg. Only trace amounts have been found in the surface water. Arsenic can cause cancer in humans, and has been linked to lung, skin, bladder, liver, kidney, and colon cancer. Other effects include skin and nerve damage.

12.8.3 Cadmium

Cadmium, a toxic metal, exists in the soils at the Site in concentrations ranging from below detection limits to 241 mg/kg. Cadmium in the surface water ranges from below detection limits to 0.0081 milligrams per liter (mg/L). Exposure to high cadmium levels can severely damage the lungs and may result in death. Smokers face greater health effects from cadmium exposure than nonsmokers. Vegetables and other plants absorb cadmium easily, and can be extremely dangerous when eaten. Aquatic organisms can vary greatly in their sensitivity to cadmium.

12.8.4 Copper

Copper in the soil ranges from 1.4 to 90,245 mg/kg. In the surface water, copper ranges from below detection limits to 2.5 mg/L. Brief exposure to copper can cause flu-like symptoms, while long-term exposure can irritate mucous membranes and cause headaches and vomiting. Copper in soil can harm microorganisms and earthworms.

12.8.5 Lead

Lead in the soil ranges from 5.4 to 177,000 mg/kg. In the surface water, it ranges from below detection limits to 0.016 mg/L. A highly toxic element, lead causes a variety of health effects. Brief exposure to high levels of lead can cause brain and kidney damage and stomach or intestinal distress. Long-term exposure to low levels of lead can affect reproductive organs, the central nervous system, blood pressure, and kidneys. Elevated lead levels stunt plant growth.

12.8.6 Manganese

Manganese in the soil ranges from 11 to 21,130 mg/kg. In the surface water, it ranges from below detection limits to 6.69 mg/L. Long-term exposure to low levels of manganese can result in central nervous system damage while respiratory problems can occur from an acute high exposure.

12.8.7 Thallium

Thallium in the soil ranges from below detection limits to 27.2 mg/kg. In the surface water, it ranges from below detection limits to 0.013 mg/L. At high exposure levels, thallium causes nervous system disturbances. Long-term exposure to low levels of thallium can cause fatigue, headaches, and depression because it accumulates in the human body. Thallium is very toxic to some rodents, and causes color changes and stunted growth in plants.

12.8.8 Zinc

Zinc in the soil ranges from 12 to 217,510 mg/kg. In the surface water, it ranges from below detection limits to 1.76 mg/L. Zinc is a trace element essential for human health. Although humans can handle proportionally large concentrations of zinc, too much zinc can cause stomach cramps and skin irritation. At very high levels, zinc can cause arteriosclerosis. Aquatic organisms can accumulate zinc and pass it to animals higher on the food chain.

12.9 Known and Potential Migration Routes

The contaminant release mechanisms and potential transport routes at the CJM Site are typical of the mechanisms and routes found at other Colorado metal mine sites. At the CJM Site, mine tunnels and shafts intersect water-bearing fractures in the mineralized country rock, draining the overlying topography. This drainage lowers the groundwater table, changes the oxidation/reduction status of the mineralized zones, and releases significant amounts of metals in the form of AMD to the surface streams. Mine wastes including waste rock, ores, and mill tailings are exposed to weathering and erosion, where they release metals and metals-laden sediments to the environment. Surface streams receive contaminated waters and sediments that move down gradient. As these releases continue over decades, the bedrock groundwater, alluvial aquifers, surface streams, stream sediments, over bank deposits, streamside plants, and wetlands may all be impacted to various degrees. The ultimate receptors are often aquatic microorganisms, fish, wildlife, livestock, and humans. Detailed information regarding COCs transport can be found in the RI Report (Walsh 2008a).

12.9.1 Airborne Transport

The soils, waste rock piles, and tailings are subject to wind erosion at the Site, and residents and visitors may be exposed to dust. The RI did not include any ambient air monitoring. It is assumed that particulates can be released and transported downwind at the Site. It is also assumed that any remedy would include consolidating contaminated soils with waste rock and tailings and covering any potential sources with clean fill, thus eliminating this potential transport pathway.

Table 12-2. Types and Characteristics of COCs Identified at the CJM Site

COCs	Sources	Symptoms
Antimony	Contaminated surface soils and mine waste material	Lung disease, heart problems, gastro-intestinal problems; long-term exposure can cause fertility problems
Arsenic	Contaminated surface soils and mine waste material	Cancer of the lung, skin, bladder, liver, kidney, and colon; skin and nerve damage
Cadmium	Contaminated surface soils and water and mine waste material	Damage to lungs, death; especially toxic to smokers
Copper	Contaminated surface soils and water and mine waste material	Flu-like symptoms; long-term exposure can cause headaches, vomiting, and irritate mucous membranes
Lead	Contaminated surface soils and water and mine waste material	Brain and kidney damage, stomach and intestinal distress; long-term exposure can affect reproductive organs, central nervous system, blood pressure, and kidneys
Manganese	Contaminated surface soils and water and mine waste material	Respiratory problems from acute high exposure; long-term exposure can result in central nervous system damage
Thallium	Contaminated surface soils and water and mine waste material	Nervous system disturbances; long-term exposure can cause fatigue, headaches, and depression from accumulation in the human body
Zinc	Contaminated surface soils and water and mine waste material	Trace element essential for human health; stomach cramps and skin irritation; arteriosclerosis

Table 12-3. Concentrations of COCs identified at the CJM Site

COCs	SW Conc. Range (Total) [mg/L]	SW Conc. Range (Dissolved) [mg/L]	GW Conc. Range (Dissolved) [mg/L]	Surface Soil Conc. Range [mg/kg]	Subsurface Soil Conc. Range [mg/kg]	Sediment Conc. Range [mg/kg]	Plant Tissue Conc. Range [mg/kg]	Fish Tissue Conc. Range [mg/kg]
Antimony	ND – 0.03	ND – 0.03	ND	ND – 5,570	ND – 42.8	ND – 27.8	0.447 – 0.676	ND – 0.522
Arsenic	ND – 0.005	ND – 0.005	ND	ND – 10,800	ND – 309	ND – 54.6	ND	ND
Cadmium	ND – 0.008	ND – 0.0072	ND – 39.9	ND – 241	0.04–10.0	ND – 11.0	0.047 – 2.39	0.0790 – 0.205
Copper	ND – 2.50	ND – 2.54	ND – 518	1.40 – 24,500	7.10 – 2,230	13.1 – 2,960	1.6 – 3.86	0.719 – 4.41
Lead	ND – 0.015	ND – 0.0157	ND – 8.34	14.0 – 177,000	5.40 – 8,020	3.20 – 885	0.155 – 2.97	ND – 0.235
Manganese	ND – 6.69	ND – 6.65	ND – 4110	11.0 – 14,500	48.1 – 12,300	29.7 – 8,100	19.5 – 186	1.27 – 3.77
Thallium	ND – 0.013	ND – 0.013	ND	ND – 27.2	ND – 24.6	ND – 75.9	ND	3.09 – 3.68
Zinc	ND – 1.73	ND – 1.76	5.66 – 23,400	12.0 – 56,800	47.9 – 1,810	ND – 2,330	30.4 – 243	20.1 – 79.1

Notes:
Conc concentration
GW groundwater
Mg/kg milligrams per kilogram
ND - not detected
SW surface water

12.9.2 Groundwater

Groundwater at the CJM Site is in the fractured mineralized host rock and in the alluvial aquifer of Left Hand Creek. At the direction of CDPHE and EPA, the RI groundwater investigation was limited to available literature sources and eight shallow alluvial monitoring wells. Deeper wells were not installed, and, as a result, any hydrologic communication between alluvial and bedrock aquifers is undetermined.

Groundwater in the bedrock aquifer discharges to mine workings as evidenced by seepage from fractures observed during mine entry and discharge from the Big Five adit. There are no monitoring wells in the vicinity of the Big Five tunnel; however, it is likely that the piezometric surface in the vicinity of the tunnel has been substantially lowered by drainage since the construction of the Big Five adit tunnel. The release of Big Five Mine water to surface water is the most significant source of contamination to the surface environment in the study area and possibly in the Left Hand Creek Watershed (LWOG 2005). There is no evidence that either the Black Jack or the White Raven Mine is discharging AMD to the surface water of the Site. Alluvial groundwater seems to have little influence on the surface water in the Big Five Mine and CJM areas; however, bedrock groundwater in the form of AMD from the Big Five adit appears to be a major source of loading. During wet portions of the year, the alluvial aquifer is presumably receiving water from the bedrock aquifer and is losing water to the bedrock aquifer during the dry season.

12.9.3 Surface Water

Left Hand Creek is the principal contaminant transport mechanism within the study area. It moves dissolved metals and suspended and bed load metals-laden sediment through California Gulch. Flow of the creek is usually controlled by the Left Hand Reservoir above the study area. Snowmelt and summer rainstorms contribute to peak flows. The stream flow was measured in September and November and was 19 and 0.5 cubic feet per second (cfs), respectively, at the upstream (west) end of the study area.

Drainage from the Big Five tunnel is a low-pH, iron-sulfate water. This acidic water introduces high concentrations of sulfate and a number of metals to surface water in the Site, including aluminum, manganese, zinc, copper, and lead. The pH and conductivity of the water change only slightly from the portal to the settling pond. Iron is oxidized and precipitated in the settling pond and wetland area. There is (on average) some increase in pH and some decrease in conductivity from the Big Five adit portal to a point just above the confluence with Left Hand Creek.

Most metals concentrations (manganese, copper, zinc, nickel, cadmium, and lead) decrease from the Big Five adit portal to the confluence. The fate and transport of these metals result from the persistence of acidic conditions from the portal to the sampling point above the confluence with Left Hand Creek. The concentration of iron decreases significantly from the portal to the confluence with Left Hand Creek, with the most dramatic decrease occurring downstream of the settling pond. The concentrations of aluminum, magnesium, sodium, calcium, and potassium in water samples did not decrease significantly (and in some instances increased) from the portal to a point just above the confluence with Left Hand Creek.

The concentrations of a number of metals in the Big Five Mine drainage area are decreased by dilution with the confluence of Left Hand Creek. The concentrations of many metals, including manganese, copper, nickel, and lead, apparently decreased to a further extent by precipitation and other processes in Left Hand Creek. These additional reductions are likely associated with the pH in Left Hand Creek, which is higher than that in the influent drainage from the Big Five Mine Area.

The Site waters contain suspended solids containing sediments with adsorbed metals, metals in colloids, and dissolved metals. There is some transport of metals in suspended sediments from the Big Five adit portal to Left Hand Creek and within the Creek. The dissolved metals may be in chemical equilibrium with adsorbed metals on sediments at some locations.

12.9.4 Waste Rock and Soils

Metals in waste rock and tailings piles are subject to wind and water erosion. In addition, these piles are potentially acid forming and subject to leaching. Erosion of waste piles and contaminated soils is a principal transport mechanism at the Site. In particular, the long steep face of the Big Five Waste Pile is subject to uncontrolled erosion, especially during the spring snow melt and summer thunderstorms. Left Hand Creek flows adjacent to the two largest contaminated soil and mine waste areas in the CJM and White Raven areas. These areas contribute elevated metals-rich sediment to the creek. Leachate from soils and mine wastes could adversely affect surface and groundwater quality in the study area. The potential receptors are current and future residents and aquatic life.

12.9.5 Sediment

Soils, waste rock, tailings, and any other solid mine waste materials are being transported by water to Left Hand Creek and down the creek throughout the length of the Site. Sediments are elevated (compared to the PRG for EPA Region 9 Residential Soils) in the creek throughout the study area including the upper and lower study area boundaries. Metals in the sediments are also likely moving back and forth between the dissolved and adsorbed phases, which could improve or degrade surface water quality. The receptors are potentially aquatic life and current and future residents. This is a mountain watershed and, based on data and observation, rates of runoff and the stream velocity are high enough to transport significant sediment through the study area.

The Big Five Mine dump is the largest waste rock pile in the study area. It has a large bare area on top that quickly sheds water down its steep side slopes during a storm or snowmelt. These side slopes are conspicuously eroded. Most of the sediments coming off the pile temporarily are trapped in the settling pond at the toe of the pile. The mine drainage coming out of the Big Five adit tunnel also contains iron oxide flocculants, much of which accumulate in the pond. Elevated metals concentrations were found in sediment samples collected in and around the settling pond and in the wetlands below the pond.

Sediment samples collected at the CJM Site have elevated metals concentrations that reflect the elevated metals in the waste piles and soils at that location. Fine-grained material (possible tailings) was observed on the banks of Left Hand Creek below the mill site (LWOG 2005). Sediment samples collected along the stream in the White Raven Area also reflect the elevated metals in soils at that location. Concentrations in the sediments remain elevated for the entire distance downstream within the Site.

12.9.6 Biology

Metals released from the various sources in the study area are accumulating in the aquatic insects and vegetation of Left Hand Creek. LWOG (2005) sampled aquatic insects throughout the entire Left Hand-James Creek Watershed and found the highest values of zinc, copper, and lead in the watershed in the California Gulch section of the creek, with zinc values reaching 1.8 mg/kg in insect body tissues.

13 Current and Potential Future Site and Resource Uses

13.1 Current and Potential Future Land Uses

One residential property is located north of Left Hand Creek. Ms. Daily currently occupies this property. The CJM office building appeared to be occupied at the time of the RI field work, but it is believed the occupants change often. The Foster residence is located on the south side of Left Hand Creek. The Fosters no longer live at this residence. During the RI field investigation, the house was unoccupied, for sale, and posted with an eviction notice.

Evidence of seasonal residents who may occupy abandoned mine structures and camper-type trailers has also been observed. A camper trailer/plywood structure is located on the top of the Big Five dump. The structure appears to be used as a part-time residence; however, it was not occupied during the RI field work. An abandoned mine building is located on the hillside immediately northwest of the dump. In addition, a few residents housed in temporary structures, such as converted school buses, have been identified in this area. The CJM Site is also currently used for recreational activities.

Most of the CJM Site is under private ownership and the future use is uncertain. For purposes of this ROD, the intended primary future use of the Site is recreational; however, because the CJM Site is zoned for residential use, environmental covenants have been included in the remedial action to preclude development. These covenants would remain in effect indefinitely, unless the remedial action is changed. Institutional controls, including restrictions/requirements of groundwater usage on the CJM Site, have also been included in the remedial action. In addition, areas outside of the CJM Site may be impacted by the Selected Remedy through access, treatment, and monitoring of the underground workings, although anticipated future land use off site is not anticipated to change.

13.2 Current and Potential Future Surface Water and Groundwater Uses

On-site surface water is not being used as a drinking water source for residents and the beneficial use of surface water for a drinking water source on site is not anticipated in the future.

Three domestic wells exist on site; however, no Maximum Contaminant Level (MCL) was exceeded in any of these wells sampled during the RI. Although no MCLs were exceeded, all of these wells were shallow, hand-dug wells in alluvium along Left Hand Creek. None of the wells appeared to be constructed in accordance with State Engineer requirements and could be considered susceptible to future contamination. As discussed in Section 13.1, environmental covenants have been included in the remedial action to restrict the use of groundwater drinking water sources on site. Future use of on-site groundwater for beneficial drinking water sources is not anticipated.

Ward residents receive their domestic water from three separate springs located approximately 5 miles west of town. These springs are located upgradient and outside of the 4-mile radius of the CJM Site (URS 1994). Ward is at roughly 9,200 feet amsl, while the Big Five adit is approximately 8,800 feet amsl. Groundwater in Ward is assumed to be upgradient based on this difference in elevation. An additional 6,500 homes in Boulder and Weld counties are served by the Left Hand Water District, which diverts drinking water downstream from the CJM Site. The remedial action is designed to meet surface water quality criteria at the downstream point of compliance (POC) prior to leaving the CJM Site and diversion into drinking water sources. Future use of downstream surface water is unlikely to change from its current use.

14 Summary of Site Risks

This section of the ROD provides a summary of the Site's human health and environmental risks. An HHRA and Ecological Risk Assessment for the site was completed in May 2008 and included in the RI Report (Walsh 2008a). The risk assessment estimated the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with the CJM Site assuming no remedial action was taken. The risk assessment provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action.

14.1 Summary of HHRA

An HHRA was performed to describe the potential for site-related risks to human receptors as part of the RI (Walsh 2008a). It contains quantitative estimates of exposure compared to estimates of cancer and noncancer health effects (i.e., hazard) in order to develop risk estimates.

The HHRA was performed in two tiers. The initial tier (Tier I) was a screening step in which the data were evaluated and summary statistics were compiled, and then maximum site-wide concentrations of each contaminant were compared to conservative, readily available screening levels. Any contaminants exceeding their initial screening levels were further evaluated in Tier II, if their detection frequency exceeded 5 percent. Tier II evaluation included developing a Site Conceptual Model (SCM) and a list of potential site receptors, identifying receptor-specific exposure estimates, and performing risk calculations for these receptors. Contaminants were also evaluated further if there was no screening value, they were known human carcinogens, or they were identified as bioaccumulative.

14.1.1 Identification of COCs

COCs associated with the former mining and milling operations at the Big Five, Captain Jack/Black Jack, and White Raven Mine areas were determined to be metals, including antimony, arsenic, cadmium, copper, lead, manganese, thallium, and zinc as discussed in Section 12. Concentrations of these chemicals are significantly above background levels for the area.

Table 14-1 presents the COCs and exposure point concentration (EPC) for each COC detected in soils and surface water (i.e., the concentration that was used to estimate the exposure and risk from each COC in soils and surface water). The table includes the range of concentrations by exposure area detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the Site), the EPC, and how the EPC was derived. The table indicates that lead and manganese are the most frequently detected COCs in soils at the Site and manganese is the most frequently detected COC in surface water at the Site. The EPC applied in the risk assessment was the lower of the maximum detected value or the 95% upper confidence limit (UCL95) value for all data. In the few cases in which the COC was not detected in any of the samples for a particular exposure area and media, the minimum reporting limit was used as the EPC. All data include use of one-half the reporting limit as a surrogate for nondetects.

Table 14-1. Summary of COCs and Medium- Specific Exposure Point Concentrations

Scenario Timeframe: Current Medium: Soil Exposure Medium: Soil								
Exposure Point	COC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
		Min	Max					
Soil on-site – Direct Contact Area: BFV	Antimony	0.86	11.2	mg/kg	85%	4.31	mg/kg	95% UCL
	Arsenic	0.46	98.4	mg/kg	94%	34.3	mg/kg	95% UCL
	Cadmium	0.03	2.9	mg/kg	91%	0.86	mg/kg	95% UCL
	Copper	1.4	1,310	mg/kg	100%	260	mg/kg	95% UCL
	Lead	18.1	1,380	mg/kg	100%	383	mg/kg	95% UCL
	Manganese	11.0	2,850	mg/kg	100%	1,400	mg/kg	95% UCL
	Thallium	0.64	6.3	mg/kg	94%	2.61	mg/kg	95% UCL
	Zinc	12.0	683	mg/kg	100%	208	mg/kg	95% UCL
Soil on-site – Direct Contact Area: BFC	Antimony	1.8	109	mg/kg	100%	109	mg/kg	MAX
	Arsenic	4.4	1,130	mg/kg	100%	1,130	mg/kg	MAX
	Cadmium	0.27	65.6	mg/kg	100%	65.6	mg/kg	MAX
	Copper	17.7	2,720	mg/kg	100%	1,440	mg/kg	95% UCL
	Lead	45.3	9,840	mg/kg	100%	9,840	mg/kg	MAX
	Manganese	51.4	1,780	mg/kg	100%	1,160	mg/kg	95% UCL
	Thallium	0.66	5.6	mg/kg	73%	3.01	mg/kg	95% UCL
	Zinc	14.8	15,000	mg/kg	100%	9,840	mg/kg	95% UCL
Soil on-site – Direct Contact Area: CJM	Antimony	0.88	5,570	mg/kg	98%	1,480	mg/kg	95% UCL
	Arsenic	3.4	10,800	mg/kg	100%	3,450	mg/kg	95% UCL
	Cadmium	0.25	241	mg/kg	100%	101	mg/kg	95% UCL
	Copper	29.4	24,500	mg/kg	100%	8,840	mg/kg	95% UCL
	Lead	83.5	177,000	mg/kg	100%	50,300	mg/kg	95% UCL
	Manganese	13.1	3,720	mg/kg	100%	1,010	mg/kg	95% UCL
	Thallium	0.6	9.2	mg/kg	100%	3.94	mg/kg	95% UCL
	Zinc	96.6	56,800	mg/kg	100%	21,600	mg/kg	95% UCL
Soil on-	Antimony	0.88	19.8	mg/kg	81%	6.44	mg/kg	95% UCL

Scenario Timeframe: Current
Medium: Soil
Exposure Medium: Soil

Exposure Point	COC	Concentration Detected Min	Concentration Detected Max	Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
site – Direct Contact Area: WHR	Arsenic	2.9	91.4	mg/kg	100%	36.6	mg/kg	95% UCL
	Cadmium	0.13	17.5	mg/kg	95%	8.32	mg/kg	95% UCL
	Copper	0.26	2,610	mg/kg	95%	600	mg/kg	95% UCL
	Lead	338	14,000	mg/kg	100%	6,370	mg/kg	95% UCL
	Manganese	34.8	14,500	mg/kg	100%	7,940	mg/kg	95% UCL
	Thallium	0.6	27.2	mg/kg	100%	15.6	mg/kg	95% UCL
	Zinc	102	3,010	mg/kg	100%	1,410	mg/kg	95% UCL
Soil on-site – Direct Contact Area: WRS	Antimony	0.91	3.6	mg/kg	38%	3.30	mg/kg	95% UCL
	Arsenic	2.5	84.5	mg/kg	100%	84.5	mg/kg	MAX
	Cadmium	0.04	4.1	mg/kg	75%	1.75	mg/kg	95% UCL
	Copper	14.3	643	mg/kg	100%	374	mg/kg	95% UCL
	Lead	14.0	2,530	mg/kg	100%	1,560	mg/kg	95% UCL
	Manganese	129	820	mg/kg	100%	669	mg/kg	95% UCL
	Thallium	0.49	2.4	mg/kg	100%	2.05	mg/kg	95% UCL
	Zinc	44.4	720	mg/kg	100%	387	mg/kg	95% UCL

Scenario Timeframe: Current
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	COC	Concentration Detected Min	Concentration Detected Max	Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
Sub-surface Soil Area: BFV	No Data							
Sub-surface Soil Area: BFC	Antimony	3.5	3.5	mg/kg	100%	3.5	mg/kg	MAX
	Arsenic	7.1	7.1	mg/kg	100%	7.1	mg/kg	MAX
	Barium	8.4	8.4	mg/kg	100%	804	mg/kg	MAX
	Cadmium	1.1	1.1	mg/kg	100%	1.1	mg/kg	MAX
	Chromium	5.5	5.5	mg/kg	100%	5.5	mg/kg	MAX
	Iron	16,600	16,600	mg/kg	100%	16,600	mg/kg	MAX
	Lead	106	106	mg/kg	100%	106	mg/kg	MAX
	Manganese	253	253	mg/kg	100%	253	mg/kg	MAX
	Mercury	0.24	0.24	mg/kg	100%	0.24	mg/kg	MAX
	Nickel	11.7	11.7	mg/kg	100%	11.7	mg/kg	MAX
	Silver	1.6	1.6	mg/kg	100%	1.6	mg/kg	MAX
	Thallium	1.3	1.3	mg/kg	100%	1.3	mg/kg	MAX
	Zinc	127	127	mg/kg	100%	127	mg/kg	MAX
Sub-surface Soil Area: CJM	Antimony	0.88	42.8	mg/kg	91%	13	mg/kg	95% UCL
	Arsenic	0.59	309	mg/kg	95%	51.4	mg/kg	95% UCL
	Barium	21.5	1,230	mg/kg	100%	411	mg/kg	95% UCL
	Cadmium	0.04	10	mg/kg	100%	3.28	mg/kg	95% UCL
	Chromium	1.8	30.2	mg/kg	100%	7.79	mg/kg	95% UCL
	Iron	7,340	33,500	mg/kg	100%	16,500	mg/kg	95% UCL
	Lead	5.4	8,020	mg/kg	100%	3,100	mg/kg	95% UCL

Scenario Timeframe: Current Medium: Subsurface Soil Exposure Medium: Subsurface Soil								
Exposure Point	COC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
		Min	Max					
	Manganese	48.1	12,300	mg/kg	100%	4,010	mg/kg	95% UCL
	Mercury	0.08	1.5	mg/kg	59%	1.08	mg/kg	95% UCL
	Nickel	1.9	16.5	mg/kg	100%	5.89	mg/kg	95% UCL
	Silver	0.1	305	mg/kg	82%	88.9	mg/kg	95% UCL
	Thallium	0.85	24.6	mg/kg	100%	9.28	mg/kg	95% UCL
	Zinc	48	1,810	mg/kg	100%	828	mg/kg	95% UCL
Sub-surface Soil Area: WHR	Antimony	0	0	mg/kg	0%	3.2	mg/kg	MAX
	Arsenic	3.2	3.2	mg/kg	100%	3.2	mg/kg	MAX
	Barium	227	227	mg/kg	100%	227	mg/kg	MAX
	Cadmium	1.9	1.9	mg/kg	100%	1.9	mg/kg	MAX
	Chromium	6.9	6.9	mg/kg	100%	6.9	mg/kg	MAX
	Iron	19,200	19,200	mg/kg	100%	19,200	mg/kg	MAX
	Lead	900	900	mg/kg	100%	900	mg/kg	MAX
	Manganese	1,860	1,860	mg/kg	100%	1,860	mg/kg	MAX
	Mercury	0.28	0.28	mg/kg	100%	0.28	mg/kg	MAX
	Nickel	5	5	mg/kg	100%	5	mg/kg	MAX
	Silver	9.1	9.1	mg/kg	100%	9.1	mg/kg	MAX
	Thallium	3.6	3.6	mg/kg	100%	3.6	mg/kg	MAX
	Zinc	449	449	mg/kg	100%	449	mg/kg	MAX
Sub-surface Soil Area: WRS	Antimony	0	0	mg/kg	0%	3.55	mg/kg	MAX
	Arsenic	0	0	mg/kg	0%	0.6	mg/kg	MAX
	Barium	34.6	34.6	mg/kg	100%	34.6	mg/kg	MAX
	Cadmium	0.07	0.07	mg/kg	100%	0.07	mg/kg	MAX
	Chromium	4.8	4.8	mg/kg	100%	4.8	mg/kg	MAX
	Iron	10,400	10,400	mg/kg	100%	10,400	mg/kg	MAX
	Lead	11	11	mg/kg	100%	11	mg/kg	MAX
	Manganese	177	177	mg/kg	100%	177	mg/kg	MAX
	Mercury	0	0	mg/kg	0%	0.06	mg/kg	MAX
	Nickel	3.6	3.6	mg/kg	100%	3.6	mg/kg	MAX
	Silver	0.12	0.12	mg/kg	100%	0.12	mg/kg	MAX
	Thallium	0	0	mg/kg	0%	1.5	mg/kg	MAX
	Zinc	47.9	47.9	mg/kg	100%	47.9	mg/kg	MAX

Scenario Timeframe: Current Medium: Sediment Exposure Medium: Sediment								
Exposure Point	COC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
		Min	Max					
Sediment on-site – Direct Contact Area: BFV	Arsenic	0.28	9.5	mg/kg	67%	3.86	mg/kg	95% UCL
	Chromium	0.66	13.2	mg/kg	97%	6.46	mg/kg	95% UCL
	Iron	4,100	495,000	mg/kg	100%	435,000	mg/kg	95% UCL
	Lead	3.2	885	mg/kg	100%	242	mg/kg	95% UCL
	Manganese	29.7	478	mg/kg	100%	228	mg/kg	95% UCL
	Mercury	0.01	1.1	mg/kg	63%	0.193	mg/kg	95% UCL
	Thallium	0.27	75.9	mg/kg	53%	20.7	mg/kg	95% UCL

Scenario Timeframe: Current Medium: Sediment Exposure Medium: Sediment								
Exposure Point	COC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
		Min	Max					
Sediment on-site – Direct Contact Area: BFC	Arsenic	0.69	54.6	mg/kg	91%	11	mg/kg	95% UCL
	Chromium	1.5	32.2	mg/kg	100%	15.5	mg/kg	95% UCL
	Iron	3,850	435,000	mg/kg	100%	179,000	mg/kg	95% UCL
	Lead	18.6	428	mg/kg	100%	159	mg/kg	95% UCL
	Manganese	34.8	1,000	mg/kg	100%	265	mg/kg	95% UCL
	Mercury	0.012	0.72	mg/kg	89%	32.8	mg/kg	95% UCL
	Thallium	0.55	25.5	mg/kg	57%	7.67	mg/kg	95% UCL
Sediment on-site – Direct Contact Area: CJM	Acenaphthylene	0	0	mg/kg	0%	0.225	mg/kg	MAX
	Alpha-Chlordane	0	0	mg/kg	0%	0.00115	mg/kg	MAX
	Aroclor-1016	0	0	mg/kg	0%	0.0225	mg/kg	MAX
	Aroclor-1221	0	0	mg/kg	0%	0.0455	mg/kg	MAX
	Aroclor-1232	0	0	mg/kg	0%	0.0225	mg/kg	MAX
	Aroclor-1242	0	0	mg/kg	0%	0.0225	mg/kg	MAX
	Aroclor-1248	0	0	mg/kg	0%	0.0225	mg/kg	MAX
	Aroclor-1254	0	0	mg/kg	0%	0.0225	mg/kg	MAX
	Aroclor-1260	0	0	mg/kg	0%	0.0225	mg/kg	MAX
	Arsenic	1	30.5	mg/kg	100%	9.76	mg/kg	95% UCL
	Benzo(a)Pyrene	0	0	mg/kg	0%	0.225	mg/kg	MAX
	Chromium	1.3	7.9	mg/kg	100%	4.49	mg/kg	95% UCL
	Heptachlor Epoxide	0	0	mg/kg	0%	0.00115	mg/kg	MAX
	Iron	4,350	15,900	mg/kg	100%	10,100	mg/kg	95% UCL
	Lead	14.9	542	mg/kg	100%	307	mg/kg	95% UCL
	Manganese	396	3,470	mg/kg	100%	1,750	mg/kg	95% UCL
	Mercury	0.01	0.12	mg/kg	41%	0.0825	mg/kg	95% UCL
	Thallium	0.27	7.5	mg/kg	41%	3.87	mg/kg	95% UCL
Sediment on-site – Direct Contact Area: WHR	Arsenic	2.3	36.8	mg/kg	100%	13.8	mg/kg	95% UCL
	Chromium	0.85	7.6	mg/kg	100%	4.58	mg/kg	95% UCL
	Iron	2,950	16,100	mg/kg	100%	11,000	mg/kg	95% UCL
	Lead	70.8	566	mg/kg	100%	260	mg/kg	95% UCL
	Manganese	415	8,100	mg/kg	100%	3,520	mg/kg	95% UCL
	Mercury	0.014	0.18	mg/kg	43%	0.0895	mg/kg	95% UCL
	Thallium	0.45	3.4	mg/kg	43%	2.06	mg/kg	95% UCL
Sediment on-site – Direct Contact Area: WRS	Acenaphthylene	0	0	mg/kg	0%	0.24	mg/kg	95% UCL
	Alpha-Chlordane	0.00021	0.00021	mg/kg	100%	0.00021	mg/kg	95% UCL
	Aroclor-1016	0	0	mg/kg	0%	0.024	mg/kg	95% UCL

Scenario Timeframe: Current Medium: Sediment Exposure Medium: Sediment								
Exposure Point	COC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
		Min	Max					
	Aroclor-1221	0	0	mg/kg	0%	0.0485	mg/kg	95% UCL
	Aroclor-1232	0	0	mg/kg	0%	0.024	mg/kg	95% UCL
	Aroclor-1242	0	0	mg/kg	0%	0.024	mg/kg	95% UCL
	Aroclor-1248	0	0	mg/kg	0%	0.024	mg/kg	95% UCL
	Aroclor-1254	0	0	mg/kg	0%	0.024	mg/kg	95% UCL
	Aroclor-1260	0	0	mg/kg	0%	0.024	mg/kg	MAX
	Arsenic	2	28.1	mg/kg	100%	10.2	mg/kg	95% UCL
	Benzo(a)Pyrene	0	0	mg/kg	0%	0.24	mg/kg	MAX
	Chromium	1.9	14.7	mg/kg	100%	6.05	mg/kg	95% UCL
	Heptachlor Epoxide	0.0005	0.0005	mg/kg	100%	0.0005	mg/kg	MAX
	Iron	4,970	27,600	mg/kg	100%	12,100	mg/kg	95% UCL
	Lead	128	574	mg/kg	100%	325	mg/kg	95% UCL
	Manganese	874	6,430	mg/kg	100%	2,630	mg/kg	95% UCL
	Mercury	0.01	0.12	mg/kg	65%	0.0683	mg/kg	95% UCL
	Thallium	0.36	12.8	mg/kg	65%	3.88	mg/kg	95% UCL

Scenario Timeframe: Current Medium: Groundwater Exposure Medium: Groundwater								
Exposure Point	COC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
		Min	Max					
Ground-water on-site – Ingestion Area: BFV	Aluminum	0.0235	1.59	mg/L	100%	1.59	mg/L	MAX
	Antimony	0	0	mg/L	0%	0.0125	mg/L	MAX
	Arsenic	0	0	mg/L	0%	0.00250	mg/L	MAX
	Boron	0	0	mg/L	0%	0.05	mg/L	MAX
	Cadmium	0.00028	0.00241	mg/L	67%	0.00241	mg/L	MAX
	Chromium	0	0	mg/L	0%	0.005	mg/L	MAX
	Copper	0.0047	0.518	mg/L	100%	0.518	mg/L	MAX
	Manganese	0.0182	1.79	mg/L	67%	1.79	mg/L	MAX
	Mercury	0	0	mg/L	0%	0.00015	mg/L	MAX
	Zinc	0.017	0.66	mg/L	100%	0.66	mg/L	MAX
Ground-water on-site – Ingestion Area: BFC	Aluminum	0.10	0.10	mg/L	100%	0.1	mg/L	MAX
	Antimony	0	0	mg/L	0%	0.0125	mg/L	MAX
	Arsenic	0	0	mg/L	0%	0.0025	mg/L	MAX
	Boron	0	0	mg/L	0%	0.05	mg/L	MAX
	Cadmium	0.00065	0.00065	mg/L	100%	0.00035	mg/L	MAX
	Chromium	0	0	mg/L	0%	0.005	mg/L	MAX
	Copper	0.0162	0.0162	mg/L	100%	0.0162	mg/L	MAX
	Manganese	0.0352	0.0352	mg/L	100%	0.0352	mg/L	MAX
	Mercury	0	0	mg/L	0%	0.000150	mg/L	MAX

Scenario Timeframe: Current
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	COC	Concentration Detected Min	Concentration Detected Max	Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
	Zinc	0.151	0.151	mg/L	100%	0.151	mg/L	MAX
Ground-water on-site – Ingestion Area: CJM	Aluminum	0.0253	0.765	mg/L	100%	0.765	mg/L	MAX
	Antimony	0	0	mg/L	0%	0.0125	mg/L	MAX
	Aroclor-1016	0	0	mg/L	0%	0.001	mg/L	MAX
	Aroclor-1221	0	0	mg/L	0%	0.002	mg/L	MAX
	Aroclor-1232	0	0	mg/L	0%	0.001	mg/L	MAX
	Aroclor-1242	0	0	mg/L	0%	0.001	mg/L	MAX
	Aroclor-1248	0	0	mg/L	0%	0.001	mg/L	MAX
	Aroclor-1254	0	0	mg/L	0%	0.001	mg/L	MAX
	Aroclor-1260	0	0	mg/L	0%	0.001	mg/L	MAX
	Arsenic	0	0	mg/L	0%	0.0025	mg/L	MAX
	Benzo(a)Anthracene	0	0	mg/L	0%	0.01	mg/L	MAX
	Benzo(a)Pyrene	0	0	mg/L	0%	0.01	mg/L	MAX
	Benzo(b)Fluoranthene	0	0	mg/L	0%	0.01	mg/L	MAX
	Benzo(k)Fluranthene	0	0	mg/L	0%	0.01	mg/L	MAX
	Boron	0.0309	1.48	mg/L	100%	1.48	mg/L	MAX
	Cadmium	0.00058	0.0399	mg/L	100%	0.0399	mg/L	MAX
	Chromium	0	0	mg/L	0%	0.005	mg/L	MAX
	Chrysene	0	0	mg/L	0%	0.01	mg/L	MAX
	Copper	0.00882	0.150	mg/L	100%	0.150	mg/L	MAX
	Manganese	0.0133	4.11	mg/L	100%	4.11	mg/L	MAX
	Mercury	0	0	mg/L	0%	0.00015	mg/L	MAX
	Zinc	0.305	23.4	mg/L	100%	23.4	mg/L	MAX
Ground-water on-site – Ingestion Area: WHR	Aluminum	0.0235	0.0235	mg/L	100%	0.0235	mg/L	MAX
	Antimony	0	0	mg/L	0%	0.0125	mg/L	MAX
	Arsenic	0	0	mg/L	0%	0.0025	mg/L	MAX
	Boron	0.0301	0.0301	mg/L	100%	0.0301	mg/L	MAX
	Cadmium	0.00394	0.00394	mg/L	100%	0.00394	mg/L	MAX
	Chromium	0	0	mg/L	0%	0.005	mg/L	MAX
	Copper	0.00537	0.00537	mg/L	100%	0.00537	mg/L	MAX
	Manganese	2.12	2.12	mg/L	100%	2.12	mg/L	MAX
	Mercury	0	0	mg/L	0%	0.00015	mg/L	MAX
	Zinc	0.836	0.836	mg/L	100%	0.836	mg/L	MAX
Ground-water on-site – Ingestion Area:	Aluminum	0.0142	0.0378	mg/L	100%	0.0378	mg/L	MAX
	Antimony	0	0	mg/L	0%	0.0125	mg/L	MAX
	Arsenic	0	0	mg/L	0%	0.0025	mg/L	MAX
	Boron	0.0214	0.0335	mg/L	100%	0.0335	mg/L	MAX
	Cadmium	0	0	mg/L	0%	0.0005	mg/L	MAX

Scenario Timeframe: Current
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	COC	Concentration Detected Min	Concentration Detected Max	Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
WRS	Chromium	0	0	mg/L	0%	0.005	mg/L	MAX
	Copper	0.00514	0.00514	mg/L	50%	0.0075	mg/L	MAX
	Manganese	0.00701	0.00701	mg/L	50%	0.0125	mg/L	MAX
	Mercury	0	0	mg/L	0%	0.00015	mg/L	MAX
	Zinc	0.027	0.0373	mg/L	100%	0.0373	mg/L	MAX

Scenario Timeframe: Current
Medium: Mine Water
Exposure Medium: Mine Water

Exposure Point	COC	Concentration Detected Min	Concentration Detected Max	Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
Mine Water – Direct Contact Are: Big Five Adit	Antimony	0	0	mg/L	0%	0.0125	mg/L	MAX
	Arsenic	0	0	mg/L	0%	0.0025	mg/L	MAX
	Barium	0.0162	0.0358	mg/L	100%	0.0336	mg/L	95% UCL
	Cadmium	0.00477	0.00726	mg/L	83%	0.00634	mg/L	95% UCL
	Chromium	0	0	mg/L	0%	0.005	mg/L	MAX
	Copper	0.959	1.42	mg/L	83%	1.3	mg/L	95% UCL
	Iron	2.96	42.8	mg/L	100%	30.2	mg/L	95% UCL
	Lead	0.000380	0.0333	mg/L	100%	0.0337	mg/L	95% UCL
	Manganese	0.708	4.3	mg/L	100%	5.39	mg/L	95% UCL
	Mercury	0	0	mg/L	0%	0.00015	mg/L	MAX
Mine Water – Direct Contact Are: Black Jack Tunnel	Antimony	0.00909	0.00909	mg/L	33%	0.00909	mg/L	MAX
	Arsenic	0.00324	0.0189	mg/L	67%	0.0189	mg/L	MAX
	Barium	0.114	1.6	mg/L	100%	1.6	mg/L	MAX
	Cadmium	0.00029	0.00047	mg/L	100%	0.000470	mg/L	MAX
	Chromium	0	0	mg/L	0%	0.005	mg/L	MAX
	Copper	0.00573	0.0106	mg/L	100%	0.0106	mg/L	MAX
	Iron	3.01	111	mg/L	100%	111	mg/L	MAX
	Lead	0.0617	0.72	mg/L	100%	0.72	mg/L	MAX
	Manganese	2.24	7.3	mg/L	100%	7.3	mg/L	MAX
	Mercury	0.000647	0.000669	mg/L	67%	0.000669	mg/L	MAX
Mine Water – Direct Contact Are: Cross Mine Tunnel	Antimony	0	0	mg/L	0%	0.0125	mg/L	MAX
	Arsenic	0.00211	0.00211	mg/L	100%	0.00211	mg/L	MAX
	Barium	0.138	0.138	mg/L	100%	0.138	mg/L	MAX
	Cadmium	0.00140	0.00140	mg/L	100%	0.0014	mg/L	MAX
	Chromium	0.00248	0.00248	mg/L	100%	0.00278	mg/L	MAX
	Copper	0.0319	0.0319	mg/L	100%	0.0319	mg/L	MAX
	Iron	5377	5377	mg/L	100%	5.77	mg/L	MAX
	Lead	0.353	0.353	mg/L	100%	0.353	mg/L	MAX
	Manganese	0.826	0.826	mg/L	100%	0.826	mg/L	MAX
	Mercury	0.000106	0.000106	mg/L	100%	0.000106	mg/L	MAX
Mine Water – Direct	Antimony	0.00941	0.00941	mg/L	50%	0.00941	mg/L	MAX
	Arsenic	0.00346	0.0108	mg/L	100%	0.0108	mg/L	MAX
	Barium	0.436	1.96	mg/L	100%	1.96	mg/L	MAX

Scenario Timeframe: Current Medium: Mine Water Exposure Medium: Mine Water								
Exposure Point	COC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
		Min	Max					
Contact Are: White Raven Tunnel	Cadmium	0.00171	0.00188	mg/L	100%	0.00188	mg/L	MAX
	Chromium	0	0	mg/L	0%	0.005	mg/L	MAX
	Copper	0.0759	0.296	mg/L	100%	0.296	mg/L	MAX
	Iron	4.94	17.9	mg/L	100%	17.9	mg/L	MAX
	Lead	0.776	2.21	mg/L	100%	2.21	mg/L	MAX
	Manganese	1.29	4.65	mg/L	100%	4.65	mg/L	MAX
	Mercury	0.00076	0.0033	mg/L	100%	0.0033	mg/L	MAX

Scenario Timeframe: Current Medium: Surface Water Exposure Medium: Surface Water								
Exposure Point	COC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
		Min	Max					
Surface Water on-site – Area: BFV	Antimony	0	NA	mg/L	0%	0.025	mg/L	Min RL
	Arsenic	0	0.005	mg/L	0%	0.005	mg/L	Min RL
	Cadmium	0.000226	0.0081	mg/L	61%	0.00478	mg/L	95% UCL
	Copper	0.0022	2.5	mg/L	78%	2.5	mg/L	MAX
	Manganese	0.0056	6.69	mg/L	83%	6.69	mg/L	MAX
	Thallium	0.00014	0.00014	mg/L	22%	0.00014	mg/L	MAX
Surface Water on-site – Area: BFC	Antimony	0.0033	0.0033	mg/L	10%	0.0033	mg/L	MAX
	Arsenic	0	0.005	mg/L	0%	0.005	mg/L	Min RL
	Cadmium	0.00021	0.00535	mg/L	70%	0.00357	mg/L	95% UCL
	Copper	0.0183	1.23	mg/L	80%	1.23	mg/L	MAX
	Manganese	0.0168	3.06	mg/L	100%	3.06	mg/L	MAX
	Thallium	0.00011	0.009	mg/L	30%	0.00014	mg/L	95% UCL
Surface Water on-site – Area: CJM	Antimony	0.0045	0.0045	mg/L	20%	0.0045	mg/L	MAX
	Arsenic	0	0.005	mg/L	0%	0.005	mg/L	Min RL
	Cadmium	0.00029	0.0025	mg/L	80%	0.0025	mg/L	MAX
	Copper	0.0217	0.224	mg/L	100%	0.19	mg/L	95% UCL
	Manganese	0.0778	0.446	mg/L	100%	0.404	mg/L	95% UCL
	Thallium	0.00014	0.00014	mg/L	20%	0.00014	mg/L	MAX
Surface Water on-site – Area: WHR	Antimony	0	NA	mg/L	0%	0.025	mg/L	Min RL
	Arsenic	0	0.005	mg/L	0%	0.005	mg/L	Min RL
	Cadmium	0.00033	0.0019	mg/L	80%	0.0019	mg/L	MAX
	Copper	0.0234	0.111	mg/L	100%	0.111	mg/L	MAX
	Manganese	0.0653	0.365	mg/L	100%	0.341	mg/L	95% UCL
	Thallium	0	NA	mg/L	0%	0.0005	mg/L	Min RL
Surface Water on-site – Area: WRS	Antimony	0.0038	0.03	mg/L	10%	0.03	mg/L	MAX
	Arsenic	0	0.005	mg/L	0%	0.005	mg/L	Min RL
	Cadmium	0.00031	0.0022	mg/L	80%	0.00206	mg/L	95% UCL
	Copper	0.024	0.127	mg/L	100%	0.0919	mg/L	95% UCL
	Manganese	0.0623	0.349	mg/L	100%	0.262	mg/L	95% UCL
	Thallium	0.00037	0.00042	mg/L	20%	0.00042	mg/L	MAX

Scenario Timeframe: Current Medium: Plant Tissue Exposure Medium: Plant Tissue								
Exposure Point	COC	Concentration Detected Min	Concentration Detected Max	Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
Plant Tissue - Ingestion Area: BFV	Antimony	0.65	0.65	mg/kg	100%	0.65	mg/kg	MAX
	Arsenic	2.4	2.4	mg/kg	100%	2.4	mg/kg	MAX
	Barium	7.54	7.54	mg/kg	100%	7.54	mg/kg	MAX
	Cadmium	1.27	1.27	mg/kg	100%	1.27	mg/kg	MAX
	Chromium	0.96	0.96	mg/kg	100%	0.962	mg/kg	MAX
	Copper	2.13	2.13	mg/kg	100%	2.13	mg/kg	MAX
	Iron	32.80	32.80	mg/kg	100%	32.8	mg/kg	MAX
	Lead	0.19	0.19	mg/kg	100%	0.192	mg/kg	MAX
	Manganese	96.30	96.30	mg/kg	100%	96.3	mg/kg	MAX
	Mercury	0.05	0.05	mg/kg	100%	0.05	mg/kg	MAX
	Nickel	0.49	0.49	mg/kg	100%	0.485	mg/kg	MAX
	Selenium	1.92	1.92	mg/kg	100%	1.92	mg/kg	MAX
	Silver	0.96	0.96	mg/kg	100%	0.962	mg/kg	MAX
	Thallium	1.92	1.92	mg/kg	100%	1.92	mg/kg	MAX
	Zinc	139.0	139.0	mg/kg	100%	139	mg/kg	MAX
Plant Tissue - Ingestion Area: BFC	Antimony	0.52	0.676	mg/kg	100%	0.676	mg/kg	MAX
	Arsenic	2.35	2.45	mg/kg	100%	2.48	mg/kg	MAX
	Barium	4.17	23.4	mg/kg	100%	23.4	mg/kg	MAX
	Cadmium	0.05	0.128	mg/kg	100%	0.128	mg/kg	MAX
	Chromium	0.94	0.99	mg/kg	100%	0.99	mg/kg	MAX
	Copper	3.81	3.86	mg/kg	100%	3.86	mg/kg	MAX
	Iron	34.70	52.9	mg/kg	100%	52.9	mg/kg	MAX
	Lead	0.22	1.26	mg/kg	100%	1.26	mg/kg	MAX
	Manganese	122.0	186	mg/kg	100%	186	mg/kg	MAX
	Mercury	0.04	0.0475	mg/kg	100%	0.0475	mg/kg	MAX
	Nickel	1.57	1.6	mg/kg	100%	1.6	mg/kg	MAX
	Selenium	1.88	1.98	mg/kg	100%	1.92	mg/kg	MAX
	Silver	0.94	0.99	mg/kg	100%	0.99	mg/kg	MAX
	Thallium	1.88	1.98	mg/kg	100%	1.98	mg/kg	MAX
	Zinc	30.40	35.4	mg/kg	100%	35.4	mg/kg	MAX
Plant Tissue - Ingestion Area: CJM	Acetophenone	0	0	mg/kg	0%	0.74	mg/kg	MAX
	Benzo(a)Anthracene	0	0	mg/kg	0%	0.109	mg/kg	MAX
	Benzo(a)Pyrene	0	0	mg/kg	0%	0.011	mg/kg	MAX
	Benzo(g,h,i)Perylene	0	0	mg/kg	0%	0.004	mg/kg	MAX
	Aroclor-1016	0	0	mg/kg	0%	0.00468	mg/kg	MAX
	Aroclo-1221	0	0	mg/kg	0%	0.00948	mg/kg	MAX
	Aroclo-1232	0	0	mg/kg	0%	0.00468	mg/kg	MAX
	Aroclo-1242	0	0	mg/kg	0%	0.00468	mg/kg	MAX
	Aroclo-1248	0	0	mg/kg	0%	0.00468	mg/kg	MAX
	Aroclo-1254	0	0	mg/kg	0%	0.00468	mg/kg	MAX

Scenario Timeframe: Current Medium: Plant Tissue Exposure Medium: Plant Tissue								
Exposure Point	COC	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
		Min	Max					
	Aroclo-1260	0	0	mg/kg	0%	0.00468	mg/kg	MAX
	Carbazole	0	0	mg/kg	0%	0.936	mg/kg	MAX
	Antimony	0.638	0.638	mg/kg	100%	0.638	mg/kg	MAX
	Arsenic	2.48	2.48	mg/kg	100%	2.48	mg/kg	MAX
	Barium	6.17	6.17	mg/kg	100%	6.17	mg/kg	MAX
	Cadmium	1.11	1.11	mg/kg	100%	1.11	mg/kg	MAX
	Chromium	0.99	0.99	mg/kg	100%	0.99	mg/kg	MAX
	Copper	2.55	2.55	mg/kg	100%	2.55	mg/kg	MAX
	Iron	49.50	49.50	mg/kg	100%	49.5	mg/kg	MAX
	Lead	2.97	2.97	mg/kg	100%	2.97	mg/kg	MAX
	Manganese	43.6	43.6	mg/kg	100%	43.6	mg/kg	MAX
	Mercury	0.0347	0.0347	mg/kg	100%	0.0347	mg/kg	MAX
	Nickel	1.44	1.44	mg/kg	100%	1.44	mg/kg	MAX
	Selenium	1.98	1.98	mg/kg	100%	1.98	mg/kg	MAX
	Silver	0.99	0.99	mg/kg	100%	0.99	mg/kg	MAX
	Thallium	1.98	1.98	mg/kg	100%	1.98	mg/kg	MAX
	Zinc	224	224	mg/kg	100%	224	mg/kg	MAX
Plant Tissue - Ingestion Area: WHR	Antimony	0.6	0.615	mg/kg	100%	0.615	mg/kg	MAX
	Arsenic	2.22	2.4	mg/kg	100%	2.4	mg/kg	MAX
	Barium	19.70	29.2	mg/kg	100%	29.2	mg/kg	MAX
	Cadmium	0.64	2.39	mg/kg	100%	2.39	mg/kg	MAX
	Chromium	0.89	0.962	mg/kg	100%	0.962	mg/kg	MAX
	Copper	2.93	3.01	mg/kg	100%	3.01	mg/kg	MAX
	Iron	35.4	43.4	mg/kg	100%	43.4	mg/kg	MAX
	Lead	0.46	0.829	mg/kg	100%	0.829	mg/kg	MAX
	Manganese	50.90	55	mg/kg	100%	55	mg/kg	MAX
	Mercury	0.04	0.049	mg/kg	100%	0.0494	mg/kg	MAX
	Nickel	1.22	1.67	mg/kg	100%	1.67	mg/kg	MAX
	Selenium	1.78	1.92	mg/kg	100%	1.92	mg/kg	MAX
	Silver	0.89	0.962	mg/kg	100%	0.962	mg/kg	MAX
	Thallium	1.78	1.92	mg/kg	100%	1.92	mg/kg	MAX
	Zinc	82.20	243	mg/kg	100%	243	mg/kg	MAX
Plant Tissue - Ingestion Area: WRS	Antimony	0.45	0.45	mg/kg	100%	0.447	mg/kg	MAX
	Arsenic	2.36	2.36	mg/kg	100%	2.36	mg/kg	MAX
	Barium	15	15	mg/kg	100%	15.0	mg/kg	MAX
	Cadmium	0.22	0.22	mg/kg	100%	0.223	mg/kg	MAX
	Chromium	0.94	0.94	mg/kg	100%	0.943	mg/kg	MAX
	Copper	2.97	2.97	mg/kg	100%	2.97	mg/kg	MAX
	Iron	36.50	36.50	mg/kg	100%	36.5	mg/kg	MAX
	Lead	1.21	1.21	mg/kg	100%	1.21	mg/kg	MAX
	Manganese	51.20	51.20	mg/kg	100%	51.2	mg/kg	MAX
	Mercury	0.03	0.03	mg/kg	100%	0.0338	mg/kg	MAX
	Nickel	1.33	1.33	mg/kg	100%	1.33	mg/kg	MAX
	Selenium	1.89	1.89	mg/kg	100%	1.89	mg/kg	MAX
	Silver	0.94	0.94	mg/kg	100%	0.943	mg/kg	MAX
	Thallium	1.89	1.89	mg/kg	100%	1.89	mg/kg	MAX
	Zinc	61.20	61.20	mg/kg	100%	61.2	mg/kg	MAX

Scenario Timeframe: Current Medium: Fish Tissue Exposure Medium: Fish Tissue								
Exposure Point	COC	Concentration Detected Min	Concentration Detected Max	Units	Frequency of Detection	Exposure Point Concentration (EPC)	EPC Units	Statistical Measure
Fish Tissue - Ingestion Area: BFV	Antimony	0.499	0.522	mg/kg	100%	0.522	mg/kg	MAX
	Arsenic	0.752	0.82	mg/kg	100%	0.82	mg/kg	MAX
	Chromium	0.249	0.626	mg/kg	100%	0.626	mg/kg	MAX
	Mercury	0.042	0.0485	mg/kg	100%	0.0485	mg/kg	MAX
	Thallium	3.09	3.68	mg/kg	100%	3.68	mg/kg	MAX
	Vanadium	0.0736	0.235	mg/kg	100%	0.235	mg/kg	MAX
Fish Tissue - Ingestion Area: BFC	No Data							
Fish Tissue - Ingestion Area: CJM	No Data							
Fish Tissue - Ingestion Area: WHR	No Data							
Fish Tissue - Ingestion Area: WRS	Antimony	1.46	1.46	mg/kg	100%	1.46	mg/kg	MAX
	Arsenic	0.73	0.73	mg/kg	100%	0.73	mg/kg	MAX
	Chromium	0.253	0.253	mg/kg	100%	0.253	mg/kg	MAX
	Thallium	3.11	3.11	mg/kg	100%	3.11	mg/kg	MAX
	Vanadium	1.46	1.46	mg/kg	100%	1.46	mg/kg	MAX

Big Five Area (BFV)
Big Five to Captain Jack Area (BFC)
Captain Jack Mill Area (CJM)
White Raven Area (WHR)
White Raven to Sawmill Area (WRS)
95% UCL = 95% Upper Confidence Limit
Min RL = Minimum Reporting Limit
MAX = Maximum observed concentration
mg/kg = milligrams per kilogram
mg/L = milligrams per liter

Laboratory data from the sampling investigations were validated prior to inclusion in the risk assessment data sets; a total of 10 percent of the data were validated and all data that were not rejected by the laboratory were included in the quantitative risk assessment. All data were deemed usable for the risk assessment.

14.1.2 Exposure Assessment

The objectives of the exposure assessment process were to estimate the type and magnitude of potential current and future human exposures to COCs in all media of concern. Consideration of the appropriate site-specific exposure scenarios provided the basis for analyzing risks at the Site. The key steps in the exposure assessment process were:

- Characterization of exposure setting;
- Identification of current and future receptors;
- Identification of potential exposure pathways; and
- Quantification of exposure.

Characterization of Exposure Setting

The CJM Site was divided into five general exposure areas based on topography, contamination sources, and historic use:

- Big Five Area;
- Big Five to Captain Jack Area;
- Captain Jack Mill Area (CJM);
- White Raven Area; and
- White Raven to Sawmill Area.

These general exposure areas corresponded to the areas of investigation discussed in Section 8 of this ROD.

Identification of Current and Future Receptors

The following potential receptors were identified from the available information:

- Current and Future Residents;
- Current and Future Recreationalists; and
- Current and Future Construction Workers.

Identification of Potential Exposure Pathways

The potential exposure media were identified in the SCM (Figure 14-1). The exposure pathways identified as potentially complete and significant are summarized as follows (Figure 12-1):

Current and Future Residents

- Incidental soil ingestion (includes surface soils, subsurface soils, waste rock, tailings);
- Dermal contact with soil (surface soils, subsurface soils, waste rock, tailings);
- Inhalation of particulates generated from surface soils to outdoor and indoor air;
- Ingestion of home grown produce;
- Ingestion of fish;
- Ingestion of groundwater, surface water or mine water as a potable water supply;
- Dermal contact with groundwater, surface water, or mine water in potable use;
- Dermal contact with groundwater during irrigation use;
- Incidental ingestion of surface water;
- Incidental dermal exposure to surface water;
- Incidental ingestion of sediments; and,
- Dermal contact with sediments.

Current and Future Recreationalists

- Incidental soil ingestion (surface soils, waste rock, tailings);
- Incidental dermal contact with soil (surface soils, waste rock, tailings);
- Incidental ingestion of surface water;
- Incidental dermal contact with surface water;
- Incidental ingestion of sediments;
- Incidental dermal contact with sediments; and,
- Ingestion of fish.

Future Construction Workers

- Incidental soil ingestion (surface and subsurface soils, including waste rock and tailings); and,
- Incidental dermal contact with soil (surface and subsurface soils, including waste rock and tailings)

Other receptors that may be present include remediation or mine workers. Exposure to off-site receptors is also possible due to migration of materials downstream. It was expected that risk estimates for residents, recreationalists, and future construction workers would offer the highest exposure rates, thus being protective of other potentially exposed people.

Quantification of Exposure

Exposure was quantified by determining EPCs, conservative receptor-specific exposure parameters, and calculating intakes.

The EPC is a conservative estimate of the average chemical concentration in each environmental medium (EPA 2002b). An EPC was determined for each Tier II Contaminant of Potential Concern (COPC) in each individual exposure area within a site (EPA 2002b). As discussed in the previous section, the EPC applied in the risk assessment was the lower of the maximum detected value or the UCL9 value for all data.

Mathematical models were used to calculate the intakes (i.e., the doses) of the COCs for each receptor, using applicable exposure routes. The equations used to calculate intakes for each pathway and scenario combination are presented in Figure 14-1 (EPA 1989; EPA 2004a). The variables used in estimating doses and the assumptions, known as exposure parameters, which were used in the model are discussed in detail in the Risk Assessment Section (Section 8) of the Remedial Investigation Report (Walsh 2008a). These parameters included variables such as daily ingestion rate of soil, exposure duration, and body weight.

Figure 14-1 Risk Assessment Equations and Calculations

NONCANCER INTAKES

Surface Soil Pathways

CDIsi = Cs * IRSc * CF * EF * EDc/ (BWc *ATc)

CDIsd = Cs * SASc * ABS * AFc * CF * EF * EDc / (BWc * ATc)

Subsurface Soil Pathways

CDIsubi = Css * IRSc * CF * EF * EDc/ (BWc *ATc)

CDIsubd = Css * SASc * ABS * AFc * CF * EF * EDc / (BWc * ATc)

Inhalation Pathways

CDIap = Cs * IRAc * EFc * EDc / (BWc * ATc * PEF)

Surface Water Potable Use Pathways

CDIswi = Csw * IRWa * EF * EDr/ (BWa * ATr)

CDIswd = Csw * SAWa * Kp * EV* ETba * EF * EDr * CFv / (BWa * ATr)

Surface Water Incidental Exposure Pathways (Wading, Swimming, Bathing)

CDIswi = Csw * IRSWc * EFsw * EDc/ (BWc * ATc)

CDIswd = Csw * SAWSc * Kp * EV * ETbc * EFsw * EDc * CFv / (BWc * ATc)

Sediment Incidental Exposure Pathways (Wading, Swimming, Bathing)

CDIsedi = Csed * IRSc * CF * EFsw * EDc / (BWc * ATc)

CDIsedd = Csed * SAWSc * ABS * AFc * CF * EFsw * EDc / (BWc * ATc)

Groundwater Potable Use Pathways

CDIgwi = Cgw * IRWa * EF * EDr/ (BWa * ATr)

CDIgwd = Cgw * SAWa * Kp * EV * ETb * EF * EDr * CFv / (BWa * ATr)

Groundwater Irrigation Use Pathways

CDIgwirrd = Cgw * SAWirr * Kp * EV * ETirr* EFirr * EDa * CFv / (BWa * ATa)

Mine Water Potable Use Pathways

CDImwi = Cmw * IRWa * EF * EDr/ (BWa * ATr)

CDImwd = Cmw * SAWa * Kp * EV * ETb * EF * EDr * CFv / (BWa * ATr)

Garden Produce Pathways

CDIveg = Cp * IRVa * CF * EFveg * EDr / (BWa * ATr)

Fish Pathways

CDIfish = Cfish * IRFa * CF * EFfish * EDr / (BWa * ATr)

Notes:
For receptor specific parameters, the subscripts a,c, and r indicate:
a=adult
c=child
r=sum of adult and child

CANCER INTAKES

Surface Soil Pathways

CDIsi = Cs * IRSadj * CF * EF / ATC

CDIsd = Cs * SASadj * ABS * CF * EF / ATC

Subsurface Soil Pathways

CDIsubi = Css * IRSadj * CF * EF / ATC

CDIsubd = Css * SASadj * ABS* CF * EF / ATC

Inhalation Pathways

CDIap = Cs * InhFadj * EF / (ATC * PEF)

Surface Water Potable Use Pathways

CDIswi = Csw * IRWadj * EF/ ATC

CDIswd = Csw * SAWadj * Kp *EV* EF * CFv / ATC

Surface Water Incidental Exposure Pathways (Wading, Swimming, Bathing)

CDIswi = Csw * IRSWadj * EFsw/ ATC

CDIswd = Csw * SAWSadj * Kp *EV* EFsw * CFv / ATC

Sediment Incidental Exposure Pathways (Wading, Swimming, Bathing)

CDIsedi = Csed * IRSadj * CF * EFsw / ATC

CDIsedd = Csed * SASDadj * CF * ABS * EFsw / ATC

Groundwater Potable Use Pathways

CDIgwi = Cgw * IRWadj * EF/ ATC

CDIgwd = Cgw * SAWadj * Kp * EV *EF * CFv / ATC

Groundwater Irrigation Use Pathways

CDIgwirrd = Cgw * SAWirr * Kp * EV * ETirr* EFirr * EDr * CFv / (BWa * ATC)

Mine Water Potable Use Pathways

CDImwi = Cmw * IRWadj * EF/ ATC

CDImwd = Cmw *Kp* SAWadj * EV * EF * CFv / ATC

Garden Produce Pathways

CDIveg = Cp * IRVadj * CF * EFveg / ATC

Fish Pathways

CDIfish = Cfish * IRFadj * CF * EFfish / ATC

Parameter Name and Units	Abbreviation		Value
Chronic Daily Intake - Surface Soil Ingestion (mg/kg-d)	(CDIsi)	=	Calculated
Chronic Daily Intake - Surface Soil Dermal (mg/kg-d)	(CDIsd)	=	Calculated
Chronic Daily Intake - Subsurface Soil Ingestion (mg/kg-d)	(CDIsubi)	=	Calculated
Chronic Daily Intake - Subsurface Soil Dermal (mg/kg-d)	(CDIsubd)	=	Calculated
Chronic Daily Intake - Inhalation of Particulates in Air (mg/kg-d)	(CDIap)	=	Calculated
Chronic Daily Intake - Surface Water (or Seep/Spring) Ingestion (mg/kg-d)	(CDIswi)	=	Calculated
Chronic Daily Intake -Surface Water (or Seep/Spring) Dermal (mg/kg-d)	(CDIswd)	=	Calculated
Chronic Daily Intake - Sediment Ingestion (mg/kg-d)	(CDIsedi)	=	Calculated
Chronic Daily Intake - Sediment Dermal (mg/kg-d)	(CDIsedd)	=	Calculated
Chronic Daily Intake - Groundwater Ingestion Potable Use (mg/kg-d)	(CDIgwi)	=	Calculated
Chronic Daily Intake - Groundwater Dermal Due to Potable Use (mg/kg-d)	(CDIgwd)	=	Calculated
Chronic Daily Intake - Groundwater Dermal Due to Irrigation (mg/kg-d)	(CDIgwirrd)	=	Calculated
Chronic Daily Intake - Mine water Ingestion Potable Use (mg/kg-d)	(CDImwi)	=	Calculated
Chronic Daily Intake - Mine water Dermal Due to Potable Use (mg/kg-d)	(CDImwd)	=	Calculated
Chronic Daily Intake - Vegetable or Edible Wild Plant Ingestion (mg/kg-d)	(CDIveg)	=	Calculated
Chronic Daily Intake - Fish Ingestion (mg/kg-d)	(CDIfish)	=	Calculated
Concentration in Surface Soil (mg/kg)	(Cs)	=	Measured
Concentration in Subsurface Soil (mg/kg)	(Css)	=	Measured
Concentration in Surface Water (or Seep/Spring) (mg/L)	(Csw)	=	Measured
Concentration in Sediments (mg/kg)	(Csed)	=	Measured
Concentration in Groundwater (mg/L)	(Cgw)	=	Measured
Concentration in Mine Water (mg/L)	(Cmw)	=	Measured
Concentration in Plants (mg/kg)	(Cp)	=	Inorganics measured; organics modeled
Concentration in Fish (mg/kg wet weight)	(Cfish)	=	Inorganics measured
Mass Conversion Factor (kg/mg)	(CF)	=	1E-06
Permeability Coefficient (cm/h)	(Kp)	=	chemical specific (EPA, 2001a)
Volumetric Conversion Factor (L/cm^3)	(CFv)	=	1.00E-03

14.1.3 Toxicity Assessment

Toxicity assessment involved two steps: hazard identification and dose-response assessment. Hazard identification determined whether exposure to a chemical was associated with a particular adverse health effect and characterized the nature and strength of the evidence of causation. The dose-response assessment was the process of predicting a relationship between the dose received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values were derived that could be used to estimate the potential for adverse effects as a function of potential human exposure to the chemical.

The toxicity values pertinent to the risk assessment were the reference dose (RfD), reference concentration (RfC), slope factor (CSF), and unit risk factor (URF). The RfD and CSF values are further differentiated in some guidance documents by exposure route (i.e., as oral [RfDo or CSFo] or inhalation [RfDi or CSFi]). The RfDo was used to predict the noncancer risks due to oral and dermal exposure. The CSFo was used to predict the cancer risks due to oral and dermal exposure. The URF approach estimated the inhalation cancer risks and the RfC was used to estimate the inhalation noncancer risks. The toxicity values used in the Tier II risk assessment are presented in tabular form in the risk assessment (Walsh 2008a).

Information regarding the toxicity of the contaminants detected in site media at levels that exceed the screening levels was compiled from regulatory sources such as the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST) (EPA 1997c). The most recent version of these databases was utilized. Office of Solid Waste and Emergency Response (OSWER) Directive 9285.7-53, issued on December 5, 2003, presents a revised hierarchy of toxicity values generally recommended for use in risk assessments and represents an update to Risk Assessment Guidance for Superfund Volume I, Part A, Human Health Evaluation Manual (RAGS A) (EPA 1989). This recommended hierarchy of toxicity values was used at the Site.

Information regarding the site-specific bioavailability of arsenic and lead was also obtained for the CJM Site. Bioavailability is the amount of a given dose that enters into the blood. By definition, an intravenous dose is 100 percent bioavailable. Absolute bioavailability (ABA) is the amount of a substance in blood due to a particular exposure route (i.e., oral exposure) divided by the amount of the substance ingested. Relative bioavailability (RBA) is the bioavailability of a substance compared to a standard reference material. The Integrated Exposure Uptake Biokinetic (IEUBK) model bioavailability parameter is in terms of ABA. It is known that the ABA of soluble lead in food and water is 50 percent (EPA 1999), and this is the value used in the IEUBK model to represent the bioavailability of soluble lead in water and food (EPA 2002d). The model presumes, by default, that the RBA of lead in soils to that of soluble lead in food and water is 60 percent. The ABA of lead in soils is then estimated by multiplying the ABA of soluble lead by the RBA of soil-bound lead to soluble lead (i.e., 60% x 50%) to arrive at an ABA value of 30 percent for soils (EPA 1999).

The relative bioavailability of lead in site soils was measured by collecting a soil sample at each of the exposure areas, and *in vitro* tests (EPA 2002d) were performed to identify the RBA. The

RBA for only one location, CJM, exceeded the default RBA of 60 percent. All site specific RBA values were used to calculate the site-specific ABA, which was then used in the IEUBK model to obtain a site-specific estimate of blood lead concentration due to exposure to site soils. This results in a site-specific estimate of a remedial goal for lead. Because the site-specific RBA value is less than the default value for four of the five areas, the risks are lower and remedial goals higher than those obtained using default RBA values. The results, given the other site-specific input parameters are identified in Table 14-2.

Table 14-2. IEUBK Model Results for Lead Exposure by Exposure Area

Exposure Area	Input Parameters				Model Output		
	RBA (%)	ABA (%)	EPC (mg/kg)	Blood Lead (ug/dl)	Geo Mean (ug/dl)	% Above Target PbB (Risk)	Soil Lead Remedial Goal [<5% Exceed 10 ug/dl)] (mg/kg)
BFV	1	0.5	383.30	10	2.706	0.271	830
BFC	0	0	9,840.00	10	25.229	97.55	860
CJM	69	33	50,336.73	10	NA	NA	380
WHR	58	29	6,373.03	10	30.544	99.124	400
WRS	6	3	1,561.92	10	7.711	29.012	750

NA – At this location, the EPC in soil produces a house dust concentration in excess of model constraints and results in data errors for all model runs

The RBA data for arsenic was used in the uncertainty analysis as the correlation of *in vivo* bioavailability with *in vitro* testing for arsenic was not well understood at the time of the risk assessment.

14.1.4 Risk Characterization

For carcinogens, risks were generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk calculations used the following equation:

Risk = Chronic Daily Intake (CDI) x SF

where: risk = a unitless probability (e.g., 2×10^{-5}) of an individual's developing cancer
CDI = chronic daily intake averaged over 70 years (mg/kg-day)
SF = slope factor, expressed as $(\text{mg/kg-day})^{-1}$

These risks were probabilities that usually were expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6}.

The potential for non-carcinogenic effects was evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a RfD derived for a similar exposure period. An RfD represented a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity was the hazard quotient (HQ). An HQ less than 1 indicated that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical were unlikely. The Hazard Index (HI) was generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI less than 1 indicated that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An HI greater than 1 indicated that site-related exposures may present a risk to human health.

The HQ was calculated as follows:

Noncancer HQ = CDI/RfD

where: CDI = Chronic daily intake
RfD = reference dose.

CDI and RfD were expressed in the same units and represented the same exposure period (i.e., chronic, subchronic, or short-term).

The risk characterization section of a ROD summarizes and combines outputs of the exposure and toxicity assessments to characterize baseline risk at a site. Baseline risks are those risks and hazards that a site poses if no action was taken.

Tier I Evaluation

Results of the Tier I data evaluation indicated that organic chemicals were not frequently occurring across the Site. Only five VOCs and seven SVOCs were detected in surface soils. No organics were detected in groundwater samples. Metals were detected at high frequencies in every media.

The Tier I screening evaluation indicated concentrations of many metals in the RI/FS surface soil samples exceeded screening values. Concentrations of only five organics in surface soils exceeded Tier I screening values, and one of these was determined to be a laboratory contaminant. In all, 15 metals and four organic compounds were carried forward as Tier II COPCs.

Many inorganics were detected in subsurface soils and numerous concentrations exceeded Tier I screening values. Nearly all of the same metals had concentrations that exceeded screening values for subsurface soils as for surface soils. In all, 13 analytes were carried forward as Tier II COPCs in subsurface soils.

Nine metals were carried forward into the Tier II analysis for surface water and seven were carried forward as Tier II COPCs for sediments. In addition, several organics were considered Tier II COPCs for sediment. Ten inorganics, PCBs, and several SVOCs were evaluated as Tier

II COPCs in groundwater. Several of the SVOCs and PCBs reporting limits exceeded groundwater screening values; however, no organics were detected in groundwater.

Ten inorganics exceeded Tier I screening levels and were evaluated in the Tier II analysis for mine water exposure. Six inorganics exceeded Tier I screening levels and were evaluated as Tier II COPCs in fish tissue.

Tier II Analysis
The Tier II analysis focused on analytes carried forward from Tier I. Three receptors were selected that best represented the range of potential users of the CJM Site. These included longtime residents, recreationalists, and construction workers. Intakes were estimated for each exposure pathway, and risks were calculated, for each Tier II COPC and potentially complete exposure pathway.

Risks at the Site
Some noncancer and cancer risks are elevated at the Site. The highest risks occur within the CJM area; however, all exposure areas across the Site present the potential for elevated noncancer and cancer risks to all receptors. Risks are much higher for residents than other receptors. Surface soils is the medium most likely to produce excess noncancer or cancer risks. Antimony, arsenic, chromium, lead, and thallium were among the COPCs producing the most widespread risks.

Few organic chemicals produced excess risks. Residential cancer risks for benzo(a)pyrene in soil, groundwater, and garden produce exceeded target levels. Note that benzo(a)pyrene was not detected in groundwater, and that one-half the reporting limit exceeded screening values. Organics were not measured in plants; however, estimated benzo(a)pyrene plant tissue concentrations based on bioaccumulation models and measured soil concentrations produced a slightly elevated excess cancer risk. Risks for workers exposed to benzo(a)pyrene or other organics by soil ingestion or dermal contact were below $1.0x10^{-6}$. There were no excess risks for recreationalists exposed to organics at any location. Although PCBs were not detected in groundwater, their reporting limits resulted in excess predicted cancer risks for this medium.

Ingestion of **surface soils** by residents produced HQs ranging from well below 1 to 150, and cancer risks ranging from $2.2x10^{-6}$ to $8.1x10^{-3}$. Dermal contact with surface soils by residents produced HQs ranging from well below 1 to 12, and cancer risks ranging from below the target cancer risk level of $1.0x10^{-6}$ to $7.7x10^{-4}$. Residential hazard indices for surface soils ranged from four to 217, and cumulative residential cancer risks ranged from $5.0x10^{-4}$ to $1.0x10^{-2}$. Recreationalist and construction worker risks were lower for exposure to surface soils.

Ingestion of **subsurface soils** by residents produced slightly lower HQs than those for surface soils. HQs ranged from well below 1 to 2, and cancer risks ranged from $1.4x10^{-6}$ to $5.1x10^{-4}$. Dermal contact with subsurface soils produced HQs less than 1, and cancer risks ranged from less than $1.0x10^{-6}$ to $1.1x10^{-5}$. Residential HIs for subsurface soils were 6 or less, and cumulative residential cancer risks ranged from $3.0x10^{-4}$ to $6. 0x10^{-4}$. Construction worker risks tended to be lower than those for residents for exposure to subsurface soils.

Ingestion of **garden produce** produced noncancer HI ranging as high as 2, and cancer risks ranging as high as 2.3×10^{-3}. Arsenic, chromium, and thallium had average on-site concentrations in plants similar to levels found in the background sample, suggesting concentrations were not elevated due to site-related activities and that risk estimates reflect an inherent level of risk for garden produce consumption.

Exposure to **surface water** by residents or recreationalists by ingestion or dermal contact produced noncancer HQs ranging from well below 1 to 3, and cancer risks ranging from less than 1.0×10^{-6} to 1.5×10^{-3} for inorganics based on the assumptions used in the risk assessment. Use of surface water as the sole drinking water source produced higher risk estimates than dermal contact or incidental use. Risks for recreationalists were lower than those for residents.

Exposure to **sediment** by ingestion produced residential noncancer HQs ranging from well below 1 to 8, and cancer risks ranging from below the target risk level of 1.0×10^{-6} to 4.4×10^{-4} for inorganics. Risks for recreationalists were lower than those for residents.

Ingestion of **fish** produced excess cancer risks for arsenic and chromium based on the assumptions used in the risk assessment. There were no excess noncancer risks due to consumption of fish from the Site. There is no thriving fishery in the immediate site vicinity, and it is unlikely that significant quantities of edible-sized fish would be caught and consumed on a long-term basis.

Groundwater ingestion contributed to high cancer risks due to arsenic and chromium. Numerous organics and chromium produced cancer risks greater than the target risk level of 1.0×10^{-6}. However, none of the organics was actually detected in groundwater samples and the risk is due to the use of one-half the reporting limit as the basis for the EPC. Chromium in groundwater is likely in a less toxic form than that used as the basis of the risk estimates. Dermal contact produced lower risk estimates than ingestion. Cadmium and zinc were the only analytes that had excess noncancer risks as indicated by HQs greater than 1.

Mine water ingestion is unlikely. However, if mine water was used as a sole drinking water source it could produce excess cancer risks for arsenic or chromium as high as 3.2×10^{-3} and elevated noncancer HQs as high as 10 under the exposure assumptions used in the risk assessment.

The risk assessment presents (in tabular form) all carcinogenic and noncarcinogic risk estimates for significant pathways of exposure by area of exposure and potential receptor (Walsh 2008a).

14.1.5 Uncertainties

Some level of uncertainty is introduced into the risk characterization process every time an assumption is made. In regulatory risk assessment, the methodology dictates that assumptions err on the side of overestimating potential exposure and risk. The effect of using numerous assumptions that each overestimate potential exposure provides a conservative estimate of potential risk.

The large number of assumptions made in the risk characterization could potentially introduce a great deal of uncertainty. Any one individual's potential risk is influenced by their individual exposure dose over time and toxic response, and will vary on a case-by-case basis. Understanding the uncertainties in the assessment should result in decisions that are more informed.

A qualitative evaluation of uncertainty was performed as part of the risk assessment. Possible factors that may contribute to uncertainty in the risk estimates include:

- Uncertainty in the adequacy of the site characterization data and historical information about the Site;
- Uncertainty in the selection of COCs;
- Uncertainty in the toxicity criteria used;
- Uncertainty in the exposure assessment; and
- Uncertainty in the EPCs.

Uncertainty in the Adequacy of the Site Characterization Data and Historical Information

Biased High

The manner in which site data are collected can lead to an overestimation or an underestimation of risk for a site. For the CJM Site, the soil samples were collected from areas suspected of being most highly contaminated, and thus were likely to bias the EPCs high. Soil samples included samples of waste rock and tailings, which were likely to bias the EPCs high and overestimate average concentrations occurring within the exposure areas. Thus, the exposure and risk estimates for inorganics were likely biased high.

There were a limited number of RI/FS samples for organic analysis were collected. This was because historic data did not indicate widespread contamination of organic chemicals. Most organics were not detected in the samples collected, suggesting the data were adequate by which to address risk and that organic contamination was not widespread across the Site.

The historic data (URS 1994) indicated SVOCs, pesticides, and PCBs were present in soil samples collected near the CJM buildings. Based on the results of site sampling activities, the historic data seem to be consistent with the current RI/FS data.

The number of site samples in any given media also lends to uncertainty. There were numerous surface and subsurface soil samples collected from across the Site; thus, soils were likely adequately characterized. Sediment and surface water samples were collected at relatively short intervals along the stream, and were collected near to wherever inputs were observed (i.e., mine drainage). Few groundwater, fish, or background samples were collected as part of the current RI/FS or historic sampling, making characterization of these media more uncertain.

Uncertainty in the Selection of COCs

No Bias

There is some uncertainty in the selection of COCs based on the review of historical data and the current RI/FS data set. Because less sampling was performed for organics than inorganics, there was the potential that some source of organic contamination was missed. However, many organics are soluble and migrate to groundwater; the lack of organics in groundwater suggested that organic contamination was not widespread. Sources of organics around the buildings were expected to wash into the stream; few organics were detected in the stream. Therefore, the available evidence indicates that the most probable COPCs were adequately identified and characterized. Uncertainty in the COPC selection was unlikely to bias the risk characterization results.

Uncertainty in the Toxicity Criteria Used

Biased High

Tier I soil criteria were applied to sediments in the Tier I evaluation. This is highly conservative because humans are not expected to contact sediments as frequently as they might contact soils. This application served to retain more analytes than necessary for the Tier II evaluation, and was thus protective, though the ultimate results of the risk characterization were not affected. Bioavailability of most metals in soil was not considered (or estimated). This most likely led to a substantial overestimation of risk for some metals and contributed uncertainty in the toxicity assessment. Bioavailability was measured for lead, arsenic, and chromium. The bioavailability of arsenic and chromium was substantially less than the default bioavailability assumptions used to assess risks. The RBA for arsenic ranged from only 3 to 7 percent, and the RBA for chromium ranged from 5.6 to 20.9 percent. However, this information was only qualitatively used to assert that it was likely that risk estimates for arsenic and chromium were overestimated. Where chemical speciation data were not available, toxicity criteria for the more toxic form of the chemical were used, which potentially overestimated risk for some chemicals.

Uncertainty in the Exposure Assessment

Biased High

The exposure assessment proposed receptors, defined exposure areas, and estimated intakes. There may be some receptors that are subsistence farmers or fisherpersons in the area; exposure for people who subsist off of the land may be underestimated by the exposure parameters used to predict exposure for the bulk of the population. However, given that there are few fish in the immediate vicinity of the mine site, it is unlikely subsistence fishing in the immediate area would be viable. Subsistence living at the elevation Captain Jack is located with respect to farming is a fairly unreasonable scenario. The growing season is expected to be short, and the terrain is not suitable for crop production. Therefore, the assumptions used in the analysis were likely to be protective of receptors occurring in the area.

Assumptions in the exposure assessment contributed to the likelihood of biasing the risk estimates high, particularly where professional judgment was necessary due to lack of site-specific information (e.g., risk from surface water based on assumption of potable use; exposure frequency and duration assumptions for recreational scenarios; and fish ingestion assumptions although a thriving fishery is lacking). The values used to represent exposure parameters were biased high (conservative) and in general were 95th percentile values. In particular, ingestion rates for garden produce and fish were very high given the surrounding site conditions.

Because even low concentrations of lead have been linked to subtle neurological effects in children, lead is regulated on blood lead concentration. Adjustments to the IEUBK Model assumptions regarding bioavailability of lead in soils were made for Tier II, which in turn influenced risk estimates. At the Captain Jack Mill, lead is more bioavailable than the default values would suggest; however, at all other locations, lead is much less bioavailable. The parameters in the IEUBK model were varied to reflect site-specific conditions that reduced uncertainty in the results. The results indicated that applying lower model parameters, which may be more typical of mining sites in the western United States, reduced the apparent risk. Thus, it is likely that estimates of risk due to lead exposure based on the default parameters were biased high.

The exposure assessment equations are general and widely applied in risk assessments; however, there are some variations. The State of Colorado applies a child-only approach to developing noncancer risk estimates for the soil pathway; however, the EPA has what is known as an "age-averaging approach," which evaluates risks for adults and children concurrently. The noncancer intakes for residents used in the risk assessment calculated only exposure to children for the soil contact pathways, who have a much higher contact rate. For garden produce and fish ingestion, the age-averaging approach was used since both children and adults were modeled as having the same contact rate. The risk assessment results indicated that risk for children were 9.3 and 2.3 times higher for thallium for the soil ingestion and dermal contact pathways; thus, for these exposure pathways, risk estimates in the risk assessment were protective for adults. Risks for the garden produce and fish pathways were 4.7 times higher for children than for exposure throughout a typical lifetime; thus, risks in the analysis for these two pathways may have underestimated potential risks to children if they ate fish or vegetables from the Site at the rates predicted in this analysis. However, as discussed previously, the garden produce and fish ingestion exposure pathways are unlikely to present a risk because contact rates and EPCs in the risk model likely overestimated average conditions at the Site.

Uncertainty in the EPCs

Biased High or Biased Low

Conservative estimates were used to represent the EPCs. The minimum of the maximum detected value or the UCL95 was used as the EPC. These statistics were likely to overestimate exposure since sampling was systematically biased, with more samples collected within impacted areas than outlying, undisturbed areas. Thus, concentrations of site related analytes were likely overestimated within each exposure area.

The small number of samples collected and use of nondetect values (½ reporting limit [RL]) to represent an EPC could have affected the risk results as numerous samples were collected for inorganic analysis but few were collected for organic analysis. Using the ½ RL to estimate EPCs could have biased the results high or low for all on-site media

14.2 Ecological Risk Assessment

A screening-level ecological risk assessment (ERA) was performed with readily available conservative values from various sources including EPA and Oak Ridge National Laboratory (ORNL). There are five major groups of ecological receptors for which screening-level risks were evaluated. These are:

- Aquatic life (i.e., plants, aquatic invertebrates, and fish);
- Terrestrial plants;
- Soil invertebrates;
- Birds; and,
- Mammals.

Many inorganics and organics exceeded screening values in each medium and thus were carried forward to the baseline analysis.

The results of the baseline analysis indicated there were numerous metals in each exposure area that produced HQs in excess of 1. There was no receptor for which all HQs were below 1. There was no exposure area that did not present a potential ecological risk.

For plants and terrestrial invertebrates exposed to surface soils, the CJM area produced the highest HQs. For aquatic life exposed to surface water, the Big Five area produced the highest HQs.

Surface soil ingestion produced HQs in excess of 1 for all avian and mammalian receptors potentially exposed to surface soils. Numerous metals had HQs above 1. Lead produced the highest HQs for birds, and arsenic produced the highest HQs for mammals. The CJM area exhibited the highest HQs for birds and mammals.

Only burrowing animals have expected exposure to subsurface soils. Subsurface soils produced HQs in excess of 1 for the montane vole. The highest HQ was 11 for aluminum at the CJM area.

There were no HQs for surface water ingestion by birds or mammals that exceeded 1, indicating use of the stream as a drinking water source is not likely to pose a risk to riparian or terrestrial receptors.

All exposure areas present a potential risk to terrestrial ecological receptors. All terrestrial exposure media produced HQs in excess of 1 for at least one receptor group. Only surface water for wildlife ingestion did not produce HQs above 1; however, surface water is potentially problematic for aquatic life. The CJM and Big Five areas present the highest ecological risk.

14.3 Basis for Remedial Action

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual releases of hazardous substances into the environment. The response action is warranted because:

1. The surface soils, subsurface soils, sediment, surface water, and groundwater COCs present either a carcinogenic risk greater than $1.0x10^{-5}$ or a non-carcinogenic HQ greater than 1 for human receptors.

2. Numerous metals are present throughout the Site that produced HQs in excess of 1 for ecological receptors.

3. Threshold levels for residential and industrial levels for lead are exceeded.

15 Remedial Action Objectives

The Remedial Action Objectives (RAOs) provide general descriptions of what the Superfund cleanup is intended to accomplish. The RAOs are established on the basis of the nature and extent of the contamination, the resources that are currently and potentially threatened, and the potential for human and environmental exposure and adverse effects. The remedial goals are media-specific, quantitative goals that define the extent of cleanup required to achieve the RAOs. These goals serve as the design basis for the Selected Remedy identified in this ROD.

RAOs, remediation goals, and remediation strategies developed for the CJM Site assume that the CJM Site consists of residential and industrial (mining) properties, and will continue to consist of residential and industrial properties for the foreseeable future. The CJM Site remedy will address affected residential exposure pathways.

15.1 RAOs for Soils, Tailings, and Waste Rock

The RAOs specific to soils, tailings, and waste rock include:

1. Reducing exposure to arsenic, lead, and thallium from incidental ingestion and/or inhalation of surface tailings/waste rock and other mine wastes; and
2. Controlling and/or reduction of run-on and run-off from soils/tailings/waste rock piles.

15.2 RAOs for Surface Water

The RAOs specific to surface water include:

1. Reducing in-stream metals concentrations;
2. Ensuring that in-stream metals concentrations do not degrade drinking water supplies diverted from Left Hand Creek; and

3. Reducing the contaminant pathways to benthic aquatic organisms living at the surface water/sediment interface or contamination in sediment to levels that are protective of aquatic life, with the ultimate goal of attaining surface water standards to ensure long-term survival of fish and benthic aquatic organisms in Left Hand Creek.

15.3 RAOs for Groundwater

Because groundwater may be affected by transported surface contamination, RAOs have also been developed for this media. The RAOs specific to groundwater are as follows:

1. Controlling and/or reducing metals loading to groundwater from surface sources;
2. Ensuring that contaminated groundwater does not adversely impact human health and aquatic ecological receptors, and
3. Ensuring that contaminated groundwater does not adversely impact receiving surface waters.

15.4 Basis and Rationale for RAOs

The basis for the RAOs for soils, tailings, waste rock, surface water, and groundwater is to clean up the Site to risk-based cleanup criteria as established for the receptor and exposure parameters evaluated in the risk assessment. The current land use on the Site is a combination of residential and recreational, and the intended primary future use of the Site is recreational. However, because the Site is currently zoned as residential, environmental covenants will need to be implemented to preclude development that could adversely impact remedy effectiveness for as long as the remedy remains in place.

Soils, Tailings, and Waste Rock

Given that soils, tailings, and waste rock contribute contamination to sediment and surface water through erosion and migration of source material, remedial cleanup levels established for these media are expected to accomplish cleanup and reduction of metal concentrations of surface water and sediment as well.

Remedial Actions at the CJM Site are expected to reduce receptor exposure to material contaminated with COCs above the following remedial cleanup levels:

- The arsenic remedial goal at a $1x10^{-5}$ cancer risk, assuming negligible dermal uptake and an RBA of 5 percent, is 85 mg/kg.

- The lead remedial goals were established on a site specific basis as follows (and as discussed in Section 14 and presented in Table 14-2): Big Five – 830 mg/kg; Big Five to Captain Jack – 860 mg/kg; Captain Jack Mill – 380 mg/kg; White Raven – 400 mg/kg; and White Raven to Sawmill – 750 mg/kg.

- The thallium remedial goal is 5.2 mg/kg based on the EPA Region 9 PRG for residential soils.

Additional metals were detected in tailings and waste rock samples at concentrations that exceeded TVSs and/or PRGs, but were not assigned remedial goals because the locations of these exceedances were co-located within the area defined by arsenic, lead, and thallium contamination. Remedial goals for the tailings, waste rock, and sediment will ensure that remediation will be completed in a manner that is protective of human health.

Surface Water

Left Hand Creek, within the St. Vrain Creek Basin, is designated by the Water Quality Control Commission (WQCC) as stream segment 4a and includes the main stem of Left Hand Creek from its headwaters to Highway 36. Compliance with remedial goals and ARARs will be measured for compliance on Left Hand Creek at a point upstream of the confluence with Puzzler Gulch. Specific monitoring points on Left Hand Creek will be established during Remedial Design to monitor the effects of the specific Remedial Action(s) within the Site.

Groundwater

For the CJM Site, site-specific numerical groundwater standards have not been established. The RAO is to minimize contamination and impacts to ground- and surface- water through the implementation of the selected remedy and to protect downstream surface- and groundwater uses and meet ARARs at the Point Of Compliance.

State environmental covenants will also include restrictions and additional requirements on any usage of on-site groundwater and/or surface water for potable water sources.

15.5 Risks Addressed by the RAOs

Implementing the Selected Remedy will address the risks associated with the COCs at the CJM Site. Exposure to contaminated soils, tailings, and waste rock will be significantly reduced through implementation of the Selected Remedy and source control will provide water quality improvement in on-site surface water. The Selected Remedy will also implement treatment to meet the surface water objectives and reduce risk to on- and off-site receptors.

16 Description of Alternatives

The following remedial alternatives were developed by CDPHE and EPA for the CJM Site:

- Alternative 1: No Action

Surface Contamination Sources Alternatives:

- Alternative 2A: Off-Site Disposal of Principal Threat Waste with Remainder Cap-in-Place
- Alternative 2B: On-Site Consolidation & Capped-Cell for Principal Threat Waste with Remainder Cap-in-Place
- Alternative 2C: On-Site Consolidation & Capped-Cells for All Contaminated Soils

Subsurface Contamination Sources Alternatives (Big-Five Adit):

- Alternative 3A: Bulkhead with Monitoring
- Alternative 3B: Bulkhead and Internal Mine-Pool Mitigation with Phased Successive Biochemical Reactor Treatment Outside of Adit
- Alternative 3C: Neutralization and Biochemical Reactor Treatment of Big Five AMD Outside of Adit
- Alternative 3D: Outside-Adit Water Treatment System for Big Five AMD

16.1 Description of Remedy Components

16.1.1 Alternative 1: No Action

This alternative is defined as no remedial action, no monitoring, and no institutional controls. Under this alternative there is no guarantee that RAOs will ever be achieved. It is assumed that AMD from the Big Five adit would continue to discharge to Left Hand Creek and the waste rock, tailings, and sediments would remain in their current location and configuration.

16.1.2 Alternative 2A: Off-Site Disposal of Principal Threat Waste with Remainder Cap-in-Place

This partial removal and site reclamation alternative would essentially eliminate the amount of waste transported off site by surface water and air pathways. In addition, surface caps would serve as a barrier between site contamination and potential human and ecological receptors.

Implementation of this alternative would take place in several specific locations at the Site. The most highly contaminated material (principal threat waste) from these areas would be excavated and removed from the Site to an off-site disposal facility, either a hazardous or non-hazardous waste landfill. The excavated areas would be backfilled with non-contaminated material and these backfilled areas, along with the remainder of the surface material with concentrations elevated above cleanup levels (i.e., surrounding soils) at the CJM Site would be regraded, amended with lime (in the top 6 inches) and capped with a 12-inch layer of site soil (select fill) and 6-inch layer of growth media. It should be noted that excavation of principal threat waste would be limited to the vertical and horizontal extents defined within the volume calculations presented in the FS (Walsh 2008b). Should material that meets the threshold for principal threat waste remain in place after the designed excavation, residual soils will be amended as described above, clean backfill material would be placed within the excavation void (on top of this material), and further placement of a soil cap would provide a more robust layer of protection in these areas. The primary elements of this alternative include:

- **Excavation** of principal threat waste;
- **Removal** of excavated waste to an off-site landfill;
- **Amendment** of remaining surface materials at areas where remaining contamination exists by mixing lime into the top 6 inches of waste material;
- **Capping** of the remaining surface materials at areas where remaining contamination exists with 12 inches of native soil and 6 inches of growth media;
- **Diversion of surface water** runoff during excavation, capping activities, and for purposes of permanent control; and
- Implementation of **access controls** such as fencing and signage to preclude or minimize access to the Site by humans or wildlife prior to, during, and after excavation and construction activities.

16.1.3 Alternative 2B: On-Site Consolidation and Capped-Cell for Principal Threat Waste with Remainder Cap-in-Place

This alternative would eliminate the amount of waste being transported off site by surface water and air pathways. The consolidation cell and surface caps would also serve as a barrier between site contamination and potential human and ecological receptors. The principal threat waste would be excavated and consolidated in an on-site consolidation cell. The excavated areas would be backfilled with non-contaminated material. These backfilled areas, along with the remainder of the surface material with concentrations elevated above cleanup levels (i.e., surrounding soils) at the CJM Site, would be regraded, amended with lime (in the top 6 inches) and capped with a 12-inch layer of select fill and 6-inch layer of growth media. As with Alternative 2A, the excavation of principal threat waste will be limited to the vertical and horizontal extents defined in the FS (Walsh 2008). However, any material remaining in place after the excavation would be amended with lime, backfilled with amended clean soil and have a soil cap installed to provide a more robust layer of protection in these areas.

The primary elements of this alternative include:

- **Excavation** of principal threat waste;
- **Construction** of an unlined consolidation cell made up of two cells within the CJM area-percent;
- **Amendment** of principal threat waste and waste remaining in place by mixing lime into the top 6 inches of waste material;
- **Capping** of remaining surface materials at areas where remaining contamination exists with 12 inches of native soil and 6 inches of growth media;
- **Diversion of surface water** runoff during excavation, capping activities, and for purposes of permanent control; and
- Implementation of **access controls** such as fencing and signage to preclude or minimize access to the Site prior to, during, and after construction of the consolidation cell by humans or wildlife.

16.1.4 Alternative 2C: On-Site Consolidation and Capped-Cells for Contaminated Soils

This complete removal and consolidation alternative would also eliminate the amount of waste being transported off site by surface water and air pathways. In addition, the consolidation cell cap would serve as a direct contact barrier between site contamination and potential human and ecological receptors. The contaminated material from these areas would be excavated and consolidated in three on-site consolidation cells.

The primary elements of this alternative include:

- **Excavation** of all contaminated material and placement of the waste into the constructed consolidation cells at the southwest portion of the Site;
- **Amendment** of waste material by mixing lime into the top 6 inches of waste material;
- **Construction** of consolidation cell(s) within the CJM and White Raven areas;
- **Diversion of surface water** runoff during excavation and for purposes of permanent control; and
- Implementation of **access controls** such as fencing and signage to preclude or minimize access to the Site prior to, during, and after construction of the consolidation cell by humans or wildlife.

16.1.5 Alternative 3A: Bulkhead with Monitoring

This alternative addresses the AMD from the Big Five adit in an effort to meet the RAOs. Based on examination of the Big Five adit, a concrete plug called a "bulkhead" would be installed approximately 470 to 675 feet from the portal. The bulkhead would consist of a concrete structure approximately 10 feet thick.

Water would back up behind the bulkhead and underground mine workings would partially flood. The surrounding area would be closely monitored to detect water leaking out of the underground workings through seeps or other previously unknown openings. The bulkhead would have a pressure gauge and valve to monitor water in the tunnel and maintain it at an optimum level.

The alternative would decrease the amount of oxygen in the open mine workings by partial flooding, which would reduce the generation of toxic AMD as well as help contain AMD from entering Left Hand Creek.

16.1.6 Alternative 3B: Bulkhead and Internal Mine-Pool Mitigation with Phased Successive Biochemical Reactor Treatment Outside of Adit

This alternative would begin with installation of a bulkhead as described in Alternative 3A and, during the first phase, would additionally treat acidic water inside the mine through a process called "in-situ mine-pool neutralization."

By installing a bulkhead, water would back up behind the bulkhead and underground mine workings would partially flood. The surrounding area would be closely monitored to detect and observe areas where water could leak out of the underground workings through seeps or other unknown openings. The bulkhead would have a pressure gauge and valve to monitor and manage the water in the tunnel at an optimum level that would allow for the best management practices for the remedy.

As acidic water builds up behind the bulkhead, wells would inject and circulate NaOH or another pH-buffering chemical into the mine pool. The chemical reaction would raise the pH of the underground water, making it more alkaline. As the alkalinity rises, some of the dissolved metals would change to a solid form and sink to the bottom of the tunnel.

During mine-pool neutralization, surface water would be monitored to assess the water quality of Left Hand Creek. If the mine-pool treatment appears to have stabilized enough to support bacterial growth after approximately two years of neutralization, but downstream surface water RAOs are not being met, design and implementation of the second phase of this alternative would commence. If downstream RAOs are being met for surface water, and monitoring indicates that AMD waters within the mine pool and groundwater reservoir were being fully controlled, project officials would consider foregoing the second phase.

The second phase of this alternative involves installing a series of "biochemical reactors" on the flat area immediately outside of the adit atop the waste dump and/or at the base of the Big Five pile. The reactors would use microorganisms to biologically transform hazardous contaminants into nonhazardous substances. The process would form non-toxic metal sulfides, effectively reducing the dissolved concentrations and mobility of copper, lead, zinc, and cadmium in AMD.

After treatment in the biochemical reactors, the water may be routed through the on-site wetlands for a final "polishing treatment" or be discharged directly into Left Hand Creek.

The biochemical reactor designed would depend on "pre-treated" conditions of the mine-pool water, and may require detailed bench- and/or pilot-scale studies. These studies would determine the appropriate reactor size, organic material and operating specifications for additional treatment.

Like other remedial components, biochemical reactors would require site-access restrictions. The process would produce small amounts of a flammable, poisonous gas (hydrogen sulfide) that may require management. In addition, the treatment system would require O&M to assess treatment effectiveness, replenish organic materials and/or perform repairs. Road improvements and on-site monitoring controls would be necessary.

16.1.7 Alternative 3C: Neutralization and Biochemical Reactor Treatment of Big Five AMD Outside of Adit

This alternative is similar to Alternative 3B. It involves AMD neutralization and biochemical reactors; however, the alternative differs significantly from 3B in that there is only one phase to this alternative. Instead of neutralizing acid water inside the mine, a neutralization/precipitation system would be built *outside* of the adit, along with the biochemical reactors. A bulkhead would be installed to control flow rates and restrict oxygen in the mine; however, neutralization of the acidic drainage would take place outside of the mine tunnel in neutralization and settling ponds.

As with the second phase of Alternative 3B, the biochemical reactors would require site access restrictions and O&M. Ongoing maintenance would most likely be more intensive under this alternative, because sludge management would be required for metal generated in the neutralization process and/or settling ponds.

16.1.8 Alternative 3D: Outside-Adit Water Treatment System for Big Five AMD

This alternative would utilize a bulkhead similar to that proposed in Alternative 3A for temporary-storage impoundment and flow-rate control. However, the remainder of the alternative is different from the other alternatives because it would involve a full-scale, active water treatment plant for the water exiting the bulkhead's flow-through valve.

Several active processes, housed within a water-treatment facility, would be used to treat the AMD water:

- **Precipitation** is similar to the process described in Alternatives 3B and 3C. Raising the alkalinity of the AMD water would create a chemical change in the dissolved metal, causing it to solidify and settle to the bottom of the tank. The precipitation treatment would be expected to remove most of the metals of concern (i.e., cadmium, copper and zinc).

- **Filtration** would involve the use of mechanical filters and presses to remove the metals and sludges, which would have to be disposed of in an on-site consolidation cell or an off-site landfill.

- **Immobilized ligand treatment** may be required. A ligand is an atom or molecule that bonds to a metal. One such treatment would use iron salts to create a bond with arsenic, allowing it to be removed from the contaminated water.

- **Polymer addition** would remove any remaining metals and further increase the alkalinity of the water before it was discharged into Left Hand Creek. A polymer is a natural or artificial chemical made up of smaller, identical molecules linked together. Polymers have high molecular weights, and are used for a variety of industrial processes.

A treatability study would need to be performed on the adit discharge water to select the specific polymer and base required. The treatability study would also be necessary to determine if an additional immobilized ligand treatment system is appropriate. Continuous O&M would be required for this system.

16.2 Common Elements of Each Remedial Component

This section of the ROD describes those components that are common to each of the remedial alternatives except the No Action Alternative. Common remedial components to all or most of the remedial alternatives include the need for a treatability study, bulkhead and mine-pool monitoring program, cap/consolidation cell-monitoring program, five-year reviews, and institutional controls.

16.2.1 Treatability Studies

All subsurface contamination sources alternatives (with the exception of Alternative 3A) contain elements of semi-passive or active water treatment. A bench-scale pilot study and treatability study is recommended for these alternatives during the design phase for the CJM Site. Dosing rates, appropriate substrates, flow rates, and other pertinent factors can be better understood and more effectively implemented if a treatability study is performed prior to construction.

16.2.2 Bulkhead and Mine Pool Monitoring Program

In order to assess the effectiveness of the bulkhead option, remote sensing technologies may be utilized to monitor the surrounding area for seeps and other releases that could emanate from the mine-pool. Specific monitoring technologies would be selected in the design phase. In addition to the instrumented monitoring systems assessing bulkhead performance and mine-pool hydrology, frequent site visits (during the first few years) and surface water sampling would be performed to closely monitor the water quality throughout the surrounding area. Additional groundwater wells may be needed (during the design and/or remedial action phases) near the confluence of the Big Five adit drainage and Left Hand Creek to determine the fate of the Big Five surface water/groundwater interaction and its impact to Left Hand Creek.

Monitoring Systems Remedial Design:

The remedial plan for all subsurface contamination sources alternatives in the Big-Five system would involve AMD storage within the mine-pool reservoir with partial passive treatment (in Alternative 3B only) of the mine-pool waters.

Mine Pool

A comprehensive monitoring system is advisable for the bulkhead and mine-pool alternatives for the following reasons:

- There is limited information regarding the extent of mine-workings and bedrock fractures through the reservoir-zone of the Big-Five tunnel;
- The remedy involves hydraulic control and "containment" of the mine-pool and/or AMD-treatment zone;
- In-situ treatment of the mine-pool systems is innovative with limited prior project applications, consequently;
- Observing both geochemistry and spatial movement of the AMD and treatment zones is warranted.

Monitoring systems would be designed to accomplish the following tasks:

- Direct-measurements of AMD-reservoir. Installation of monitoring instruments into the mine-tunnel bore-holes and behind the bulkhead to place pressure-transducers and geochemical sensors, with electronic data-collection/storage and data-uploads to minimize on-site sampling, data collection and laboratory-analytical costs.
- Subsurface Spatial Observation. Utilization of geophysical monitoring (electrical-resistivity [ER]) to assess the stability and/or changes to mine-pool chemistry, and locations and movements of groundwater transport. Locating and utilizing wells to monitor~~ing~~ such dynamics in fractured igneous bedrock geology, is very costly with highly uncertain results. Geophysical methods, while also costly, provide much higher certainty and insight into groundwater system dynamics.

Monitoring Systems Remedial Action:

Mine Pool Reservoir

Direct-measurements are needed of the tunnel-waters with pressure-transducers, thermometers, and geochemical-sensors in wells and behind the bulkhead.

Mine-Pool Bedrock-Groundwater Reservoir
Five 2,000-foot geophysical arrays (permanent below-ground electrode pins) are recommended for high-resolution ER-tomography to image subsurface conditions and spatial-hydraulics beneath a 50-acre area overlying and adjacent to the mine-pool area. The electrical components include control-system hardware and multiplexors for near real-time data-collection software and storage, system calibration, and remote data-download/transmission. It is anticipated that Idaho National Laboratories, in collaboration with Colorado School of Mines, would be involved with design-installation of the ER-geophysical systems.

16.2.3 Cap/Consolidation Cell Monitoring Program

All surface contamination sources alternatives include capped areas and/or capped consolidation cells. Monitoring programs would be required which would likely include watering and other care required for the success of new vegetation, additional placement of seed in areas of unsuccessful revegetation during the initial attempt, and other needed repairs to the surface of the cap. In addition, periodic maintenance would be required to provide remedy protection and maintain the integrity of the cap.

16.2.4 Five Year Reviews

Five-Year Reviews would be required at the CJM Site since varying amounts of contamination would remain on site that would prohibit unlimited and unrestricted use.

16.2.5 Institutional Controls

Throughout construction, site access would be limited. Temporary fencing would be used to prevent access to excavation and capping areas as well as the Big Five adit area and signs prohibiting trespassing would be posted. Once vegetation was been established, extensive fencing throughout the CJM Site would not be anticipated; however, a fence, or other appropriate access-barriers, would likely remain around any consolidation cells. In addition, to protect human health from the potential interface between on-site contaminated surface water and groundwater while cleanup is ongoing, CDPHE and the EPA would request that the Colorado Office of State Engineers (OSE) issue an order restricting future well drilling within the boundaries of the CJM Site. In addition, a Colorado State environmental covenant would be placed into effect for select portions of the CJM Site that will restrict digging and preclude development.

16.3 Distinguishing Features of Each Alternative

16.3.1 No Action Alternative

Alternative 1: No Action

Estimated Time for Design/Construction:	Not applicable
Estimated Time to Reach Remediation Goals:	Not applicable
Estimated Capital Cost:	$ 0
Estimated Lifetime O&M Costs:	$ 0

Discount Factor:	3% (see explanation Sec 17.7)
Estimated Total Present Worth Cost:	$ 0
Number of Years Cost Is Projected:	Not Applicable

The No Action Alternative is included as a baseline for evaluation of the other remedial alternatives, as required by the NCP. Under Alternative 1, no remedy will be implemented and source areas would not meet RAOs for the Site.

16.3.2 Surface Contamination Sources Alternatives

CDPHE and EPA evaluated the following three alternatives for treating the surface source material at the CJM Site. Approximately 34,000 cy of material exceeding cleanup levels are addressed in these alternatives, including approximately 9,000 cy of principal threat waste material.

Alternative 2A: Off-Site Disposal of Principal Threat Waste with Remainder Cap-in-Place

Estimated Time for Design/Construction:	Unknown
Estimated Time to Reach Remediation Goals:	Unknown
Estimated Construction Cost:	$ 2,165,000
Estimated Design Cost:	$ 205,000
Estimated Lifetime O&M Costs:	$ 28,000
Discount Factor:	3% (see explanation Sec 17.7)
Estimated Total Present Worth Cost:	$ 2,397,000
Number of Years Cost Is Projected:	30 years

1. **Disposal of Principal-Threat Waste Off-Site:** The highest-concentration contaminant materials would no longer be present on site or within the watershed.

2. **Treatment of Remaining On-site Wastes:**
   If lime is added at a dosing rate of 20 percent by volume into the top 6 inches of waste material, approximately 1,200 cy of lime would be required for this alternative. Following construction of the cap, additional organic amendments could be incorporated if required, and vegetation would be drilled into the prepared slope.

3. **Operation and Maintenance Components:**
   Erosion control blankets and/or straw mulch would be necessary to prevent erosion of the soil cap while the vegetation takes hold. All capped locations would require annual maintenance to ensure the vegetation is preventing significant erosion of the soil cap. In addition, reseeding may be required throughout the first few years.

4. **Monitoring Components:**
   Once vegetation has been established, a fence surrounding the capped areas is not anticipated; however, periodic monitoring would be required to assess the condition of the capped areas and provide remedy protection.

Alternative 2B: On-Site Consolidation and Capped-Cell for Principal Threat Waste with Remainder Cap-in-Place

Estimated Time for Design/Construction:	Unknown
Estimated Time to Reach Remediation Goals:	Unknown
Estimated Construction Cost:	$ 804,000
Estimated Design Cost:	$ 264,000
Estimated Life Time O&M Costs:	$ 277,000
Discount Factor:	3%
Estimated Total Present Worth Cost:	$ 1,344,000
Number of Years Cost Is Projected:	30 years

1. **Principal-Threat Waste Remains On-Site Within Engineered Cell:**

Remaining lower-level wastes capped in place would result in landforms more readily amenable to future residential construction, but would require more extensive environmental covenants.

2. **Treatment Components:**

The treatment components of this alternative are identical to Alternative 2A, with the exception of lime being added to the principal threat waste as well as to the waste material left in place.

3. **Operation and Maintenance Components:**

O&M components would be similar to Alternative 2A with the exception of additional periodic maintenance of the on-site consolidation cell. Reseeding of the consolidation cell may also be required.

4. **Monitoring Components:**

As with Alternative 2A, once vegetation has been established, a fence surrounding the capped areas would not be anticipated; however, a fence surrounding the on-site consolidation cell would be anticipated. In addition, periodic monitoring would be required to assess the condition of the capped areas and the on-site consolidation cell and provide remedy protection.

Alternative 2C: On-Site Consolidation and Capped-Cells for Contaminated Soils

Estimated Time for Design/Construction:	Unknown
Estimated Time to Reach Remediation Goals:	Unknown
Estimated Construction Cost:	$ 742,000
Estimated Design Cost:	$ 325,000
Estimated Lifetime O&M Costs:	$ 183,000
Discount Factor:	3%
Estimated Total Present Worth Cost:	$ 1,250,000
Number of Years Cost Is Projected:	30 years

1. **All Contaminant Materials Moved into On-Site Containment Cells:**

This would minimize the area of the site subject to environmental covenants, but would result in "pre-mining" landforms less amenable to future home-site development.

2. **Treatment Components:**
As with Alternatives 2A and 2B, lime would be added at a dosing rate of 20 percent by volume to the top 6 inches of waste material in the on-site consolidation cells. Theoretically, no waste material would be left in place under this alternative; therefore, no treatment would be incorporated into an overall cap for the excavated areas.

3. **Operation and Maintenance Components:**
O&M components would be similar to Alternatives 2A and 2B. Reseeding of the consolidation cells would likely be required and periodic maintenance would be needed to maintain the integrity of the caps.

4. **Monitoring Components:**
A fence surrounding each of the consolidation cells would be anticipated under this alternative and maintenance would be required. In addition, periodic monitoring would be required to assess the condition of the on-site consolidation cells and provide remedy protection.

16.3.3 Subsurface Contamination Sources Alternatives

Alternative 3A: Bulkhead with Monitoring

Estimated Time for Design/Construction:	Unknown
Estimated Time to Reach Remediation Goals:	Unknown
Estimated Construction Cost:	$ 525,000
Estimated Design Cost:	$ 1,342,000
Estimated Lifetime O&M Costs:	$ 1,478,000
Discount Factor:	3%
Estimated Total Present Worth Cost:	$ 3,345,000
Number of Years Cost Is Projected:	30 years

1. **Treatment Components:**
It is expected that with the elevated water table behind the bulkhead, the total mass loading of metals from the Big Five AMD to the watershed would be significantly less, due to submersion of some of the sulfidic rock material underground in an oxygen-depleted mine pool, hence retarding the reaction- mass causing AMD.

2. **Operation and Maintenance Components:**
Ongoing O&M components would not be anticipated under this alternative.

3. **Monitoring Components:**

In order to assess the effectiveness of the bulkhead option, remote sensing technologies including geophysics would be utilized to monitor the surface and the subsurface of the surrounding area. Pressure transducers would also be monitored regularly as part of the ongoing monitoring effort to assess the water level behind the bulkhead. Additional groundwater wells may be needed (during the design and/or remedial action phases) in the vicinity of the confluence of the Big Five adit drainage and Left Hand Creek to determine the fate of the Big Five surface water/groundwater interaction and its impact to Left Hand Creek. The comprehensive bulkhead monitoring system would be required as described in Section 16.2.2.

Alternative 3B: Bulkhead and Internal Mine-Pool Mitigation with Phased Successive Biochemical Reactor Treatment Outside of Adit

Phase I	
Estimated Time for Design/Construction:	Unknown
Estimated Time to Reach Remediation Goals:	Unknown
Estimated Construction Cost:	$ 1,494,000
Estimated Design Cost:	$ 1,474,000
Estimated Lifetime O&M Costs:	$ 855,000
Discount Factor:	3%
Estimated Total Present Worth Cost:	$ 3,824,000
Number of Years Cost Is Projected:	30 years

Phase II	
Estimated Time for Design/Construction:	Unknown
Estimated Time to Reach Remediation Goals:	Unknown
Estimated Construction Cost:	$ 1,270,000
Estimated Design Cost:	$ 897,000
Estimated Lifetime O&M Costs:	$ 4,408,000
Discount Factor:	3%
Estimated Total Present Worth Cost:	$ 6,575,000
Number of Years Cost Is Projected:	30 years

1. **Treatment Components:**

A portion of the sulfide minerals within the mine would be submerged in a relatively anoxic mine pool, thus retarding the kinetics of the oxidation reaction and reducing the release rate of metals and other contaminants. In addition, mine-pool mitigation measures, including introduction of pH-buffering agents to raise the pH within the tunnel would likely further reduce the release rate of metals and other contaminants and likely cause dissolved metals to precipitate out of solution.

If containment/treatment were not achieved with mine-pool mitigation measures, and/or water quality did not sufficiently improve within Left Hand Creek, the second phase of this alternative would be implemented. Specifically, metals would be removed and concentrated through further treatment in a bioreactor, resulting in a further reduction in toxicity of adit drainage water.

2. Operation and Maintenance Components:

This system would be intended as a semi-passive system. Ongoing monitoring and maintenance would be required for the mine-pool mitigation system as well as to address sludge management at the biochemical reactors. In addition, if a liquid substrate biochemical reactor is selected, the operational requirements for this type of system would be more involved as organic substrate would require constant addition. However, if a solid substrate biochemical reactor is selected, the repair and maintenance requirements could be more involved due to substrate plugging and sludge accumulation. Sludge would accumulate with either type of biochemical reactor, and ongoing maintenance for sludge disposal to maintain water flow through the delivery piping would be required. Regular off-site sludge disposal would likely be required and access would need to be maintained to both sludge cells.

3. Monitoring Components:

While the mine pool was being neutralized inside the Big Five tunnel, surface water monitoring would be conducted to assess the water quality of Left Hand Creek. If, after two years of mine-pool neutralization, the mine-pool treatment appeared to have stabilized and the downstream RAOs were not being met for surface water, the second phase of this alternative would be implemented. If treatment had not yet stabilized, additional monitoring would be conducted to ascertain the effectiveness of the in-situ mine-pool neutralization prior to implementation of the second phase. If downstream RAOs were being met for surface water, the second phase of this alternative would not be implemented.

An automated monitoring system (monitoring discharge from the mine pool and water quality at the most downstream point at the Site) would be advantageous. This system could be designed to collect data as often as necessary; however, on-site power would be required. Various monitoring systems should be evaluated as part of the design phase for this alternative.

In addition to water quality monitoring to assess mine-pool mitigation success, the bulkhead and associated mine-pool would also be monitored for containment effectiveness through the use of remote sensing methods, including geophysics. Likewise, the pressure transducer should be monitored regularly and additional groundwater wells may be needed. Because this treatment system would discharge to Left Hand Creek, treated water would need to be designed to meet surface water criteria. A carefully observed monitoring/sampling and analysis program would be necessary under this alternative.

Alternative 3C: Neutralization and Biochemical Reactor Treatment of Big Five AMD Outside of Adit

Estimated Time for Design/Construction:	Unknown
Estimated Time to Reach Remediation Goals:	Unknown
Estimated Construction Cost:	$ 1,950,000
Estimated Design Cost:	$ 2,493,000
Estimated Lifetime O&M Costs:	$ 6,577,000
Discount Factor:	3%
Estimated Total Present Worth Cost:	$ 11,019,000
Number of Years Cost Is Projected:	30 years

1. **Treatment Components:**

This alternative is similar to Alternative 3B; however, in lieu of mine-pool mitigation, neutralization cells would be utilized to adjust pH prior to entry into a biochemical reactor treatment system. This alternative is not phased like Alternative 3B, but instead assumes that biochemical reactors would be required to meet surface water discharge criteria.

2. **Operation and Maintenance Components:**

Similar to Alternative 3B, this system would be intended as a semi-passive system. Ongoing monitoring and maintenance would be required for neutralization ponds and cells as well as to address sludge management at the biochemical reactors. Sludge management is anticipated to be much more laborious in this alternative versus Alternative 3B, as all treatment would occur outside of the adit. Regular off-site sludge disposal would likely be required more frequently and access would been to be maintained to both sludge cells in the bioreactor as well as to the neutralization ponds and cells.

3. **Monitoring Components:**

For the underground portions of this alternative, the monitoring program would be the same as Alternative 3B Phase 1. For the aboveground installed portion of the alternative, the long-term monitoring requirements would be similar to those described in the second phase of Alternative 3B.

Alternative 3D: Outside-Adit Water Treatment System for Big Five AMD

Estimated Time for Design/Construction:	Unknown
Estimated Time to Reach Remediation Goals:	Unknown
Estimated Construction Cost:	$ 2,628,000
Estimated Design Cost:	$ 1,868,000
Estimated Lifetime O&M Costs:	$ 15,251,000
Discount Factor:	3%
Estimated Total Present Worth Cost:	$ 19,747,000
Number of Years Cost Is Projected:	30 years

1. **Treatment Components:**

   Metals would be removed and concentrated through active water treatment, resulting in a reduction in toxicity of adit drainage water. The condition of low pH in adit discharge would also be brought into compliance through treatment. A continuous precipitation treatment system would include neutralization tanks for pH adjustment, precipitation/coagulation processes, clarifiers, and potential mixed media filters and immobilized ligand systems. Aeration tanks may also be required to remove manganese.

2. **Operation and Maintenance Components:**

   Ongoing and continuous O&M would be required under this alternative. Sludge disposal would also be required on a frequent and continual basis.

3. **Monitoring Components:**

   Mine-pool monitoring for stored equalization waters would be similar to Alternative 3A. In addition, because this treatment system would discharge to Left Hand Creek, treated water would need to be designed to meet surface water criteria. A carefully observed monitoring/sampling and analysis program would be required under this alternative to adjust ongoing active treatment components effectively.

16.4 Other Common Elements and Distinguishing Features of Each Alternative

Other common elements and distinguishing features unique to each alternative include key ARARs, long-term reliability of the remedy, quantities of untreated waste, and uses of presumptive remedies or innovative technologies. Tables 20-1 through 20-3 summarize the ARARs pertaining to the remedial alternatives and the Selected Remedy. Several of the remedial alternatives have elements in common, including excavation and waste disposal requirements.

16.4.1 Key ARARs

With the exception of the No Action Alternative, it is believed, based on the analysis of the feasibility study, that an appropriate design for all retained technologies, or technology combinations, can be developed and remediation applied for each media of concern to meet applicable ARARs.

16.4.2 Long-Term Reliability of the Remedy

The magnitude of risk would remain indefinitely if no action is taken at the CJM Site. All of the alternative technologies considered for remedial action would provide long-term reliability. The second phase of the Selected Remedy for subsurface contamination sources would be implemented if ARARs are not being met after implementation of the first phase. The Selected Remedy for surface contamination sources is expected to provide long-term reliability with periodic maintenance. If the Selected Remedy cannot be implemented as planned due to circumstances not foreseen at the time of this ROD, then CDPHE and EPA will develop an alternate plan. At this time CDPHE and EPA cannot determine the cost for replacement of the remedy, because there is insufficient data for analysis of such circumstances.

16.4.3 Quantities of Untreated Waste

No untreated waste would remain at the CJM Site in the Selected Remedy.

16.4.4 Use of Presumptive Remedies or Innovative Technologies

The use of presumptive remedies is not appropriate at the CJM Site. The in-situ mine pool neutralization treatment is an innovative approach to utilize the subsurface mine-pool reservoir as a neutralization storage and treatment vessel in an effort to decrease oxygenation of the acidic mine water, stabilize and control flow from the adit, and contain precipitation sludges and other treatment byproducts within the isolated underground workings.

16.5 Expected Outcomes of Each Alternative

Other than the No Action Alternative, implementation of any of the alternatives considered for this site is expected to reduce the human health risk over time at the CJM Site. The Selected Remedy is expected to achieve RAOs for soils, tailings, and waste rock immediately upon construction completion. RAOs for surface water and groundwater are expected to be achieved within 1 to 3 years following completion of the subsurface contamination source portion of the Selected Remedy. The outcome of the remedy is not expected to change the land and surface water use at the CJM Site because it will likely continue to be used for recreation. However, future development, including residential dwellings, and groundwater usage will become restricted through environmental covenants. Implementation of the Selected Remedy will reduce risk to human health and protect aquatic life in Left Hand Creek.

17 Comparative Analysis of Alternatives

EPA uses nine NCP criteria to evaluate remedial alternatives for the cleanup of a release. These nine criteria are categorized into three groups: threshold, balancing, and modifying. The threshold criteria must be met for an alternative to be eligible for selection. These criteria are overall protection of human health and the environment and compliance with ARARs. The balancing criteria used to weigh major tradeoffs among alternatives are: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The modifying criteria are State acceptance and community acceptance. Table 17-1 briefly describes the evaluation criteria.

Based on the initial screening of technologies and evaluation of alternatives, a number of remedial alternatives were evaluated for each site-impacted area. Tables 17-2 and 17-3 summarize how these alternatives comply with the nine evaluation criteria specified in the NCP §300.430(f)(5)(i). The No Action Alternative for each media is not considered further in the comparative analysis of alternatives because it cannot meet the threshold criteria or address risks at the Site. A comparative analysis of the remedial alternatives other than the No Action Alternative follows.

Table 17-1. Evaluation of Criteria for Superfund Remedial Alternatives

Evaluation of Criteria
Protectiveness of Human Health and the Environment determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.
Compliance with ARARs evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that relate to the site, or whether a waiver is justified.
Long-term Effectiveness and Permanence considers the ability of an alternative to maintain protection of human health and the environment over time.
Reduction of Toxicity, Mobility, or Volume of Contaminants Through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
Short-term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
Implementability considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services, and the reliability of institutional controls.
Cost includes estimated capital and annual O&M costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.
State/Support Agency Acceptance considers whether CDPHE agrees with EPA's analyses and recommendations, as described in the RI/FS and Proposed Plan.
Community Acceptance considers whether the local community agrees with CDPHE's analyses and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

Table 17-2. Summary of Comparison Evaluation of Surface Contamination Sources Alternatives

Evaluation Criteria	High	Medium	Low
Overall protection of human health and the environment	Alternatives 2A and 2C	Alternative 2B	-
Compliance with ARARs	Alternatives 2A and 2C	Alternative 2B	-
Long-term effectiveness and permanence	Alternatives 2A, 2B, and 2C	-	-
Reduction of toxicity, mobility, or volume	Alternative 2A	Alternatives 2B and 2C	-
Short-term effectiveness	Alternatives 2A, 2B, and 2C	-	-
Implementability	Alternative 2B	Alternatives 2A and 2C	-
Cost	Alternative 2C - $1,249,500	Alternative 2B - $1,344,200	Alternative 2A - $2,396,700

Table 17-3. Summary of Detailed Evaluation of Subsurface Contamination Sources Alternatives

Evaluation Criteria	High	Medium	Low
Overall protection of human health and the environment	Alternative 3D	Alternatives 3B and 3C	Alternative 3A
Compliance with ARARs	Alternatives 3B, 3C, and 3D	Alternative 3A	-
Long-term effectiveness and permanence	Alternative 3D	Alternatives 3B and 3C	Alternative 3A
Reduction of toxicity, mobility, or volume	Alternatives 3B, 3C and 3D	Alternative 3A	-
Short-term effectiveness	Alternatives 3A, 3B, 3C, and 3D	-	-
Implementability	Alternative 3A	Alternative 3B	Alternatives 3C and 3D
Cost	Alternative 3A - $3,345,100	Alternative 3B - $3,823,700 (Phase I) $6,574,600 (Phase II) Alternative 3C - $11,019,000	Alternative 3D - $19,746,700

17.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

Surface Contamination Sources Alternatives

Alternatives 2A and 2C both provide a high degree of protection to human health and the environment. Alternative 2B would consolidate only portions of the waste and cap the remaining waste in place and therefore would be less protective than Alternatives 2A and 2C in that contaminated materials would remain present over a larger portion of the site. Alternative 2A could be viewed as more protective with respect to site conditions, however, removal-transport of the wastes off-site over public highways in mountainous terrain adjacent to streams presents possibilities of accidents and spills. Therefore, Alternative 2C is viewed as most protective.

Subsurface Contamination Sources Alternatives

Alternative 3A would be least protective because no active treatment of AMD would take place; furthermore, protectiveness would be wholly dependent on the integrity of hydraulic containment within the bedrock. Alternative 3D would assure the highest level of AMD remediation. However, Alternatives 3B, and 3C would significantly reduce the transport of contaminants from the Big Five adit to the waters of Left Hand Creek through controlled containment and treatment phases not dissimilar to a conventional water treatment process.

Furthermore, the contaminant transport decrease and treatment of contaminated waters underground in Phase I and in the biochemical reactors in Phase II would result in a reduction in contamination and level of protectiveness that, properly implemented, would very likely be equivalent to Alternative 3D. The Phase I partial treatment underground may result in elimination, through dispersion and natural attenuation, of potential human health risks associated with surface and groundwater quality impacts from the underground mine water. Phase II would result in the elimination of potential human health risks associated with surface and groundwater quality impacts from the treated mine water. Also, restriction of Site access through institutional controls, such as the portal door, would limit the exposure of on-site receptors. Seep monitoring would also aid in protecting the surrounding environment and assessing the effectiveness of the bulkhead. Due to the high degree of fracturing and faulting in the area, along with weak rock within and surrounding the adit tunnel, the bulkhead may leak. Mine-pool mitigation would treat the AMD in situ and improve water quality for leaking water and for water exiting the flow-through valve of the bulkhead. If, after two years of mine-pool neutralization, the mine-pool treatment appeared to have stabilized and the downstream RAOs were not being met for surface water, the second phase of this remedy would be implemented.

17.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP §300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations, which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA §121(d)(4). Compliance with ARARs addresses whether a remedy will meet all of the ARARs or provides a basis for invoking a waiver.

Surface Contamination Sources Alternatives

All surface contamination sources alternatives would comply with ARARs, but with differences in certainty. Alternative 2C and 2A achieve compliance with ARARs with the highest degree of certainty, via removal or the most effective containment for contaminated material. Alternative 2B would contain and treat principal threat waste but with only a moderate level of protection to receptors given that more capped waste is left in place.

Subsurface Contamination Sources Alternatives

While all subsurface contamination alternatives have the potential to comply with ARARs, it is not possible to state that a single-phase untreated bulkhead (Alternative 3A) would achieve the Point-of-Compliance ARARs at the Site, because seepage volume and potential locations are unknown, and the quality of any water that may seep from the plugged tunnel and mine-pool reservoir is unknown. Although Alternative 3D would have highly controllable water treatment, the associated underground storage reservoir integrity would present the same uncertainties performance uncertainties as Alternative 3A. The selected alternative would likely comply with ARARs; however, treatability studies would be required to specifically determine compliance with chemical-specific ARARs. Based on the water quality of the Big Five adit drainage and the efficiency of the biochemical reactor processes, CDPHE and EPA believe that the selected alternative would be capable of meeting chemical-specific ARARs if properly designed and operated. Manganese might not be sufficiently removed under Alternative 3A or even under 3B or 3C. Manganese removal would be evaluated after remedy implementation. Manganese does not have an MCL but has a secondary drinking water standard due to taste and appearance.

Further considerations might include additional treatment trains. It is possible that other regulatory measures may need to be undertaken, such as development of a site-specific water quality standards under the Clean Water Act (CWA) or a waiver due to technical impracticability under CERCLA.

17.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been attained. This criterion includes the consideration of residual risk that will remain on site following remediation and the adequacy and reliability of controls.

Surface Contamination Sources Alternatives

All surface contamination sources alternatives would provide long-term solutions with no residual effect concerns. .

Subsurface Contamination Sources Alternatives

Alternative 3A has significant uncertainty, and consequently is rated "low" with respect to achieving this criteria due to uncertainty associated with the interconnectivity of the Big Five adit with other mine workings in the region. Discharge from other mine locations may occur and seep monitoring would be required to assess the effectiveness of the bulkhead. Alternative 3D is rated high, but would only sustain that rating by maintaining withdrawal of untreated mine-pool water for on-going processing through a WTP. While Alternatives 3B and 3C are rated "medium", they are the only alternatives that would provide a combination of in-situ source isolation along with treatment. The selected alternative may have long-term effectiveness without the second phase if seepage from bedrock is controlled and/or the water quality of seepage is of sufficient quality. In addition, mine-pool neutralization would likely be effective in raising the pH of in-situ water and effectively precipitating some COCs out of solution. If the second phase of the selected alternative was implemented, residual risk to potential receptors would be substantially removed while the biochemical reactor was operating. This treatment alternative is long-term and would be required in perpetuity. The system would require regular maintenance and continuous operation in order to be effective in meeting the remedial objectives of the Site.

17.4 Reduction of Toxicity, Mobility, or Volume

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Surface Contamination Sources Alternatives

Alternative 2A attains the highest rating by virtue of the removal of principal-threat waste from the site. Even though Alternatives 2Ba and 2C have moderate scores, these alternatives effectively achieve the objective for treatment and reduction in mobility by consolidation and capping. Alternative 2C may be more effective that Alternative 2B since there is less footprint of capped waste on-site and the resulting containment cells have less area exposed to cap degradation and secondary contaminant releases.

Subsurface Contamination Sources Alternatives

All of the subsurface contamination sources alternatives would provide a reduction of mobility of the adit water and its associated contaminants. Alternatives 3B, 3C, and 3D would have the highest score by containment and varying degrees of treatment of site AMD. Alternative 3A would only partially submerge and contain AMD, and therefore only have a moderate reduction of toxicity or mobility. While Alternatives 3B, 3C and 3D could be highly effective, the mine-pool storage reservoir under 3C and 3D could still have containment uncertainties comparable to Alternative 3A. Alternative 3B is the only alternative that involves, directly and indirectly, mine-pool contaminant reduction. Measures would be undertaken during design and geotechnical evaluation/design of the bulkhead to minimize the potential for AMD release from another mine portal/shaft.

17.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

Surface Contamination Sources Alternatives

With the use of engineering controls, all surface contamination sources alternatives would provide short-term effectiveness. Minimal risk would result from actions taken during implementation of the selected alternative. Excavation of contaminated materials might produce dust. Also, contaminated wastes would be transported over and outside of the Site. Workers might be exposed to contaminated materials during remedial actions. There might also be adverse environmental impacts resulting from the excavation and construction activities. All removal, transportation, and construction activities would be completed within one year.

Subsurface Contamination Sources Alternatives

All of the subsurface contamination sources alternatives would be effective in the short term (construction period). In addition, construction and drilling activities associated with mine-pool mitigation in the selected alternative could be controlled with SOPs, and risks to workers and the environment would be minimal. If the second phase of the Alternative 3B is implemented, construction activities would include construction and monitoring of the biochemical reactor system, construction of a building to house the biochemical reactors, and installation of discharge channels and pipes. Construction health and safety protocols would be established to reduce physical hazards to workers; however, the risk is considered minimal. On-site residents exist and construction activities could create dust and noise. Mitigation measures and a detailed monitoring program would be required to bolster the short-term effectiveness of this alternative. The RAOs would be achieved once the biochemical reactor system is operational. There is the possibility that precipitates and silt from the AMD could plug up the substrate or subsurface pipes, thus inhibiting the effectiveness of the bioreactor. This would require unclogging or replacement of the substrate or piping. In addition, sludge management would be required.

17.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Surface Contamination Sources Alternatives

All of the surface contamination sources alternatives would be implementable. Although there would be a moderate level of operational requirements associated with Alternative 2C, such as excavation, consolidation, compaction, grading, and capping, it would be technically feasible. Alternative 2A would also have a moderate level of operational requirements associated with excavation back filling and hauling off site contaminated material, but would be technically feasible. Alternative 2B would be most implementable because there is less material handling than with Alternative 2A or 2C.

The Captain Jack is located on mostly private property. It is anticipated that agreements with private property owners would be needed for any Remedial Action undertaken at the Site. These agreements would need to address access, permanent easements/deed restrictions, and any institutional controls that would be necessary to ensure long-term permanence of the Selected Remedy.

Subsurface Contamination Sources Alternatives

All actions proposed in all of the subsurface contamination sources alternatives are implementable.

With respect to bulkhead implementation, all of the alternatives would require well-qualified design engineering and construction personnel. The provider of engineering services would need to have extensive experience in evaluating the geotechnical conditions of underground adits and/or tunnels and determining required support. Additionally, access to the primary work of bulkhead construction would require the ancillary task of upgrading a portion of an inactive mine, originally constructed to now-primitive standards and which has suffered decades of neglect, to a level in full compliance with modern requirements for safety. Some work was completed in 2007 to a five-year design life; a 20-year design would be needed for additional tunnel work.

With respect to the needed surface components of the AMD treatment options, Alternatives 3C and 3D would be most difficult to implement due to the need for significant site development (acquiring flat-round space) for sludge-management and treatment plant facilities and operations. Alternative 3B would be the most efficient use of available space, and could be implemented within the presently available site-configuration. Injection and extraction wells could be drilled at the proposed locations discussed in previous sections with minimal access road improvements. On-site power would be required, as would a continuous/semi-continuous monitoring system designed to evaluate the dosing rate of a neutralizing agent to the mine pool. The rock within the mine tunnel could absorb a significant amount of a caustic reagent added to the mine pool, and pH adjustment might be limited due to potential sludge accumulation.

The construction workforce would need to be primarily composed of personnel with substantial underground mining experience, including use of mechanical and manual equipment suitable to the very confined clearances present in a small, historic adit. The workforce would also need advanced experience in recognizing and avoiding or mitigating underground mine hazards that may be more frequent or severe than typically encountered in a currently operating mine. Additionally, individuals constructing the injection and extraction wells would need to have substantial experience in subsurface drilling and would need to utilize appropriate equipment to maintain the stability of borehole installations into a historic mining tunnel.

It is expected that the elevation of the mine pool would need to be monitored following the bulkhead installation. This would be done indirectly by observing the pressure gauge at the bulkhead, and also indirectly with geophysics methods to track mine-pool spatial patterns and outward flow paths. After initial neutralization, discharged water would require monitoring through the bulkhead flow-through valve to assess the adequacy of mine-pool mitigation treatment measures.

In the event that the second phase of this alternative would be required, biochemical reactors have been installed at mine sites with increasing success over recent years. Biochemical reactors, properly designed, can be utilized at high-altitude sites with cold climates. The remoteness of the CJM Site and absence of power would not pose a problem. The second phase of this alternative would require a complete treatability study and design and would greatly benefit from a small-scale pilot plant prior to full construction.

17.7 Cost

For the cost estimating, CDPHE directed Walsh to use 3% discount rate. This rate is used by CDPHE for estimation purposes for other environmental programs and is based on the Consumer Price Index and inflation. This rate differs from the rate suggested in the NCP and OSWER Directive 9355.3-20. Using the lower rate will allow for the cost estimating of these alternatives to be more accurate given the increasing and unpredictable costs of labor and construction materials.

Cost includes estimated capital and O&M costs as well as present worth costs. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent. Estimated costs associated with each of the remedial alternatives are summarized in Table 17-4. The estimated costs associated with the Selected Remedy are detailed in Appendix B. The total cost for the Selected Remedy for the Site is approximately $11.74 million (including implementation of Phase II of the subsurface contamination sources alternative).

Table 17-4. Cost Summary for Alternatives

	Total	Construction	Design	O&M
Surface Contamination Sources Alternatives				
Alternative 2A: Off-Site Disposal of Principal Threat Waste with Remainder Cap-in-Place	$2,396,700	$2,164,486	$204,500	$27,700
Alternative 2B: On-Site Consolidation and Capped Cell for Principal Threat Waste with Remainder Cap-in-Place	$1,344,200	$803,722	$263,915	$276,580
Alternative 2C: On-Site Consolidation and Capped Cells for Contaminated Soils	$1,249,500	$741,537	$325,383	$182,602
Subsurface Contamination Sources Alternatives				
Alternative 3A: Bulkhead with Monitoring	$3,345,100	$524,900	$1,341,855	$1,478,394
Alternative 3B: Bulkhead and Internal Mine-Pool Mitigation with Phased Successive Biochemical Reactor Treatment Outside of Adit	$10,398,300	$2,764,038	$2,371,338	$5,262,923
Phase One	$3,823,700	$1,494,400	$1,474,427	$854,858
Phase Two	$6,574,600	$1,269,638	$896,911	$4,408,065
Alternative 3C: Neutralization and Biochemical Reactor Treatment of Big Five AMD Outside of Adit	$11,019,000	$1,949,638	$2,492,667	$6,576,647
Alternative 3D: Outside-Adit Water Treatment System for Big Five AMD	$19,746,700	$2,627,880	$1,868,294	$15,250,515

17.8 State Acceptance

All alternatives were developed jointly by CDPHE and EPA. Both agencies contributed to the comparative analysis performed for each alternative and both agencies agree that the Selected Remedy is an appropriate decision response to public comments and preferences over the Proposed Plan's Alternative 2B.

17.9 Community Acceptance

The community strongly preferred Alternative 2C. This was made known during the public meeting on the Proposed Plan and through submitted written public comments.

Based on the comments received strongly expressing a preference for Alternative 2C, and the relative equivalence of the effectiveness and cost of Alternatives 2B and 2C, the agencies have changed the selected remedy from the proposed Alternative 2B to Alternative 2C for surface contamination in conjunction with Alternative 3B for subsurface contamination. During the Public Comment Period, local stakeholders communicated expressed their acceptance of Alternative 3B.

18 Principal Threat Wastes

The NCP establishes an expectation that the lead agencies will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430(a)(1)(iii)(A)). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile, which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied.

Principal threat waste at the CJM Site is defined as material with lead concentrations exceeding 1,460 mg/kg (based on the CDPHE Hazardous Materials and Waste Management Division Soil Cleanup TVS for Industrial Land Use). The value of 1,460 mg/kg was derived through exposure modeling performed by CDPHE in an attempt to determine the most appropriate risk-based threshold for industrial land use. Because arsenic and thallium are typically co-located with lead, lead was selected as the definitive metal for this classification.

Based on public comment, the selected remedy will include excavation of <u>all</u> surficial contaminated material exceeding the residential levels (from areas not located under a capped area), and placement into the amended and capped consolidation cell(s). This specific treatment will more effectively enable CDPHE to carefully monitor the effectiveness of the remedy and control potential erosion or maintenance issues before these materials can become re-released to the Site.

19 Selected Remedy

The CDPHE and EPA will implement the surface sources selected remedy in a single phase at the CJM Site and will implement the subsurface sources selected remedy in two phases to optimize treatment of the site-impacted media. The Selected Remedy (a combination of Alternatives 2C and 3B) for the various sources is as follows:

- Surface Contamination Sources: On-Site Consolidation and Capped Cells for Contaminated Materials; and
- Subsurface Contamination Sources: Bulkhead and Internal Mine-Pool Mitigation with Phased Successive Biochemical Reactor Treatment Outside of Adit.

19.1 Summary of the Rationale for the Selected Remedy

19.1.1 Surface Contamination Sources Alternative

The selected alternative will be protective of human health and the environment because contaminated waste will be excavated and consolidated into a more isolated location in a capped consolidation cell. The alternative complies with ARARs and is considered a permanent long-term remediation alternative. It is more implementable and cost effective than off-site disposal. While the alternative will not reduce the toxicity or volume of contamination on site, it will effectively isolate and contain the materials and reduce contaminant mobility in the form of erosion prevention and surface water controls. The alternative will be effective in the short term and can be implemented at the Site with readily available technology and equipment.

19.1.2 Subsurface Contamination Sources Alternative

Alternative 3B was selected because the remedy will undertake restoration of the ground and surface waters by treating mine water "in-situ". The selected alternative will be protective of human health and the environment because the bulkhead will eliminate the current direct-discharge of untreated AMD into Left Hand Creek, and create an impounded mine pool for treatment, with additional biological treatment components, as necessary. The alternative will comply with ARARs and is considered a permanent long-term remediation alternative. Monitoring will be performed to assess success of the in-situ mine-pool mitigation and observe the mine pool for chemical and physical equilibrium. Surveillance will be conducted to identify potential problematic conditions associated with elevated groundwater levels caused by the bulkhead and associated mine pool. Remediation success will be evaluated by comprehensive monitoring of mine-pool chemistry and hydraulic conditions plus surface-discharge reconnaissance, and by monitoring water quality in Left Hand Creek at a compliance point established above the downstream confluence with Puzzler Gulch. Interim monitoring points will be located downstream of each Remedial Action area (i.e., Big Five, CJM, and White Raven areas) in order to evaluate the effectiveness of each area's remediation to a successful overall cleanup of the site.

If mine-pool mitigation is not sufficient to achieve compliance, a second-phase remediation will occur with the installation of biochemical reactors. Final treatability studies and design for the biochemical reactors will be based on equilibrium conditions of the mine pool after neutralization processes have been underway for up to two years. This alternative will further reduce toxicity, volume, and mobility of contaminants, further reducing the potential for untreated AMD discharging to Left Hand Creek. The neutralization and treatment processes recommended for the mine pool will enable sequestering of metals by precipitation within submerged mine workings prior to releases via seepage or the flow-through bulkhead valve.

While it is not possible to accurately estimate metals loading reduction into Left Hand Creek from the Phase I remediation alone, it is believed that metals loading to the creek will be significantly reduced. However, if RAOs and ARARs are not achieved with Phase I, the additional implementation of Phase 2 provides a high degree of assured protection for Left Hand Creek. In addition, sludge management under both phases of the selected remedy will be less than outside-adit neutralization and treatment. Additionally, the provisions for a second treatment point within the mine pool will enable neutralization optimization or possibly injection of an organic compound to promote additional metals decontamination within the mine pool or prior to Phase 2 biochemical treatment. Implementing this selected remedy in a phased approach will allow for a potential significant cost savings in the event that Phase I alone meets water quality criteria.

19.2 Description of the Selected Remedy

19.2.1 Surface Contamination Sources Alternative

This removal and consolidation alternative is a comprehensive effort that would be effective in meeting the RGs and identified ARARs for the contaminated media on the surface of the Site. Except for the small upper-layer of contaminated surface material, the Big-Five waste rock dump will be capped in place.

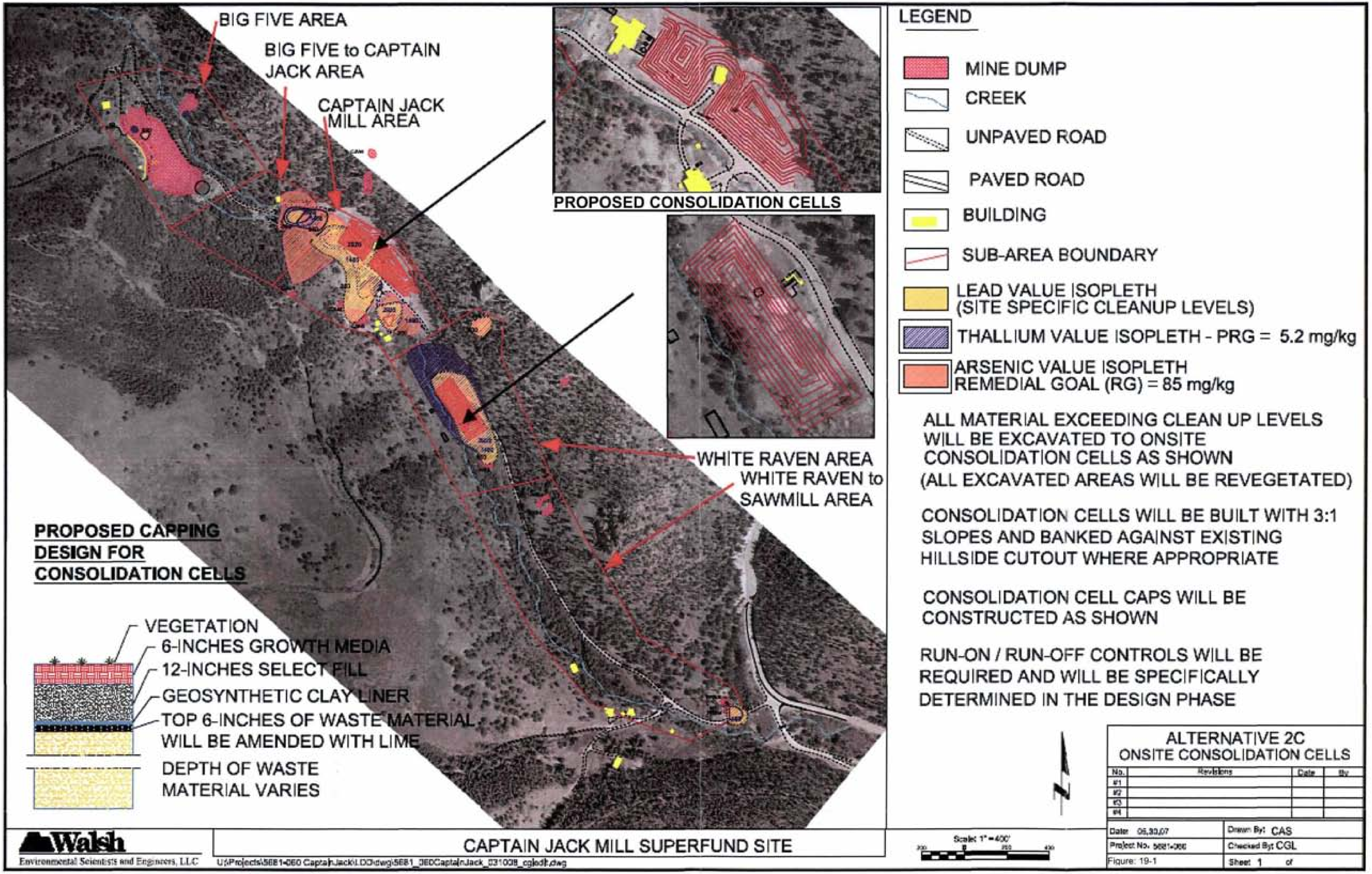
The action of removal, consolidation, and capping of all contaminated surface materials would essentially eliminate the amount of waste transported off site by surface water and air pathways. In addition, the consolidation cell cap would serve as a direct contact barrier between site contamination and potential human and ecological receptors. The contaminated material from these areas would be excavated and consolidated in three on-site consolidation cells.

The primary elements of removal of contaminated surface material exceeding residential threshold levels to an on-site consolidation cell at the CJM Mine include:

- **Excavation** of approximately 92 cy of waste from the Big Five area, 620 cy of waste from the Big Five to CJM area, 17,500 cy from the CJM area, 15,500 cy from the White Raven area, and 260 cy from the White Raven to Sawmill area, and placement of the waste into the constructed consolidation cells at the southwest portion of the Site;
- **Amending** waste material by mixing lime into the top 6 inches of waste material;
- **Construction** of three consolidation cells within the CJM and White Raven areas to provide containment for approximately 37,000 cy of waste material (including a 10-percent expansion factor);
- **Diversion of surface water** runoff during excavation and for purposes of permanent control; and
- Implementation of **access controls** such as fencing and signage to preclude or minimize access to the Site prior to, during, and after construction of the consolidation cell by humans or wildlife.

Determination of Material to Be Removed

Under this alternative, materials exceeding 85 mg/kg of arsenic, site-specific values of lead, and/or 5.2 mg/kg of thallium would be excavated to a depth of approx. three (3) feet and placed in consolidation cells located at the CJM Site along the scarified surface bordering the former tailings ponds on the northeast and at the White Raven area. Approximately 6,784 cy of contaminated soil/tailings are already located in these two areas; therefore, only 27,188 cy of the total contaminated 33,972 cy of material would require excavation. XRF technology should be employed to identify these materials along with the spatial distribution shown in Figure 19-1. Because waste material amendment and capping in place is not included in this alternative, additional efforts may be needed to ensure that all waste material is excavated and removed to the consolidation cells. For costing purposes the lower limit of excavation is assumed to be 3 feet. The design phase of this project will further consider this issue depending on the vertical extent of contaminated material.


BIG FIVE AREA
BIG FIVE to CAPTAIN JACK AREA
CAPTAIN JACK MILL AREA
PROPOSED CONSOLIDATION CELLS
WHITE RAVEN AREA
WHITE RAVEN to SAWMILL AREA
PROPOSED CAPPING DESIGN FOR CONSOLIDATION CELLS
VEGETATION
6-INCHES GROWTH MEDIA
12-INCHES SELECT FILL
GEOSYNTHETIC CLAY LINER
TOP 6-INCHES OF WASTE MATERIAL WILL BE AMENDED WITH LIME
DEPTH OF WASTE MATERIAL VARIES
LEGEND
MINE DUMP
CREEK
UNPAVED ROAD
PAVED ROAD
BUILDING
SUB-AREA BOUNDARY
LEAD VALUE ISOPLETH (SITE SPECIFIC CLEANUP LEVELS)
THALLIUM VALUE ISOPLETH - PRG = 5.2 mg/kg
ARSENIC VALUE ISOPLETH REMEDIAL GOAL (RG) = 85 mg/kg
ALL MATERIAL EXCEEDING CLEAN UP LEVELS WILL BE EXCAVATED TO ONSITE CONSOLIDATION CELLS AS SHOWN
(ALL EXCAVATED AREAS WILL BE REVEGETATED)
CONSOLIDATION CELLS WILL BE BUILT WITH 3:1 SLOPES AND BANKED AGAINST EXISTING HILLSIDE CUTOUT WHERE APPROPRIATE
CONSOLIDATION CELL CAPS WILL BE CONSTRUCTED AS SHOWN
RUN-ON / RUN-OFF CONTROLS WILL BE REQUIRED AND WILL BE SPECIFICALLY DETERMINED IN THE DESIGN PHASE
ALTERNATIVE 2C
ONSITE CONSOLIDATION CELLS
No. Revisions Date By
#1
#2
#3
#4
Date: 06.30.07
Project No. 5681-060
Figure: 19-1
Drawn By: CAS
Checked By: CGL
Sheet 1 of
Scale: 1" = 400'
Walsh
Environmental Scientists and Engineers, LLC
CAPTAIN JACK MILL SUPERFUND SITE

Ancillary work would also include: design and oversight; mobilization, communications system, per diem, site facilities, contractors' job planning and coordination time, etc.; minor road improvements; site grading to include interfacing with mine adit drainage and/or treatment facilities; drainage system and erosion control; revegetation; and demobilization.

Excavation
Because the Site is accessed by one single-vehicle road, excavation would be highly inefficient due to the time spent waiting for trucks to move throughout the Site. Narrow segments of the road are present and therefore additional communication would be required to facilitate removal of this material. Assuming the road could be improved for 10-cy tandems, with 12 trucks, production would be approximately 400 cy per day. This yields an expected removal phase average duration of 85 working days assuming 10.5 hours of service per truck (11 hours loading time on site). Staggered truck start times would be required to prevent undue idle truck time for best excavation efficiency.

Significant road improvements were made during the EPA action in 2007; therefore, the Big Five waste pile is now accessible through use of the road at the base of the pile. In light of steep grades, transporting excavated material from the Big Five waste pile to the consolidation cell locations could still require additional road improvements and may provide access challenges. Further, this pile would require some grading and stabilization earthwork to facilitate excavation of this waste material. Additional potential areas for grading could be used to the southwest of the existing pile toward the on-site pond; however, this effort would require coordination with the subsurface contamination source alternative selected.

Historic structures are likely to be present in the areas of excavation; however, the adit tunnel, Captain Jack Mine and Mill, and White Raven Mine are not recommended as eligible for listing in the NRHP as discussed in Section 1.2.3. Therefore, excavation around structures at these locations will not likely adversely impact this alternative. Remediation of a small amount of lead contaminated soil is recommended for an area of the Conqueror Mill. The Conqueror Mill is recommended for inclusion in the NRHP and remediation at this site would need to consider historic preservation.

Consolidation Cell Construction
This action includes an on-site consolidation cell consisting of conceptually up to three consolidation cell areas; two of which would be located at the southeastern section of the CJM Mine at the site of the former tailings pond, and one would be located at the White Raven area. The specific location in the Captain Jack Mill area for the consolidation cell(s) will be determined based on cut and fill evaluations to be conducted during the Remedial Design phase. Approximately 27,188 cy of waste material (excluding 6,784 cy of material that is already located in the proposed consolidation cells at the CJM and White Raven areas) would be placed and compacted within the consolidation cells from all five areas of contamination at the Site.

The footprint of the proposed consolidation cell conceptually will be split into two cells oriented in rectangular shapes with sides measuring approximately 120 feet by 115 feet and filled to 15 vertical feet. The material will be situated on flat topography and filled so that it backs against the existing steep grade of the embankment to the northeast. An unlined consolidation cell with a GCL and soil cap will provide a physical barrier and greatly reduce the threat of release of contaminants. In addition, by adding lime to the top 6 inches of waste material, the risk of metals migration from the consolidation cell to on- or off-site receptors will be further reduced. By locating the consolidation cell within the CJM area, the hauling distance from the surrounding contaminated material over the entire Site will be minimal. Again, specific cell location(s) in the Captain Jack Mill footprint area will be determined during Remedial Design.

The contaminated material will be placed in the consolidation cell(s) which will include the following layers:

- A 6-inch vegetative layer consisting of growth media; soil amendments with the micro- and macronutrients necessary to sustain growth; and native vegetation and mulch, erosion mats, or other sufficient cover to reduce surface erosion, encourage transpiration, and reduce infiltration through the consolidation cell;
- A 12-inch vegetative layer consisting of common soil sufficient for development of good root support for vegetation, and for moisture storage;
- GCL designed to be an impermeable liner to prevent percolation and infiltration of water; and
- Lime addition to the top 6 inches of waste material to further stabilize metals in place.

This configuration will provide physical protection of the waste material from weathering and erosion. The containment side slopes proposed will be at a 3 (horizontal) to 1 (vertical) slope, based upon available space and maintenance considerations. However, this configuration may be revised during design based upon geotechnical analyses concerning slope stability, foundation settlement, and the compaction rate of the waste material. The cover system should greatly reduce the risk of release of contaminants from the consolidated material through dissolution processes. The top will be sloped from the center of the containment outward toward the side slopes at a minimum 5-percent slope to allow for good lateral drainage within the cover section, and limit erosive velocities of local runoff on the cap. If erosion matting is not used, the slope will be roughened to prevent rill erosion from forming (Munshower 1994; Goldman et al. 1986).

Surface Water Diversion

In order to provide remedy protection for the consolidation cell(s), significant surface water control measures will be required, including regrading of surrounding slopes, engineered channels to divert runon from the consolidation cells, and slope grading at the consolidation cell surfaces to prevent ponding and rills. The engineered channels will divert surface water south of the consolidation cell and ultimately into Left Hand Creek, and will be equipped with appropriately sized riprap, vegetation, or other erosion control prevention measures. Check dams may not be required because slopes may be flat enough to control surface-flow velocity.

The perimeter runoff control system for the consolidation cell area will consist of a shallow ditch system. This perimeter will intercept runoff from the surface of the cap and divert runon from adjacent slopes away from the containment. Diversions from the perimeter ditches will outfall from adjacent slopes away from the consolidation cell.

Appropriate stormwater pollution prevention measures and Best Management Practices (BMPs) such as diversions, sediment ponds, or silt fencing will be incorporated into the project to minimize the potential for adverse impacts to water quality during construction. All disturbed areas will be graded to drain, and then vegetated with native species as soon as practicable in order to minimize construction-related sediment transport. Fugitive dust emissions will be limited by the use of dust palliatives, or sprinkling as appropriate.

Revegetation

Vegetation on the consolidation cell caps surface would protect it from gullying and scouring by surface water, thereby minimizing erosion. The top caps would be sloped from the center of the containment outward with a minimum of 5-percent slope to allow for good lateral drainage within the cover section, and 3:1 slide slope to limit erosive velocities of local runoff on the cap. In addition, if erosion matting were not used, the slope would be roughened to prevent rill erosion from forming. Revegetation activities would be implemented on site as soon as practicable after completing construction activities. Site preparation would include necessary soil amendments and/or fertilizer to support vegetation.

Based on a successive planting scheme, the recommended initial plantings would consist of a mix of plants, which would include both quick colonizers as well as a few species more adapted to later stages of ecological succession. Planting would be limited seasonally. Crushed rock may also be used to reduce erosion from the cap during the revegetation process; however, this decision would be made during the design phase of the project.

O&M activities for this alternative would likely include watering and other care required for the success of new vegetation, additional placement of seed in areas of unsuccessful revegetation during the initial attempt, and other needed repairs to the surface of the cap.

After excavation of waste material, revegetation would be used to control erosion of exposed surfaces and inhibit sediment loading to the creek. All appropriate areas would be excavated in a manner that leaves a slope graded to drain and ready for revegetation. Following excavation, organic amendments would be incorporated into the exposed surface. In addition, vegetation would be drilled into the prepared slope. Erosion control blankets and/or straw mulch would be necessary to prevent erosion of the soil cap while the vegetation develops. Reseeding may be required throughout the first few years.

Institutional Controls

Throughout construction, site access will be limited. Temporary fencing will prevent access to excavation and capping areas, and signs prohibiting trespassing will be posted. Once vegetation has established, a fence surrounding the capped areas is not anticipated. However, a permanent fence is anticipated around the consolidation cell to prevent access to maintain the integrity of the cap and secure the principal threat waste. Signs prohibiting trespassing will also be posted around the perimeter of the consolidation cell. Additional institutional controls at the site will include environmental covenants (to prevent property owners from digging or excavating into capped locations), building restrictions (i.e., no building allowed) for the area where the consolidation cells are constructed, and limited fencing during repair or maintenance of the capped areas.

19.2.2 Subsurface Contamination Sources Alternative

The selected alternative is designed to address the AMD from the Big Five adit tunnel in an effort to meet the remediation goals and identified ARARs for the CJM Site. Based on a reconnaissance of the Big Five adit tunnel, a bulkhead could be installed at a location approximately 470 to 675 feet from the portal. Conceptually, the bulkhead will consist of a concrete structure with a thickness of approximately 10 feet. In order to be able to draw down and sample water behind the bulkhead, it will contain stainless steel piping and valves. The annular space between the plug and the roof and ribs will be grouted to seal water flow when the valves are closed. Mine-pool mitigation will take place upstream of the bulkhead through neutralization injection and extraction loops. A flow-through valve will be installed to discharge treated water. As a second phase of this alternative (as required), a biochemical reactor will be installed if effective treatment is not occurring within the mine tunnel and compliance with ARARs is not being achieved.

Phase I: Bulkhead Installation and Mine-Pool Mitigation

Location and Design, Preparatory Work, Installation, and Post-Grouting of Bulkhead

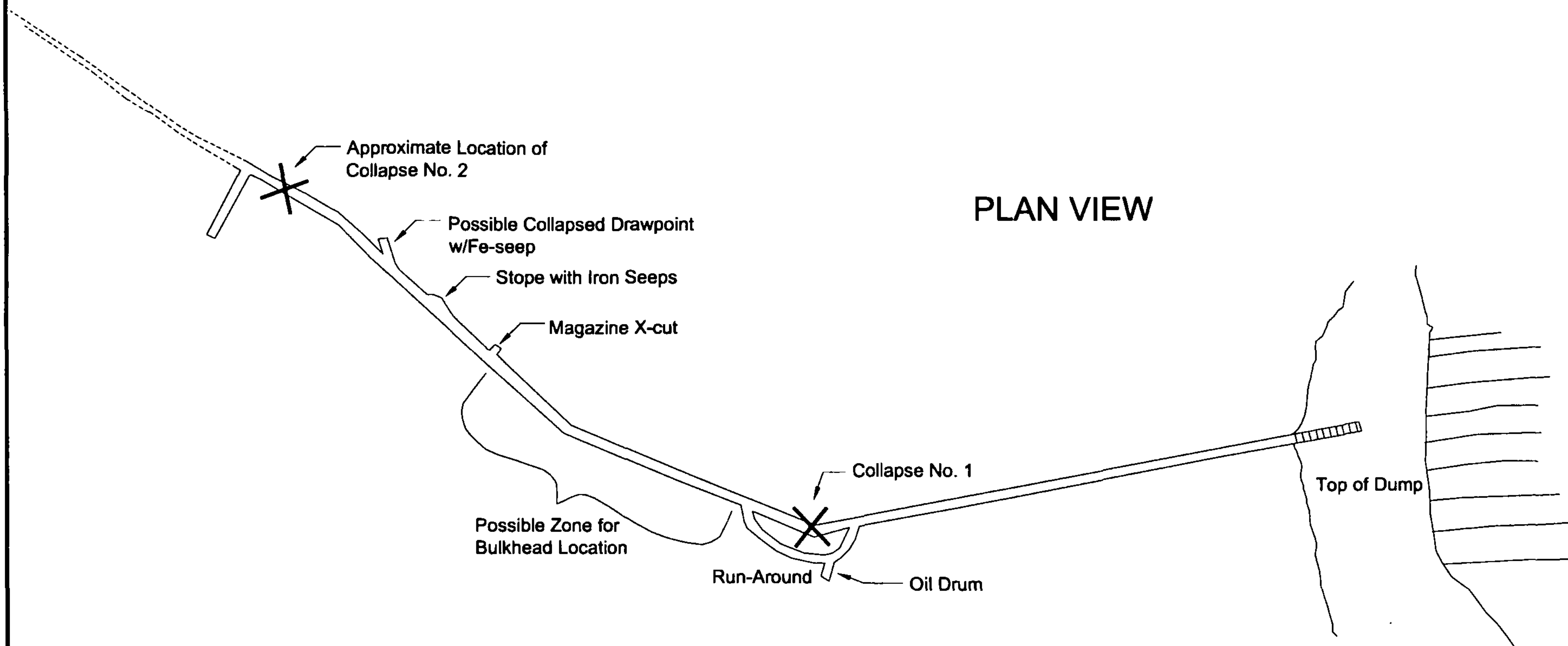
The location and design of the bulkhead is depicted on Figure 19-2. The major factors that were considered when choosing this location were:

- geochemical factors (placement by all major mineralized seeps),
- structural geology and hydrogeologic factors (character and competency of rock fabric),
- expected post-bulkhead groundwater flow rate and resultant oxygen flux,
- presence of sufficient overburden to prevent hydrofracturing, and
- identification of other mine workings, favorable geometry, and the rehabilitation work required to gain safe construction access.

While the bulkhead was not designed in this phase of the project, major design factors that are recommended include:

- adit dimensions and geometry at the location under consideration,
- maximum static head that may be imposed on the structure,
- rock compressive strength and the associated resistance to punching shear,
- the amount of water in a straight line path adjacent to the bulkhead, and whether formation grouting or multiple bulkheads will likely be required to reduce seepage potential.

One possible location for the bulkhead initially considered was the location near the first collapse, at approximately 300 feet. Upon further analysis, this option was screened out as a possible bulkhead location, primarily because the review of mine maps indicated there was insufficient cover above to prevent the possibility of hydro-fracturing the rock mass.



Not to Scale

Bulkhead Location

No.	Revisions	Date	By
#1			
#2			
#3			
#4			

Date: 02/05	Drawn By: RW
Project No. 5861-010	Checked By:
Figure: 19 - 2	Sheet of

Walsh
Environmental Scientists and Engineers, LLC

Captain Jack RI/FS

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An area that appears potentially suitable for a bulkhead is the tunnel zone between 470 to 675 feet from the portal. At 700 feet in, prominent highly mineralized seeps exist. Additionally, at approximately 738 and 785 feet from the portal, there are two points where rubble-filled openings to other mine workings exist. These would be problematic and expensive to seal off.

Both structural and practical factors will require confirmation during the design phase and prior to finalization of a decision in favor of the bulkhead location placement; however, with the available knowledge, a bulkhead has been deemed implementable in this tunnel. The design phase should also include an evaluation of the extent of jointing present to determine whether formation grouting is likely to be required, and following adit rehabilitation and installation of utilities to the bulkhead zone, confirmatory cores of the rock in the bulkhead location will need to be collected and tested for strength.

The design phase should also determine the conceptual operation of the mine-pool reservoir in terms of hydraulic head and reservoir characteristics behind the bulkhead. This elevation will be based on data gathered during the geotechnical evaluation and design of the bulkhead and mine-pool reservoir. The maximum level at which the mine pool will be managed is, at most, below the collar of the California Raise. In addition, it is known that the Big Five adit accesses several other shaft-accessed mine workings to the north (such as the Columbia Shaft and other shafts closer to the Town of Ward), and also the Niwot Cross Cut. Attention will be required to ensure that mine-pool levels are not allowed to back up water that could release from mine-workings near Ward. While the New California Raise is the lowest in elevation of the known openings to the Big Five workings (other than the portal), an extensive monitoring program should be designed and installed to monitor the location and migration of mine-pool water as it rises within the underground workings and bedrock zones associated with the Big Five tunnel. The extensive monitoring program is described later in this section. The purpose of the monitoring program should be to optimize the mine-pool water management program such that water storage and/or treatment will be operated to minimize the potential for unintended groundwater discharges to surface water and groundwater systems. Any unintended discharges could result in exceeded ARARs or other potential releases.

Adit Tunnel Rehabilitation

During the stage of underground investigation and mapping, observations will include the amount of additional work required to clean out the adit back to the proposed bulkhead location. This work will consist of the scaling of any loose rock, clean up of sludge accumulations and rock fall debris on the floor of the adit, removal of old utilities currently present in the tunnel, and the installation of ground support as necessary to ensure the safety of workers. Some of these tasks were completed by EPA as part of the 2007 Emergency Removal work; however, a detailed evaluation will be required to evaluate the stability of the tunnel and identify any additional needed rehabilitation tasks.

The Ground Control Plan will require approval by a Colorado Registered Professional Engineer with appropriate education and experience in the analysis of tunnel support requirements. This plan will specify measures to be taken, including scaling, rock bolting, and possibly installation of steel sets or other support systems.

Additionally, ancillary to the rehabilitation, temporary utilities will be installed. For temporary service, this will likely be a 12- to 16-inch flexible vent bag connected to a centrifugal fan of approximately 20 horsepower (HP), a 120-volt power cord, and flexible HDPE piping for compressed air and drilling water.

Depending on the adit dimensions, either a 1 cy or ½ cy-capacity diesel-powered "Load-Haul-Dump" (LHD) unit will be used to haul muck out and haul supplies into the mine adit. An LHD is a low profile, rugged-wheel loader specially adapted for use in underground mines.

Additional rehabilitation work may be required to stabilize the adit for injection and extraction wells. The first injection and extraction well loop is intended for construction at approximately 2,400 feet inby. This is approximately at the location where the Niwot Cross Cut intersects the Big Five tunnel. The second treatment point will be installed closer to the bulkhead, west of the Peak to Peak Highway. Additional discussions regarding these injection and extraction wells are presented in the mine-pool mitigation section below.

Bulkhead Preparatory Work

Once the adit has been cleaned up to the area of the bulkhead, the following steps will be taken to prepare for the bulkhead installation:

1. Safety barricades and signage will be erected by the first collapse to restrict access to nonrehabilitated areas.

2. A mine safety rescue team will be mobilized.

3. A shallow cofferdam will be constructed to impound water, which would otherwise be running through the bulkhead area. A pipe will be installed to transmit the water through the work area without it spreading out on the floor.

4. The bulkhead area will be scaled of any loose rock and cleaned up using the LHD, shovels, and compressed air blowpipes until only clean and competent rock surfaces remain.

5. The inby (back) form and rebar cage will be constructed. The back form usually consists of a substantial wooded wall, which is braced against the pressure of the pumped concrete by large steel beams rock-bolted into the adit. A rebar cage, as per the bulkhead design, will be erected. Accommodations will be made for piping penetrations as per design.

6. The outby (front) form and rebar will be completed in a manner similar to the rear form.

7. Piping and valve installation will be completed. Typically, there will be one or more stainless-steel lines passing through the bulkhead, equipped with acid-resistant valves. These will allow water samples to be collected and, if necessary, water behind the bulkhead to be released.

8. Pre-placement of grout piping (optional) will occur. The perimeter of the bulkhead (between the concrete plug and the adit roof and ribs) will need to be grouted after the concrete shrinks slightly, generally between 7 to 28 days after placement. The grout could either be injected through pre-positioned grout pipes that pass through the front form and rebar, or through packers placed in holes that are drilled after the main concrete pour. If pre-positioned pipes are used, the risk of drilling into rebar will be eliminated; however, the pipes will either need to have the ends protected from clogging with concrete or be drilled out before the post-grouting.

9. Pre-pumping inspection of rebar, forms, and piping by the design engineer will be required before actual concrete is installed.

Bulkhead Installation

Bulkhead installation steps will include:

1. Construct concrete lines. High-pressure steel lines and hoses will be laid from the concrete pump unit to the bulkhead area.

2. Provide for an emergency cold joint. Proper materials, a design, and a plan will need to be on hand during the bulkhead concrete pumping to provide for a satisfactory emergency cold joint should mechanical failure or other reasons prevent the contractor from completing the bulkhead pour in a continuous process. Typical emergency cold joint measures could include sculpting a keyway in the already-poured concrete, placement of rebar normal to the plane of the cold joint, or installation of a suitable waterstop (preferably chemical grout triple-tubes) across the plane of the cold joint, inside the keyway.

3. Set up mixer. The Site is not accessible for ready-mix concrete trucks; therefore, it is assumed for estimating purposes that the concrete mix would travel up to the Site in 1,000 kg "super sacks," one trip at a time on the back of a 1-ton 4x4 flatbed truck, and would be mixed on Site. A hydraulic-driven portable mixer, similar to that used by Asarco, Inc. at the remote Rawley-12 mine bulkhead project near Bonanza, Colorado, will be set up and used. This type of unit can be powered using an auxiliary hydraulic tap from an LHD or wheel loader.

4. Mix the concrete and pump. On the appointed day, a wheel loader will be used to lift the super sacks into position at the mixer. A measured amount of water will be added, and the mix will be discharged into the diesel-powered concrete pump. During the concrete mixing and pumping, the engineer or a qualified representative will observe the addition of water and collect samples for testing to verify that the concrete meets the design specifications.

Post-Grouting of Bulkhead Perimeter

Following a shrinkage period of between 7 to 28 days, post-grouting of the slight annular space between the concrete plug and the adit roof and ribs will be performed. This will be conducted with either chemical or Portland cement-based grouts, using either pre-placed pipes or drilled holes and grout packers.

Valve Operation and Water Quality Testing

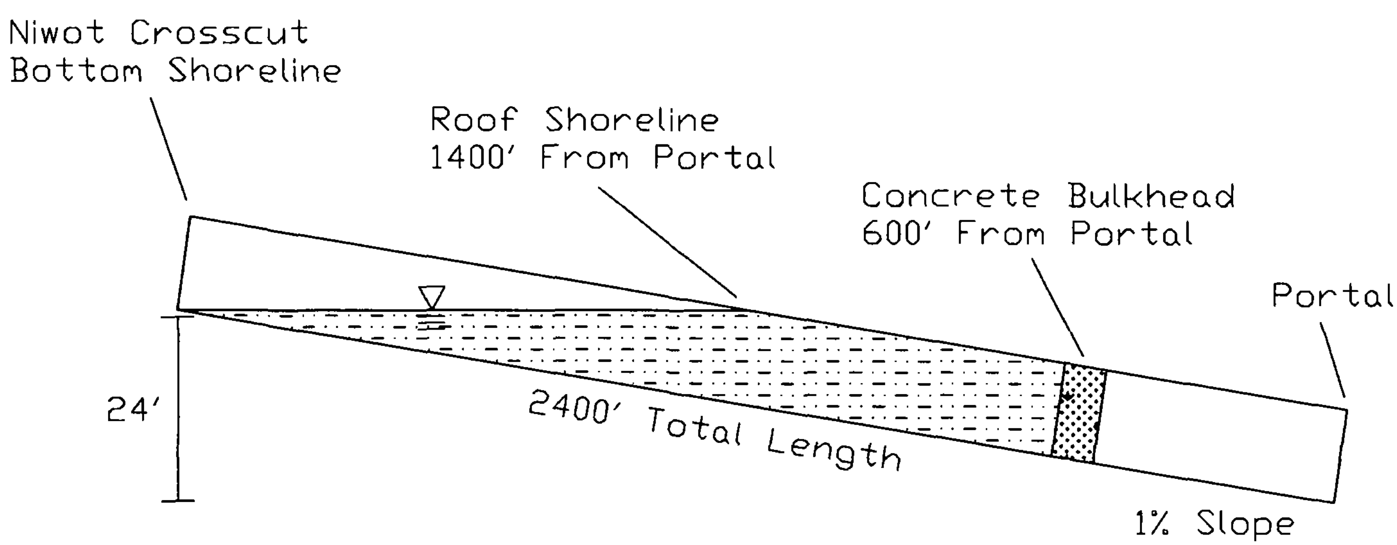
After the grout has set, the valves will be closed and the bulkhead will be placed into service. Water samples should be collected behind the bulkhead and also at "upstream" locations within the mine pool to observe changes in dissolved oxygen over time. Additionally, observations will be recorded regarding the nature and extent of any residual seepage, either around the bulkhead or through the surrounding rock formation. Additional sampling will be required during the period in which the bulkhead valves are kept closed, to monitor the water quality conditions and stratification behind the bulkhead and adjust mine-pool mitigation measures appropriately. Once mine-pool mitigation is successfully operating and the mine pool has chemically and physically stabilized, compliance with instream ARARs will be evaluated. Operation of the valve will be determined at that time.

Mine-Pool Mitigation

Approximately ½ mile west of the adit portal, and just west of the Peak-to-Peak Highway, an area is present that appears to be at the intersection of the Big Five and Niwot Cross Cut. Located approximately ½ mile upstream of the proposed bulkhead installation, this location also appears to be where the "headwaters" of the mine-pool reservoir could occur. This assertion is based on a theoretical calculation assuming that the adit dimensions (10 by 10 feet) will flood without seepage and continue back into the ground at a slope of approximately 1 percent. Based on a fully flooded tunnel length of 800 feet and a partially flooded tunnel length of an additional 1,000 feet (assuming that the bulkhead is installed at approximately 600 feet inby, the roof shoreline is located at approximately 1,400 feet inby, and the bottom shoreline is located at approximately 2,400 feet inby), it would take approximately 23 to 34 days to flood the mine tunnel at rates of 20 to 30 gpm (see Figure 19-3). Baseline conditions of pre-bulkhead groundwater and geology (ER-surveys, etc.) need to be completed prior to impoundment and filling of the mine-pool.

The mine-pool mitigation treatment options are anticipated to include a neutralization loop with an injection and extraction well drilled into the tunnel reservoir at the location discussed above. In addition, a secondary treatment access point where additional neutralization could be added if required (see Figure 19-4) will be installed "downstream" of this location, but at a point upstream of the bulkhead. It is assumed that the injection and extraction wells will be approximately 450 feet deep, and will introduce a caustic agent such as NaOH. Ongoing monitoring will be required to ascertain whether effective neutralization is taking place. In addition, the loop injection and extraction rate, along with the dosing rate, will require ongoing adjustment to adequately buffer the flooded workings and raise the pH. It is anticipated that a substantial amount of alkalinity will be consumed in reactions with the rocks inside the tunnel and sludge generation will require ongoing monitoring. A bench-scale treatability study/pilot study should be conducted based on the specific geochemical characteristics of the Big Five drainage prior to design of the mine-pool mitigation system. Sludge generation could be

10′ x 10′ in Dimension



Alternative 3B - Theoretical Big Five Adit Flooding Calculations

No.	Revisions	Date	By
#1			
#2			
#3			
#4			

Date: 01.23.09	Drawn By: JRR
Project #5681-060	Checked By:
Figure: 19-3	Sheet of

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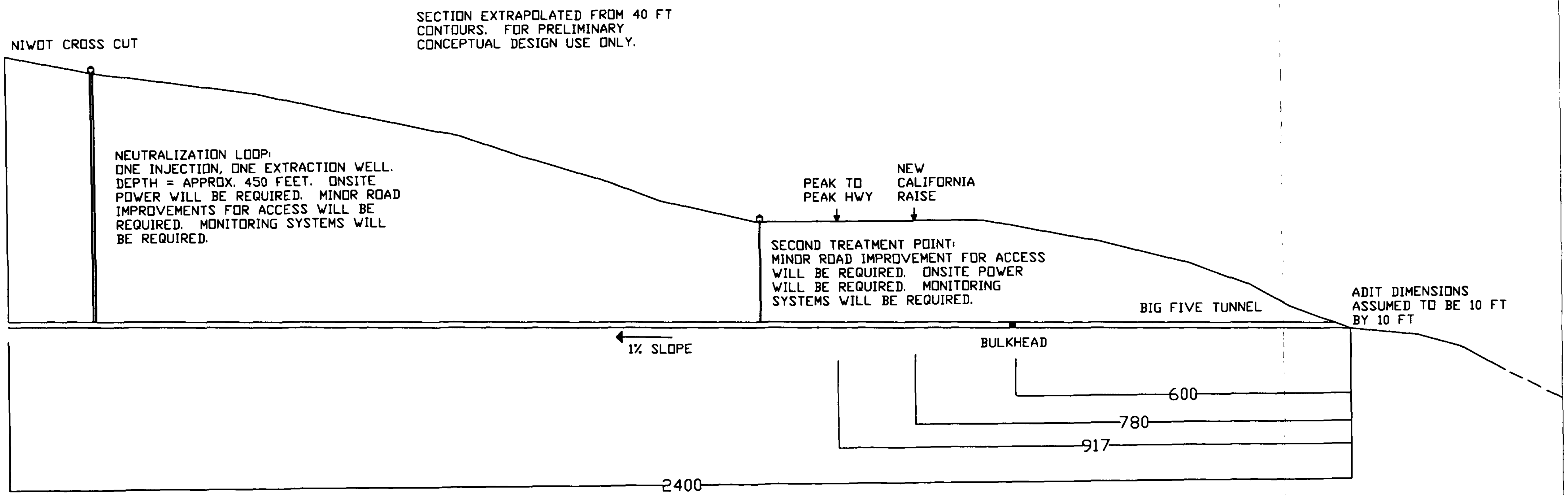

Alternative 3B - Conceptual Locations of Mine Pool Mitigation Structures

No.	Revisions	Date	By
#1			
#2			
#3			
#4			

Date: 01.23.08	Drawn By:
Project #5681-060	Checked By:
Figure: 19-4	Sheet of

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U:\Projects\5681-060 CaptainJack\MINE POOL MITIGATION CROSS SECTION.dwg evaluated in such a study with titration analyses of neutralization reactions coupled with an evaluation of the presence and quantity of non-oxidized rock present in the tunnel.

Another approach is to utilize the secondary treatment point farther downstream and just upstream of the bulkhead for caustic injection only (without extraction) if sludge buildup appears to be a problem within the tunnel. This would create a shorter contact time within the mine tunnel itself and potentially limit the metals that would precipitate out of solution prior to discharge through the valve of the bulkhead. If this approach was pursued, metal precipitates would begin to fall out after discharge from the adit, and if not routed through a settling pond, could result in a greater buildup of sludge within the biochemical reactor. A detailed bench-scale treatability/pilot study should be performed to further explore this option if required.

As a final option, the secondary treatment point could also be utilized for injection of an organic nutrient to "jump start" the bio-reaction prior to entry into the biochemical reactors. Again, a detailed bench-scale treatability/pilot study would be required to evaluate the suitability of this treatment as well as to evaluate the sludge generation potential for this type of injection.

The injection and extraction well locations will require clear access, on-site power, and a small storage facility for maintenance equipment and caustic. The secondary treatment point will also require a similar infrastructure. In addition, ongoing monitoring will be required to measure the dosing rate and control the pumping rate of all wells. The flooded tunnel may require additional considerations due to seeps, fractured rock, and elevated head pressure. A Site-specific monitoring plan, which includes monitoring the water levels at several locations within the mine pool and behind the bulkhead through a pressure transducer, should be completed that addresses these various scenarios.

Surface Water Compliance and Controls

Once water is treated within the mine pool, compliance with surface water criteria will be determined at the downstream POC at the Site. Ongoing monitoring will be required to assess whether the mine-pool mitigation treatment is successful as discussed in the long-term monitoring section of this alternative.

Surface water controls will also be required to redirect stormwater runoff from the upper waste rock pile near the Big Five portal. The diversion will involve excavation of a trench approximately 100 feet long. The trench will slope to the east along the top of the waste rock pile diverting water away from the pile. The trench will be excavated to approximately 3 feet wide at the bottom and lined with a 45-mil EPDM liner and riprap.

Institutional Controls

Institutional controls will include proprietary controls, including environmental covenants to maintain site access restrictions during construction and permanent access restrictions to the Big Five adit. This will include installation of a grated steel door at the portal to impede access to the tunnel.

Initial and Long-Term Monitoring

If water within the tunnel is not adequately treated by the bulkhead and mine-pool mitigation measures and the quality of the water escaping the underground workings and surfacing (through seeps or other) is not meeting in-stream standards at the compliance point, a successive biochemical reactor will be installed as Phase II of this alternative.

While the mine pool is being neutralized inside the Big Five tunnel, surface water monitoring will be conducted to assess the water quality of Left Hand Creek. If, after two years of mine-pool neutralization, the mine-pool treatment appears to have stabilized and the downstream RAOs are not being met for surface water, the second phase of this alternative will be implemented. If treatment has not yet stabilized, additional monitoring will be conducted to ascertain the effectiveness of the in-situ mine-pool neutralization prior to implementation of the second phase. If downstream RAOs are being met for surface water, the second phase of this alternative will not be implemented.

It is anticipated that water quality within Left Hand Creek will improve after installation of the bulkhead and mine-pool mitigation, and source minimization (through excavation, capping, and/or consolidation of waste material). If water quality subsequently worsened and exceeded water quality standards, Phase II would be implemented. Loading determinations from specific segments of the remedy into the stream will be monitored to evaluate remedy performance.

An automated monitoring system (monitoring discharge from the mine pool and water quality at the most downstream point at the Site) will be advantageous. This system could be designed to collect data as often as necessary; however, on-site power will be required. Various monitoring systems should be evaluated as part of the design phase for this alternative.

In addition to water quality monitoring to assess mine-pool mitigation success, the bulkhead should also be monitored for containment effectiveness through the use of digital satellite imagery. Specific monitoring technologies will be selected in the design phase. Remote sensing techniques have the ability to detect changes in vegetation indicative of increased water flow over time, and these types of data could be utilized to screen for potential seep locations. In addition, frequent Site visits (during the first few years) and surface water sampling will be performed to closely monitor the water quality in the surrounding area. The pressure transducer will be monitored regularly as part of the ongoing monitoring effort to assess the water level behind the bulkhead. Additional groundwater wells may be needed (during the design and/or remedial action phases) in the vicinity of the confluence of the Big Five adit drainage and Left Hand Creek to determine the fate of the Big Five surface water/groundwater interaction and its impact to Left Hand Creek.

EPA-recommended monitoring systems may include the following:

Mine-Pool Remedial Design Investigations

The conceptual plan for the mine pool is to create an AMD reservoir in the subsurface extending from the bulkhead up the valley approximately 1 to 2 miles west to the intersection of the Niwot Cross Cut and Big Five adit. This location, plus another monitoring site midway between this junction and the bulkhead location, are the planned areas for placing wells into these tunnels in order to:

- Ascertain the flow conditions and chemistry of the respective "upstream" waters;
- Develop a looped-pipeline mixing system for AMD mitigation; and
- Monitor mine-pool hydraulic and geochemical conditions.

While these areas are accessible for tracked drilling rigs, the tunnel segments lie 400 to 500 feet underground. Because the historical maps of mine/tunnel workings have no survey data, locating the tunnel "target zones" either involves drilling holes on 5 to 10-foot-spacings across multiple transects, or utilizing geophysical methods to detect/locate the tunnel voids prior to drilling. Surface applications of geophysics (ER and time-domain electromagnetics [TEM]) are methods recommended by the Idaho National Laboratory (INL) to obtain subsurface "imaging" of the tunnel locations. The benefit of ER and TEM methods is that they minimize the number of drill locations and per-foot drilling expense, as well as resulting surface disturbance requiring reclamation.

Monitoring Systems Remedial Design

The remedial plan for control and treatment of the Big Five system involves two stages: Stage 1 – AMD mitigation within the mine-pool reservoir, and Stage 2 – installation of a bioreactor for final treatment of partially treated mine-pool waters.

Stage 1 – Mine Pool. A comprehensive monitoring system is advisable for the bulkhead and mine-pool alternatives because:

- There is limited information regarding the extent of mine workings and bedrock fractures through the reservoir zone of the Big Five tunnel.
- The remedy involves hydraulic control and "containment" of the mine pool and/or AMD treatment zone.
- In-situ treatment of mine-pool systems is innovative with limited prior project applications.
- Observing both geochemistry and spatial movement of the AMD and treatment zones are warranted.

Monitoring systems would therefore be designed for:

- Direct measurements of AMD reservoir. Install monitoring instruments into the mine-tunnel bore holes and behind the bulkhead to place pressure transducers and geochemical sensors, with electronic data collection/storage and data uploads to minimize on-Site sampling, data collection, and laboratory analytical costs.
- Subsurface spatial observation. Utilize geophysical monitoring (e.g., ER) to assess the stability and/or changes to mine-pool chemistry, and locations and movements of groundwater transport. Locating and utilizing wells to monitor such dynamics in fractured igneous bedrock geology is very costly with highly uncertain results.

Geophysical methods, while also costly, provide much higher certainty and insight into groundwater system dynamics.

Stage 2 – Bioreactor. Because biological treatment systems rarely maintain relatively "static" operating conditions (typical with chemical-mechanical treatment plants), monitoring systems to detect sensitive biogeochemical trends are needed to make operational adjustments and prevent biological "shutdowns" of treatment metabolics.

Remedial Action-Monitoring Systems

Mine-Pool Tunnel Reservoir. Direct measurements are needed of the tunnel waters using pressure transducers, thermometers, and geochemical sensors in wells and behind the bulkhead.

Mine-Pool Bedrock Groundwater Reservoir. Five 2,000-foot geophysical arrays (permanent belowground electrode pins) are recommended for high-resolution ER tomography to image subsurface conditions and spatial hydraulics beneath a 50-acre area overlying and adjacent to the mine-pool area. The electrical components include control-system hardware and multiplexors for near-real-time data-collection software and storage, system calibration, and remote data-download/transmission. It is anticipated that INL, in collaboration with Colorado School of Mines, will be involved with design-installation of the ER geophysical systems.

Bioreactor Cells. pH sensors, thermocouples, metal-ion sensors, auto-control valves and pumps, software/data-storage/communication links will be installed at or near the Big Five adit portal.

Phase II: Successive Biochemical Reactor Treatment

Phase II will be implemented in the event that adequate treatment does not occur within the tunnel after bulkhead installation and mine-pool mitigation in a manner that is protective of human health and the environment.

Location and Design of Successive Biochemical Reactor

When water exits the bulkhead valve, the drainage would be diverted into an HDPE pipe that would then be routed underground out of the Big Five adit and into a biochemical reactor. The biochemical reactor may be located on top of the Big Five pile or below the pile in the area that is now the on-site pond. The size of the bioreactor will depend on the substrate chosen (i.e., solid or liquid substrate). If additional neutralization is required prior to entry into a biochemical reactor, neutralization chemicals (such as NaOH) could be placed in a gravity drip system inside the adit in such a manner that caustic could be added directly into an HDPE pipe exiting the flow-through valve of the bulkhead. In addition, or in place of this approach, the pipe could divert water into neutralization ponds prior to entry into the biochemical reactors to further increase the pH of the discharge. Specific design elements (i.e., size and location) would be determined during design and based upon the post-treatment mine pool chemistry and the volume requiring treatment. These items will not be known until the bulkhead is installed and the mine-pool monitoring program data have been completely evaluated. Complete evaluation is estimated to require one to two years following bulkhead installation.

EPA experts recommend raising the pH of the water entering the biochemical reactors to approximately 6. A large portion of the alkalinity needed to precipitate metals can be generated within the bioreactor (based on the substrate material) and the treated water will require a pH range compliant with surface water quality standards.

A solid substrate biochemical reactor would contain organic matter that would degrade over time to produce a substrate that would facilitate the growth of bacteria and other microorganisms. A liquid substrate biochemical reactor would require constant addition of an organic material (i.e., alcohol) to facilitate the reaction. The bacteria and microorganisms would react with sulfate in the AMD to produce sulfide ions, which in turn would precipitate as metal ions in the AMD. The bacteria would produce bicarbonate in addition to the sulfide ions that would raise the pH of the effluent.

One challenge that will arise in the design phase of this alternative will be to select the type of substrate (solid or liquid) and determine how best to adapt the design to site conditions. For example, a solid substrate reactor will require significant space and may require a design in parallel to facilitate maintenance. While sufficient room is presumed available on the Site (the on-site pond and downstream gradual slopes would likely provide sufficient space), the configuration of a solid substrate bioreactor may still require adaptation to ensure access for maintenance and repairs and adequate residence time. Conversely, a liquid substrate bioreactor would require additional power and operational requirements because the system is designed to be only semi-passive and the constant addition of an organic substrate would be required.

Many of the general design considerations for successive biochemical reactors at the CJM Site would require detailed bench and/or pilot-scale studies. These studies would be used to determine the appropriate organic substrate and sizing requirements, as well as any additional dosing rates for caustic. In addition, metal loadings and retention time must be considered with respect to long-term substrate permeability. This could be determined during the design phase.

The necessary bacteria and microorganisms do not grow at pH levels below 5.5; therefore, neutralization of the AMD in the mine-pool mitigation system would be designed to raise the pH to a minimum of 6. To avoid vandalism, freezing, and human safety issues, depending on the type of biochemical reactor selected, the biochemical reactors could be built below grade and covered with a layer of large boulders (for a solid substrate biochemical reactor), or housed in a "greenhouse-type" building to minimize climate fluctuations and better control unpleasant odors (e.g., hydrogen sulfide gas). Fans could be installed within the building and air circulation could be managed as part of the O&M plan.

Hydrogen sulfide gas will accumulate within any confined spaces immediately above or connected to the biochemical reactors. While it typically dissipates rapidly in open space, nuisance odors can become a problem well before levels pose actual health risks. Based on the properties of hydrogen sulfide gas, odors typically might be noticed up to 1,000 feet from the biochemical reactors and on-site residents may be affected. A detailed hydrogen sulfide monitoring and control plan should be developed as part of the design phase for this alternative. Additionally, if the decision is made to adjust treatment in the mine-pool mitigation system and to add an organic compound via the secondary treatment access point, hydrogen sulfide gas may accumulate within the mine tunnel itself. If this option is pursued during treatability studies and further research in the design phase, ventilation shafts with fans and other controls may be required at boreholes or collapsed shafts.

After the water passes through the biochemical reactors, a drainage system would collect the effluent for discharge by gravity flow to an appropriate location downgradient of the treatment system, upgradient of the existing natural wetlands, and ultimately to Left Hand Creek. The natural wetlands currently on site would provide a "polishing" stage to this treatment alternative and assist in improving water quality.

Sludge

Sludge production will occur within the mine pool and from the biochemical reactors. Ongoing sludge maintenance will be required at the Site, although sludge management will be much less intensive, as neutralization will occur within the tunnel. Two sulfide sludge cells are anticipated for installation after the biochemical reactors and should be installed in parallel to allow for maintenance. As with the biochemical reactors, odor control may be required for the sludge cells and/or frequent off-site disposal.

The amount of caustic soda (solid) consumed and sludge volume generated were estimated based on the calculated total mass load from the Big Five adit. Total mass load was defined as total non-carbon dioxide (CO_2) acidity (as calcium carbonate [$CaCO_3$]) times flow volume (i.e., $\sum$ [non-CO_2 acidity] x $\sum$ [Q] = total mass load). Acidity was selected as a surrogate to acid/metal/sulfate mass loading due to its direct correlation to water treatment reagent consumption. Average flow measurements and flow-weighted non-CO_2 acidity and TDS were calculated based on measured flow rates, field pH and specific conductance measurements, and metal analyses of water samples collected in September and November 2004 and February 2005 (see Table 19-1).

Table 19-1. Big Five Adit Water Quality and Flow Data[1] Used to Estimate Caustic Soda (Solid) Consumption and Water Treatment Sludge Volume

Parameter	Unit	Sampling Date (Sample Location : BFV-WS-04)		
		September 2004	November 2004	February 2005
Aluminum (D)	mg/L	3.34	1.96	1.4
Iron (D)	mg/L	5.71	9.55	8.78
Manganese (D)	mg/L	4.05	3.44	3.23
Specific Conductance	uS/cm	832	635	605
Calculated TDS[2]	mg/L	541	413	393
pH	Std. Unit	3.4	5.87	7.7
Flow Rate	gpm	37.7	18.8	53.4
Calculated non-CO_2 Acidity(as $CaCO_3$)[3]	mg/L	59	43	37

(D) =dissolved
Cm=centimeter
[1] See RI Report (Walsh 2008a) for complete water quality analyses.
[2] TDS calculations [*Ref: Hem (1992)*]: $TDS_{calculated}$ = Specific Conductance (uS/cm) X 0.65
[3] Acidity calculation [*Ref: Hedin et al. (1994), and Watzlaf et al. (2004)*]:

$$acidity_{calculated} = 50\{1000(10^{-pH}) + [2(Fe^{II}) + 3(Fe^{III})]/56 + 2(Mn)/55 + 3(Al)/27\}$$

Table 19-2. Big Five Adit Water Treatment – Caustic Soda (Solid) Consumption and Sludge Production

	Mine Water						Neutralization Reagent[3]	Treated Mine Water Solids[4]			Estimated Total Sludge Volume[5]
Year Following Installation of Bulkhead	Estimated Average Flow Rate (gpm)[1]	Flow-Weighted Non-CO_2 Acidity (as $CaCO_3$) (mg/L)[1]	Flow-Weighted TDS (mg/L)[1]	Flow Volume (gallons/yr)	Acidity as $CaCO_3$ (dry tons)	Mine Water Solids (dry tons)	Caustic Soda (dry tons)	Solids (mg/L)	Solids (% by wt.)	Solids (dry tons)	@ 2% Solids (cubic feet)
1	37	50	492	19,250,136	4.0	39.5	3.23	532	0.05%	42.7	1,328
> 1[2]	37	17	164	19,250,136	1.3	13.2	1.08	177	0.02%	14.2	443

[1] *Based on estimated flow rates, acidity, and TDS of mine water samples collected in September and November 2004 and February 2005 (See* Table 3-1). *To address additional oxidation of sulfidic rock, the calculated acidity and TDS were multiplied by a factor of 1.1.*

[2] *Due to the reduction of sulfide oxidation rates resulting from mine flooding it was assumed that 1 year following installation of the bulkhead the calculated acidity and TDS would be reduced by 66.7%.*

[3] *Based on flow-weighted non-CO_2 acidity as $CaCO_3$ multiplied by a conversion factor and divided by neutralization efficiency (See table immediately below).*

For example, if 100 tons of acid as $CaCO_3$ was the amount of acid to be neutralized, then it can be estimated that 80 tons of caustic soda (solid) would be needed to neutralize the acidity in the mine water (100(0.80)/1.0).

[4] *Sum of reagent added to neutralize mine water and initial (pre-treatment) mine water solids content.*

[5] *Assumed sludge density (lbs/ft^3) (may not be achievable based on treated initial solids content of mine water): at 2% solids density is 64.36 lbs/cf*

The estimated amount of caustic soda (solid) consumed, initial solids content of the treated mine water, and the volume of sludge generated as a result of treatment of Big Five adit water is provided in Table 19-2. The solids content of the treated mine water during and following the first year, following installation of the bulkhead, was estimated to be 0.05 and 0.02 percent (by weight), respectively. The anticipated volume of sludge that will accumulate after the first year of treatment is estimated to be approximately 49 cy. The anticipated volume of sludge that will accumulate each year thereafter is estimated to be approximately 16 cy. These are very small sludge quantities given the total volume of the tunnel/mine-workings, and therefore should present no long-term issues due to available sludge storage capacities within the mine-pool reservoir.

The estimated sludge densities may not be attainable due to the following factors:

1. The initial solids content of the treated mine water is quite low.
2. Neutralization of acidic water with caustic soda produces a gelatinous loose floc, although experience with impoundments containing sludges at other sites shows these precipitates will readily settle and densify during compaction.
3. A minor amount of sludge consolidation is anticipated behind the Big Five adit bulkhead as a result of the subaqueous conditions encountered in the flooded mine (if neutralization is performed in situ).

Sludges generated by sulfate-reducing processes within bioreactor cells are much denser sulfide forms and have far less volume than oxy-hydroxide sludges; sludges produced in the bioreactors will likely be disposed of as solid waste; however, this should be confirmed by a treatability study. CDPHE requires that any waste produced from the biochemical reactors system pass a Toxicity Characteristic Leaching Procedure (TCLP) analysis, a Paint Filter Liquids Test (Method 9095), a Percent Solids test (greater than 40 percent), and a pH test ($2.0 < pH < 12.5$) prior to disposal in a landfill. In addition, sludge must meet the waste acceptance criteria for the receiving landfill.

O&M

This system is a semi-passive system. Ongoing monitoring and maintenance will be required for the mine-pool mitigation system as well as to address sludge management at the biochemical reactors. In addition, if a liquid substrate biochemical reactor is selected, the operational requirements for this type of system will be more involved because organic substrate will require constant addition. However, if a solid substrate biochemical reactor is selected, the repair and maintenance requirements may also be complicated due to substrate plugging and sludge accumulation. Sludge will accumulate with either type of biochemical reactor, and ongoing maintenance for sludge disposal to maintain water flow through the delivery piping will be required. Regular off-site sludge disposal will likely be required and access must be maintained to both sludge cells.

Long-Term Monitoring

As discussed in Phase I, because this treatment system will discharge to Left Hand Creek, treatment will need to be designed so that surface water criteria is attained at the POC. A carefully observed monitoring/sampling and analysis program will be necessary under this alternative and, at a minimum, will include the following effluent sampling requirements. At system startup and as needed following normal operations of the system, influent and effluent will be collected for analysis of antimony, arsenic, cadmium, copper, lead, manganese, thallium, zinc, biological oxygen demand (BOD), chemical oxygen demand (COD), TDS, and TSS. In addition, pH, temperature, specific conductance, and turbidity will be measured as needed with field equipment.

In addition, as discussed in Phase I of this alternative, an automated monitoring system will be advantageous. Various monitoring systems should be evaluated as part of the design phase of this alternative.

19.3 Cost Estimate for the Selected Remedy

Appendix B includes details of the estimated costs to implement and construct the Selected Remedy. The estimated total cost to implement and construct the Selected Remedy presented in this ROD (including both phases of the subsurface sources alternative) is $11.74 million. The information in this cost estimate for the Selected Remedy is based on the best available information regarding the anticipated scope of the remedial alternative.

Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a technical memorandum in the Administrative Record file or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

19.4 Expected Outcomes of the Selected Remedy

The expected outcomes of the selected remedy, in terms of resulting land and surface water uses, cleanup levels and risk reduction achieved as a result of the response action, and anticipated impacts are summarized below.

19.4.1 Available Land Uses

The surface of the Site will no longer present long-term risk to recreational users. Environmental covenants will remain in place to prevent development of the long-term remedy components at Site and restrict subsurface exploration and/or digging. In addition, environmental covenants will be implemented to restrict groundwater use on the Site in order to provide remedy protection for the consolidation cell and the capped areas, and also the areas associated with the bulkhead, mine-tunnels and mine-pool reservoir mitigation and monitoring components.

19.4.2 Available Surface Water Uses

The selected remedy is anticipated to restore surface water quality to surface water standards and aquatic life standards at the downstream POC within the first few years after implementation. Based on the source control employed for the surface contamination sources alternatives, the surface water quality within the CJM Site is also anticipated to improve over the next five to 10 years following remedy implementation. It is not anticipated that surface water will be used as a primary drinking water source on the CJM Site in the future.

19.4.3 Final Cleanup Levels

Table 19-3 shows the final cleanup level for the COCs. In addition, the subsurface contamination sources selected alternative will be designed to meet surface water quality and aquatic life standards at the POC downstream of the Site. The Selected Remedy will address both surface and subsurface contamination sources through consolidation, containment, and treatment. The final cleanup levels will be protective of human health and are expected to restore the surface water and soil. The Site is expected to be available for continued recreational land use as a result of the remedy.

Table 19-3. Summary of Cleanup Criteria for COCs

Exposure Area	Remedial Action Level (mg/kg)
Definition of Contaminated Material	
Arsenic	85
Thallium	5.2
Lead (by Exposure Area)	
Big Five	830
Big Five to CJM	860
CJM	380
White Raven	400
White Raven to Sawmill	750

20 Statutory Determinations

Under CERCLA §121 and the NCP §300.430(f)(5)(ii), the lead agencies must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

20.1 Protection of Human Health and the Environment

The Selected Remedy will be protective of human health and the environment. Consolidation and treatment of Principal Threat Waste will address contaminant migration and reduce cancer and non-cancer risks to below safe levels. Treatment, stabilization, and capping of material with concentrations elevated above the cleanup levels but below the threshold for classification as Principal Threat Waste will further reduce the risk of on-site exposure for potential receptors and migration off site.

Surface water ARARs will be met at the downstream POC for the Site through the in-situ neutralization planned behind the bulkhead within the Big Five adit, the second-phase on-site bioreactor treatment (if needed), and/or the source control of contaminated waste rock, tailings, and surface soils.

Implementation of the Selected Remedy will not pose unacceptable short-term risks or cross-media impacts. The remedy can be readily implemented with available technology.

20.2 Compliance with ARARs

The NCP §300.430(f)(5)(ii)(B) and (C) require that a ROD describe the Federal and State ARARs that the Selected Remedy will attain or provide justification for any waivers. ARARs include substantive provisions of any promulgated Federal or more stringent State environmental standards, requirements, criteria, or limitations that are determined to be legally ARARs for a CERCLA site or action. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Relevant and appropriate requirements are requirements that, while not legally "applicable" to circumstances at a particular CERCLA site, address problems or situations sufficiently similar to those encountered at the site that their use is relevant and appropriate. The ARARs are presented below and in more detail in Tables 20-1 through 20-3.

The specific ARARs used for the Selected Remedy include the state regulations found in the Code of Colorado Regulations (including those codes pursuant to the Colorado Revised Statutes), as well as federal regulations found in the Code of Federal Regulations and the U.S. Code.

Aquatic life and surface water quality ARARs will be achieved at the downstream POC. The monitoring points throughout Left Hand Creek will be used to assess remedy effectiveness and loading parameters. Because on-site surface water will not be used for beneficial uses (i.e., drinking water), it is appropriate to use this downstream point to assess compliance with ARARs.

Groundwater compliance with ARARs will be determined through monitoring at the downstream extent of contamination. This POC was determined based on State of Colorado Regulation 41.6.C1a, Section ii, which establishes the downstream extent of contamination as the POC. The RI identified two areas of contamination within the CJM Site, one around the Big Five area and the other around the Black Jack/White Raven areas. Monitoring points below these areas, BFC-WG-100704 and WRS-WG-12-101204, respectively, attain the groundwater quality standards. The BFC-WG-100704 site is a shallow, hand-dug residential well on the north side of Left Hand Creek. This well is directly connected to the creek and is not using groundwater that is hydraulically downgradient of the contaminant source of the Big Five tunnel. This drinking water supply will be monitored for compliance with drinking water standards. The POC, in accordance with Regulation 41.6 shall be established at well WRS-WG-12-101204.

Table 20-1. ACTION SPECIFIC ARARS FOR CJM SITE

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comments
FEDERAL				
Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 (Resource Conservation and Recovery Act [RCRA] Subtitle D)	40 CFR Part 257, Subpart A: § 257.3-1 Floodplains, paragraph (a); § 257.3-7 Air, paragraph (b)	Regulates the generation, storage, handling and disposal of solid waste.	On-Site: Applicable or Relevant and Appropriate Offsite: Applicable	Relevant and appropriate to in-place capping. Applicable to on-site consolidation or off-site disposal.
RCRA Subtitle C	40 CFR Part 261.4(b)(7) and RCRA Section 3001(b) (Beville Amendment)	Regulates the generation, treatment, storage and disposal of hazardous wastes.	Applicable	Applicable for disposal of listed wastes.
Standards Applicable to Generation of Hazardous Waste	40 CFR Part 262, pursuant to 42 USC § 6922	Establishes standards for the generation of hazardous waste.	See RCRA Subtitle C	
Standards Applicable to Transporters of Hazardous Waste	40 CFR Part 263, pursuant to 42 USC § 6823	Regulates the transportation of hazardous waste.	See RCRA Subtitle C	
Hazardous Materials Transportation Act, D.O.T. Hazardous Materials Transportation Regulations	49 USC §§ 1801-1813 49 CFR Parts 107, 171-177	Regulates the transportation of hazardous materials.	See RCRA Subtitle C	
Dredge and Fill Requirements	40 CFR 230-233, 320-330, Section 404, pursuant to 33 USC § 1251-1376	Prohibits discharge of dredged of fill material into wetlands or navigable waters of the U.S. without permit.	Applicable	
Underground Storage Tanks	40 CFR Part 280	Establishes regulations for the monitoring, design, and construction of underground storage tanks.	No	None present at site
Underground Injection Control Regulations	40 CFR §§ 144.12, 144.24, and 144.25, pursuant to 42 USC § 123(e)(1)	Establishes requirements for injection of waste water into wells and aquifers.	Applicable	Would apply if injecting to a mine shaft or mine workings.

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comments
National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122, 125, pursuant to 33 USC § 1342	Regulates the discharge of pollutants to waters of the U.S.	Applicable	Would apply to point source discharges
STATE				
Colorado Solid Waste Disposal Sites and Facilities Act	6 Code of Colorado Regulations (CCR) 1007-2, pursuant to CRS § 30-20-101, et.seq.	Establishes standards for the licensing, locating, constructing, and operating solid waste facilities.	On-Site: Applicable or Relevant and Appropriate Offsite: Applicable	Relevant and appropriate to in-place capping. Applicable to on-site consolidation or off-site disposal.
Colorado Hazardous Waste Act	25-15-301 to 327 C.R.S. and 6 CCR 1007-3	Regulates generation, storage and disposal of hazardous waste, and the siting, construction, operation, and maintenance of hazardous waste disposal facilities.	Applicable or relevant and appropriate	Relevant and appropriate if wastes generated during remedial action fail TCLP. Applicable for off-site disposal of hazardous wastes generated.
Colorado Mined Land Reclamation Act	CRS 34-32-101 to 125 Rule 3 of Mineral Rules and Regulations	Regulates all aspects of mining, including reclamation plans and socioeconomic impacts.	Applicable	
Colorado Discharge Permit System	5 CCR 1002-61	Implementation of the Colorado Water Quality Control Act, and applies to operations discharging to waters of the state from a point source.	Applicable	Would apply to point source discharges
Colorado Water Quality Control Act Storm Water Discharge Regulations	5 CCR 1002-61	Regulates discharge of storm water during construction activities.	Applicable	
Protection of Fishing Streams	CRS 33-5-101 - 107	Establishes notification requirements for modifications to streams.	Applicable	
Reservoirs and Rules and Regulations for Dam Safety and Dam Construction	CRS 37-87-101 - 125, 37-80-(11k), and 24-4-103	Establishes rules and regulations for the design, construction, and operation of dams and reservoirs.	No	Independently applicable
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-3; Section III.D.1.b.c.d; Sections II.D. 2.b.c.e.f.g.; Reg. 1	Regulates fugitive emissions during construction.	No	Contemplated actions would not trigger permit requirements, however dust control will be required.
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-5, Regulation 3 APENs	Establishes requirements for obtaining permits.	No	Contemplated actions would not trigger permit requirements

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comments
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-4, Regulation 2 Odors, Part A	Regulates generation of odors.	Applicable	Applicable to passive treatment system. No other remedial actions generate odors.
Colorado Noise Abatement Statute	CRS §§ 25-12-101, eq.seq.	Establishes standards for controlling noise.	Applicable	In areas zoned residential, commercial or industrial
Colorado Environmental Real Covenants Act	CRS § 25-15-317 to 327	Requires environmental covenant whenever environmental remediation project results in less than unrestricted land use or uses an engineered structure or feature that requires monitoring, maintenance or operation to function or that will not function as intended if disturbed.	Applicable	

Table 20-2. CHEMICAL SPECIFIC ARARS FOR CJM SITE

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comments
FEDERAL				
Clean Water Act Federal Water Quality Criteria	40 CFR Part 131 Quality Criteria for Water, 1986, pursuant to 33 USC § 1314	Sets standards for surface water to protect aquatic life and human health.	Applicable	
National Primary Drinking Water Regulations (MCLs)	40 CFR Part 141, Subpart B pursuant to 42 USC §§ 300g-1 and 300j-9	Regulates drinking water quality.	Applicable	New Arsenic Standard is TBC until 2006 effective date, after which it will be Relevant and Appropriate.
National Primary Drinking Water Regulation Goals (MCLGs)	40 CFR Part 141, Subpart F, pursuant to 42 USC 300g-1	Sets goals for contaminant levels	No.	To be considered.
National Secondary Drinking Water Regulations (SMCLs)	40 CFR Part 143, pursuant to 42 USC §§ 300g-1(c) and 300j-9	Sets standards for drinking water based on health and aesthetics.	Applicable	
Federal Total Maximum Daily Loads (TMDLs)	Clean Water Act 33 USC 1313; 40 CFR Part 130.7	Requires states to identify impaired waters and to establish total maximum daily loads to ensure that water quality standards can be attained; possible TBC.	No	Potential TBC. The WQCD has not completed a TMDL for Left Hand Creek and James Creek, Segments 4a and 4b.
Clean Air Act, National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50, pursuant to 42 USC § 7409	Sets standards for air emissions.	Applicable	If anticipated remedial actions include source categories covered by the regulations.
National Emission Standards for Hazardous Air Pollutants	40 CFR Part 61, Subparts N, O, P, pursuant to 42 USC § 7412	Regulates emission of hazardous chemicals to the atmosphere.	Applicable	If regulated constituents present at site.
Toxic Substances Control Act, PCB Spill Cleanup Policy	52 FR 10688 April 2, 1987	Regulates hazardous materials from manufacture to disposal.	Applicable	If regulated constituents present at site
Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites	EPA Directive #9355.4-12, July 1994	Suggests levels for lead in soils.	No	TBC

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comments
EPA Sediment Toxicity Guidelines	EPA 905/R-00/007, June 2000	Prediction of sediment toxicity using consensus-based freshwater sediment quality guidelines.	No	TBC
RCRA Subtitle C Groundwater Protection Standards	40 CFR 264.92-264.101	Sets standards for groundwater at RCRA facilities.	Relevant and Appropriate	The remedial action is not expected to address RCRA wastes.
STATE				
Colorado Primary Drinking Water Standards	5 CCR 1003-1	Establishes health-based standards for public water systems.	Relevant and Appropriate	St. Vrain Creek classified for water supply use.
Basic Standards and Methodologies for Surface Water: WQCD Reg. No. 31	5 CCR 1002-31	Provides basic standards, antidegradation rule, implementation process, and system for classifying surface water, assigning water quality standards and review of classifications and standards, as determined by the Colorado WQCC.	Applicable	
Colorado Classification and Numeric Standards for Segments 4a. and 4b. of St. Vrain Creek, South Platte River Basin: WQCD Reg. No. 38	5 CCR 1002-38	Classification and numeric standards for the South Platte River Basin, including tributaries and standing bodies of water. Classification identifies actual beneficial uses of water and allowable concentrations of various parameters.	Applicable	
Basic Standards for Groundwater: WQCD Reg. No. 41	5 CCR 1002-41	Sets standards for contaminants in groundwater.	Applicable	
Colorado Air Pollution Prevention and Control Act, CRS § 25-7-101 et. seq.	5 CCR 1001-10 Part C(I) and (II), Regulation 8	Sets standards for air emissions.	Yes	If anticipated remedial actions include source categories covered by the regulations.
Colorado Emission Standards for Hazardous Air Pollutants	CRS § 25-7-108, 5 CCR 1001-10, Reg. 8	Regulates emission of hazardous chemicals to the atmosphere.	Yes	If regulated constituents present at site.

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable <u>or</u> Relevant and Appropriate	Comments
Proposed Soil Remediation Objectives Policy Document	CDPHE Hazardous Materials and Waste Management Division (HMWMD), December 31, 1997	Proposes guidance in establishing soils cleanup standards.	No	TBC
Provisional Implementation Guidance for Determining Sediment Deposition Impacts to Aquatic Life in Streams and Rivers	Colorado Water Quality Control Commission Policy 98-1, June 1998, revised May 2002	Guidance for assessing impacts to aquatic life and habitat conditions caused by human induced erosion and deposition of materials in aquatic systems.	No	TBC

Table 20-3. LOCATION SPECIFIC ARARS FOR CJM SITE

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comments
FEDERAL				
National Historic Preservation Act	16 USC § 470 et seq. A portion of 40 CFR § 6.301 (b), 30 CFR Part 63, Part 65, Part 800	Regulates impacts to historic places and structures.	Applicable	
The Historic and Archaeological Data Preservation Act of 1974	16 USC 469 40 CFR § 6.301(c)	Protects sites with archeological significance.	Applicable	
Historic Sites Act of 1935, Executive Order 11593	16 USC §§ 461 et.seq. 40 CFR § 6.301(a)	Regulates designation and protection of historic places.	Applicable	
The Archaeological Resources Protection Act of 1979	16 USC §§ 470aa-47011	Regulates removal of archeological resources from public or tribal lands.	Applicable	
Executive Order No. 11990 Protection of Wetlands	40 CFR § 6.302(a) and Appendix A	Minimizes impacts to wetlands.	Applicable	
Executive Order No. 11988 Floodplain Management	40 CFR § 6.302 and Appendix A	Regulates construction in floodplains.	Applicable	
Wild and Scenic Rivers Act	16 USC §§ 1271-1287 40 CFR § 6.302(e) 36 CFR Part 297	Establishes requirements to protect wild, scenic, or recreational rivers.	No	No regulated rivers impacted
Wilderness Act	16 USC 1311, 16 USC 668 50 CFR 53, 50 CFR 27	Limits activities within areas designated as wilderness or National Wildlife Refuge.	No	Area not a designated wilderness
Fish and Wildlife Coordination Act	16 USC § 661 et seq. 40 CFR § 6.302(g)	Requires coordination with Federal and State agencies to provide protection of fish and wildlife.	Applicable	
Endangered Species Act	16 USC §§ 1531-1543 50 CFR Parts 17, 402 40 CFR § 6.302(b)	Regulates the protection of threatened or endangered species.	Applicable	Only if threatened and endangered species or their habitats are identified
Section 404, Clean Water Act	33 USC 1251 et.seq. 33 CFR Part 330	Regulates discharge of dredge or fill materials into waters of the United States	Applicable	

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comments
Migratory Bird Treaty Act	16 USC § 703-12	The act contains a requirement for agencies to examine proposed actions by the government relative to habitat impacts and impacts to individual organisms.	Applicable	
Executive Order No. 12962 Recreational Fisheries	16 USC § 742a-d and e-j; 16 USC § 661-666c; 42 USC § 4321; and 16USC § 1801-1882	The order contains a requirement that Federal agencies, to the extent permitted by law and where practicable and in cooperation with State and Tribes, improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities.	Applicable	
STATE				
Historic Places Register	CRS §§ 24-80.1-101 to 108	The State historic preservation officer reviews potential impacts to historic places and structures.	Applicable	
Colorado Natural Areas	Colorado Revised Statutes, Title 33 Article 33, Section 104	Maintains a list of plant species of "special concern." Recommends coordination among Division of Parks and Outdoor Recreation.	Applicable	Only if appropriate plant species are present
Colorado Species of Special Concern and Species of Undetermined Status	Colorado Division of Wildlife Administrative Directive E-1, 1985, modified	Protects species listed on the Colorado Division of Wildlife generated list.	Applicable	Only if listed wildlife species are present
Wildlife Commission Regulations	2 CCR 405-0	Establishes specific requirements for protection of wildlife.	Applicable	
Non-game, Endangered, or Threatened Species Act	CRS §§ 33-2-101 to 108	Standards for regulation of non-game wildlife and threatened and endangered species.	Applicable	Only if appropriate species are present
Colorado Historical Prehistoric and Archaeological Resources Act	CRS 24-80-401 to 410, 1301 to 1305.	Regulates prehistoric and archaeological resources on State lands	Relevant and Appropriate	If actions affect State lands.

20.3 Cost Effectiveness

The Selected Remedy is cost-effective because its costs are proportional to its overall effectiveness (see 40 CFR §300.430(f)(l)(ii)(D)). This determination was made by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (i.e., that are protective of human health and the environment and comply with all Federal and any more stringent State ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). The overall effectiveness of each alternative was then compared to the alternative's costs to determine cost effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence represents a reasonable value for the invested money.

The subsurface remedial action component-estimated present worth cost is slightly higher when compared to other semi-passive treatment alternatives; however, the ability to phase the alternative could provide a potential for cost savings (if the second phase is not constructed) and allows for flexibility in treatment adjustment within the mine tunnel itself, rather than generating large quantities of additional waste material (i.e., sludge), which would require off-site disposal. The design and operations and maintenance costs are significant for the subsurface alternative because extensive monitoring will be required for the in-situ treatment approach. However, the relationship between this cost and the effectiveness and degree of protectiveness offered by the remedy was determined to be proportional.

20.4 Utilization of Permanent Solutions to the Maximum Extent Practicable

EPA and CDPHE have determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the CJM Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, both agencies concur that the Selected Remedy provides the best balance of tradeoffs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element, bias against off-site treatment and disposal, and considering community acceptance.

The Selected Remedy treats, consolidates, and caps the principal threat wastes and treats and caps the remaining surface waste material on site. Treatment of the subsurface contamination sources (i.e., AMD) is also included in the Selected Remedy and the phased options of this component of the alternative provides for flexibility and adaptation to meet aquatic life and surface water quality ARARs. The Selected Remedy satisfies the criteria for long-term effectiveness by providing source control for on-site contamination plus containing and treating AMD. The Selected Remedy does not present short-term risks different from the other treatment alternatives. There are no special implementability issues that set the Selected Remedy apart from any of the other alternatives evaluated.

20.5 Preference for Treatment as a Principal Element

EPA and CDPHE have determined that the treatment of the source area wastes (surface and subsurface contamination sources) satisfies the statutory preference for the selection of a remedy that involves treatment as a principal element. By treating the contaminated soils with lime addition and utilizing neutralization and potentially bioreactor treatment for the AMD, the Selected Remedy addresses principal threats posed at the Site by utilizing treatment as a significant portion of the remedy.

20.6 Five-Year Review Requirements

CERCLA §121(c) and the NCP §300.430(f)(5)(iii)(C) provide the statutory and legal bases for conducting Five-Year Reviews. This remedy is not expected to immediately achieve the RAOs on the CJM Site, particularly ARAR compliance at the downstream POC within Left Hand Creek), and it will result in hazardous conditions remaining on site in the surface water above levels that allow for unlimited use and unrestricted exposure. Therefore, statutory reviews will be conducted every five years after initiation of the removal action to ensure that the remedy is, or will be, protective of human health and the environment. In addition, ongoing monitoring will be conducted to determine the applicability, appropriateness, and timing required for implementation of the second phase of the subsurface contamination sources alternative (i.e., on-site bioreactors).

21 Documentation of Significant Changes

Based on submitted written and verbal public comments submitted on the Proposed Plan, the agencies have changed the selected remedy from the proposed remedy for surface contamination from Alternative 2B to Alternative 2C. The selected remedy for subsurface contamination remains as proposed Alternative 3B.

Other changes to the Selected Remedy 2C include the source of borrow/capping material and potentially the number of consolidation cells.

The source of capping/fill material might be obtained only from on-site sources, rather than the alluvial valley above the Big Five Adit. The alluvial valley area is the historical location of Camp Frances, deemed significant by Boulder County Parks and Recreation. It is not certain that adequate borrow/cap material may be available from the escarpment above the Captain Jack Mill location. The exact quantities will be determined during Remedial Design. If necessary, soil borrow sources elsewhere within Boulder County may be sought, or even commercial purchases may be necessary, at costs that could exceed the contingency-margin stated in the FS.

The number and location of consolidation cells will be determined during Remedial Design, with borrow material excavation at the CJM site location. There may be an opportunity to have only one consolidation cell. The configuration could be generally a prismatic geometric form tucked into the toe of the hill slope above the CJM. Specific cut and fill evaluations and cell geometry will be completed during Remedial Design.

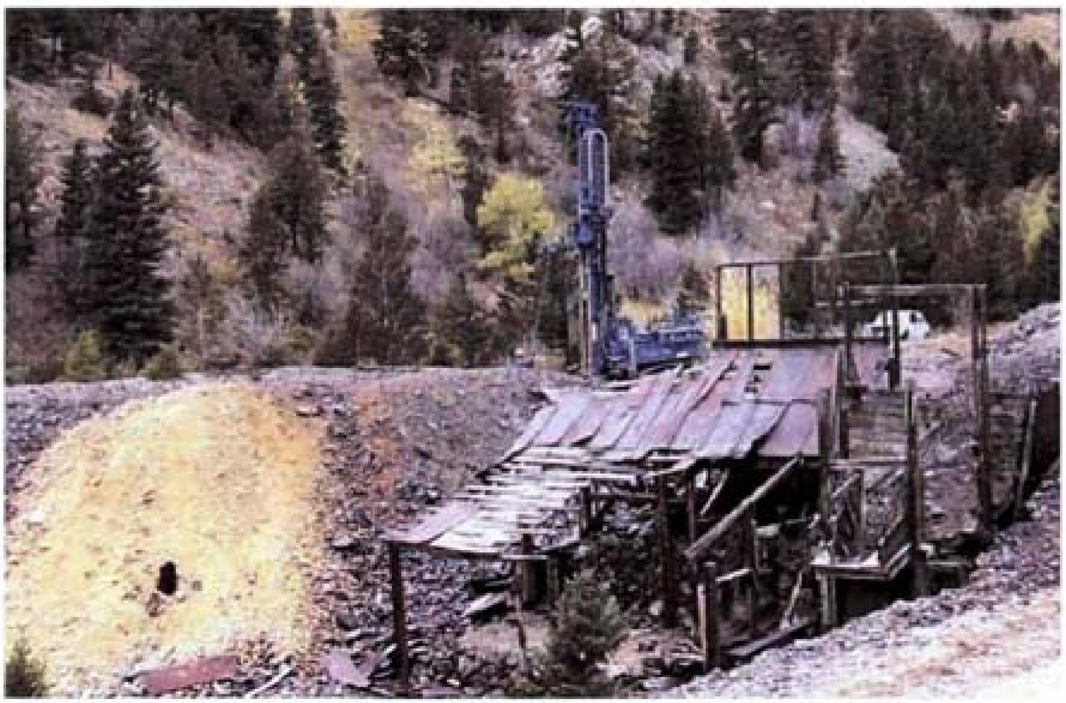
22 Technical and Legal Issues

CDPHE and EPA developed the remedy. CDPHE and EPA jointly proposed the remedy to the public in the Proposed Plan and now jointly approve the Selected Remedy.

CAPTAIN JACK SUPERFUND SITE

CDPHE PROJECT: HMWMD-RP-06

EPA ID: COD981551427



PART THREE: RESPONSIVENESS SUMMARY

23 Responsiveness Summary

The Responsiveness Summary summarizes information about the views of the public and concerned stakeholders regarding both the remedial alternatives and general concerns about the site submitted during the public comment period. This summary also documents, in the record, how public comments were integrated into the decision making process.

The Administrative Record file for the site, located at the CDPHE office in Denver, Colorado and at the EPA Region 8 Records Center in Denver, contains all of the information and documents supporting this ROD. The comment period for the Proposed Plan for the CJM Site opened on June 16, 2008 and ended on August 5, 2008. This Administrative Record file includes a transcript of the public meeting held by CDPHE and the EPA on July 2, 2008 to describe the preferred alternative.

23.1 Overview of Community Support for Remedy and Alternatives

The selected remedy for cleaning up the Captain Jack Mill Superfund Site has two components, as it controls both surface and subsurface contamination sources.

To control subsurface contamination, the remedy (**Alternative 3B** in the RI/FS and Proposed Plan) consists of an installed bulkhead, mine pool mitigation, and phased successive biochemical reactor treatment. The concrete bulkhead will plug the draining mine adit, impounding the mine water. The mine pool environment will have reduced oxygen levels, which, coupled with an injected caustic chemical, will raise the pH to neutralize the water.

After approximately two years of neutralization, CDPHE may install a series of biochemical reactors outside of the mine. The reactors use microorganisms to transform hazardous contaminants into non-hazardous substances. Following bioreactor treatment, the water would flow through wetlands for additional "polishing" treatment before entering Lefthand Creek.

Community support is high for the subsurface contamination remedy. Stakeholders back the in-situ neutralization and phased bioreactor treatment. Because of uncertainties over the mine workings, stakeholders ask for extensive groundwater monitoring once the bulkhead is installed.

Under the selected surface remedy (**Alternative 2C** in the RI/FS and Proposed Plan), all waste will be excavated and placed in several on-site consolidation cells. This plan differs from the preferred alternative of the Proposed Plan (Alternative 2B), which would place only the material categorized as Principal Threat Waste in an on-site consolidation cell. The selected remedy (2C) calls for excavation of all site material with contaminants of concern in concentrations above the remedial action levels.

To contain the waste, each consolidation cell will have a cap. The caps will likely consist of six inches of topsoil, on top of 12 inches of select fill, on top of a geosynthetic clay liner. Before the liner is placed on the waste, caustic material would be mixed into the top six inches of the waste material to minimize acidic leaching. Officials will fully evaluate potential locations for the consolidation cells during the design phase.

The decision to switch the surface contamination remedy from Alternative 2B to Alternative 2C was significantly influenced by public comment. Expressed during the public comment period, community opinion appears squarely behind surface contamination Alternative 2C. Local residents at the public meeting, the Lefthand Creek TAG Coalition (LCTC) and the town of Ward all supported 2C because it places all of the site's waste in a cell, not just the Principal Threat Waste. Local stakeholders view the set of consolidation cells as a stronger barrier against contaminated material release than options presented in the other alternatives. In a representative example of stakeholder opinion, the LCTC writes,

> *Based on the evidence presented in the Proposed Plan, we prefer Alternative 2C. This alternative moves more contaminated waste rock from the banks of Lefthand Creek, which we surmise would result in greater reduction in groundwater contributions of metals to Lefthand Creek. The cost of Alternative 2C is slightly less.*

No new remedy alternatives were presented during the public comment period.

23.2 Background on Site Community Involvement

The Captain Jack Superfund site has held community interest since the mid-19th century, when mining began for gold and silver. The surrounding area grew as a mining community, until mining operations stopped in the early 1990s. Former miners continue to live in the Ward area.

Interest in the site arises from multiple community perspectives. The surrounding community views the Captain Jack cleanup effort through both site-specific and watershed perspectives. Through the site-specific lens, nearby property owners highlight issues that affect their property: groundwater contamination that may impact their wells, how the cleanup affects property values, and institutional controls. From the watershed perspective, local stakeholders are concerned with issues such as the ecological vitality of Lefthand Creek and the public drinking water supply. These stakeholders view the Captain Jack Mill site as a significant contributor of metals to the watershed.

Recent media coverage of mine sites in Colorado affects community interest in the Captain Jack Mill Superfund site. In 2005, a collapse and blockage in the Big Five adit at Captain Jack was found, threatening a blowout. In response, EPA and CDPHE initiated an emergency removal to rehabilitate the tunnel and drain the pooled mine water in early 2007.

Captain Jack stakeholders also paid particular attention to events that unfolded in Leadville during spring and summer 2008. The Leadville Drainage Tunnel blockage caused county commissioners and state representatives to declare a "disaster emergency," detailing the potential for a catastrophic blowout and flood. Although later reports found there to be minimal danger of blowout, the media coverage and political attention led to governmental action. EPA drilled a hole into the tunnel and is siphoning the pooled water into a Bureau of Reclamation treatment plant. The similarity of the Leadville mine site (although it was much larger in scale), along with its safety and political implications, make it a case study of interest for the Captain Jack community.

23.3 Summary of Local Stakeholder Concerns

The alternatives presented in the Remedial Investigation / Feasibility Study (RI/FS) and Proposed Plan distinguish between surface and subsurface contamination sources. This distinction has helped the local community view and comment on the remedies actions as effective source control.

Subsurface alternatives involving the bulkhead provoke local concern. Because it isn't certain exactly where the bulkhead will back up the water in the Big Five mine workings, the local community has requested extensive monitoring and preparation for potential collapses. Further, the Lefthand Creek TAG Coalition commented that it didn't believe the bulkhead would completely stop groundwater contamination of Left Hand Creek.

The predominant local concern is over the selection of Alternative 2B as the preferred remedy for surface source contamination. Various local stakeholders expressed a preference for 2C over 2B, because 2C places all of the site's waste materials within consolidation cells. Alternative 2B, on the other hand, creates a single repository for the site's Principal Threat Waste and caps the remaining material in place. Local stakeholders are not convinced that merely capping the waste will reduce metal transport into Left Hand Creek. They question how well the waste caps will perform during heavy runoff, and what will happen if the water table rises to surface contamination sources.

Local stakeholder comments on the various contamination pathways lead a larger concern: Do the remedies ensure that the water quality of Left Hand Creek is protective of public health and the environment? To that end, comments request that CDPHE add measurable objectives for fish population and in-stream sediment levels. The Lefthand Watershed Oversight Group would like to see studies for baseline fish population levels, to compare with post-remediation levels. Stakeholders also questioned whether the standards – which intend to clean the site to industrial levels – will achieve the stated aquatic life and public health objectives.

Local residents, the town of Ward, and Boulder County all have expressed desire to preserve the mining site's historic buildings. They have questions on how the remedial action will affect the mine buildings on site, and request that the dirt for waste capping does not come from the nearby Camp Frances historical town site. Local stakeholders also have asked that remedial action leave the Switzerland Trail railroad spur intact. Other comments on the ultimate end-use address restrictions on the land. Will future owners be able to dig into the capped waste piles, or mine anywhere on the property?

Multiple comments addressed the bureaucratic hurdles of carrying out the cleanup. Local stakeholders referenced the recent Leadville collapse, requesting that governmental agencies continue to engage the community and respond to its concerns. Another asked whether the funding was sufficient to fully implement the cleanup. Local concerns center around three subjects:

1. How protective (of public health and the environment) is the selected remedy?
2. How noticeably will remedy construction and implementation change the site?
3. What risk does the backed-up underground pool of mine-water present for secondary migration, leakage and potential releases?
4. Does CDPHE or EPA foresee any implementation obstacles?

23.4 Stakeholder Comments and Agency Responses

23.4.1 Boulder County Land Use Comments

Comment 1: *"We'd like to request that the Big Five boarding house as well as the retaining wall/mill foundation on this site not be disturbed and that construction fencing be used to delineate these areas to keep machinery away from these features."*

Response: All construction activities shall have appropriate measures emplaced to protect historical structures.

Comment 2: *If the Conqueror Mill Site will be disturbed, Boulder County Land Use requests an explanation of the disturbance and information on how it can be avoided. "From our discussion on site it sounded like the Conqueror Mill Site wasn't going to be disturbed. If this isn't the case we'd like more detail and for it to be avoided to the extent possible."*

Response: There is a small amount of Principal Threat Waste located at the Conqueror Mill site that will need to be removed. Care will be taken to assure that the historic structures be kept undisturbed. Specific locations of the material needing removal will be identified during the Remedial Design phase of the project. It is not anticipated that the amount of material that will need to be removed will be extensive.

Comment 3: *"[The Francis townsite] is an area that the county has been working to preserve and locally landmark. If fill is needed from near this area we'd like to be able to evaluate what area could be impacted as this has not been a part of the 106 process at this time."*

Response: Prior to any removal and hauling of nearby soil resources from outside the currently disturbed areas of the site, agencies will conduct a full historical evaluation. The evaluation conforms to the Nation Historic Preservation Act of 1966 (as amended), the Archaeological Resources Preservation Act of 1979 (as amended), and Colorado Revised Statutes 24-72-203 (1) and 24-80-405 (2). The quantity and quality of necessary fill material and its source will be determined during Remedial Design. Any consideration of the use of soil-materials from Camp Frances will incorporate all effort to avoid adverse impact to the integrity of the historic values of the site.

Comment 4: *"We'd like for the Switzerland Trail Rail Spur to be left intact. If the RR grade is needed for accessing the area I would suggest avoiding major alterations or regrading of this feature."*

Response: If the rail spur grade is potentially needed for continued use as a material hauling corridor, a full evaluation like the one described in Comment 3 will be conducted.

23.4.2 Town of Ward, Colorado Comments

Comment 1: *Town of Ward prefers 2C over 2B; concerned about placement of the consolidation cell.*

"For the Surface Contamination Sources Alternatives, the Town of Ward prefers Alternative 2C. While your preferred alternative, Alternative 2B, deals with the 9000 cy of Principal Threat Waste, Alternative 2C deals with the entire 85,000 cy of contaminated waste rock, tailings, and soil. Alternative 2C will require excavation of approximately 33,970 cy of contaminated material, and construction of perhaps 3 consolidation cells, but at a cost slightly less than Alternative 2B.

Given the amount of time, energy, and money put into this superfund site, there is no substantive reason not to remediate all of the contaminated surface material, particularly as it is cost effective.

Ward does have a concern about the location options for the consolidation cell(s). As stated on page 5 of the Proposed Plan, an option is to place the cell(s) in the "alluvial valley above the Big Five tunnel." This is rather non-specific, and we would prefer the cells be in the area where the contaminated material is. The alluvial valley above the Big Five is the location of Camp Francis, a significant archaeological site, which need not and must not be impacted by remediation of the Captain Jack Superfund Site. Similarly, borrow material for the consolidation cells should not come from the Camp Francis area."

Response: Based upon public comments received Alternative 2C will be implemented. Consolidation cells will most likely be located in the areas of the Big Five waste rock pile, the Captain Jack Mill tailings ponds area, and the White Raven waste rock pile.

Comment 2: *Wants assurance that extensive monitoring will occur under Alternative 3B. "For the Subsurface Contamination Sources Alternatives, Preferred Alternative 3B seems acceptable, as long as the surrounding area is indeed 'closely monitored to detect and observe areas where water could leak out of the underground workings through seeps or other unknown openings.'"*

Response: The monitoring program implemented for all remedies will be designed to measure the response of the constructed remedies. The Alternative 3B remedy monitoring program will be extensive, due to inherent uncertainties of the remedy. Built into the monitoring program will be a community outreach component ensuring that surrounding landowners and residents expediently receive and communicate site information. CDPHE is very interested in utilizing this type of remedy elsewhere in the state and will implement a robust monitoring program to assure that backing water up into the mountain will not cause secondary problems to occur at another location.

Comment 3: *"The Town of Ward Historic Preservation Commission and local historians have expressed concern about the preservation of historic buildings, structures, and sites in the project area. We ask that the Big Five mine office building and the mill foundation wall be fenced and protected from any adverse impacts during the remediation process. We would also ask that the Switzerland Trail RR spur be left intact, and that Camp Francis not be impacted (as discussed in Comment 1 above)."*

Response: Prior to any mining of soil from outside the current site, agencies will conduct a full historical evaluation. The evaluation conforms to the Nation Historic Preservation Act of 1966 (as amended), the Archaeological Resources Preservation Act of 1979 (as amended), and Colorado Revised Statutes 24-72-203 (1) and 24-80-405 (2). The quantity and quality of necessary fill material will be determined during Remedial Design.

23.4.3 Lefthand Creek Technical Advisory Group Coalition Comments

Comment 1: *Site risk to surrounding populations is incomplete.*

"First, the stream is called 'Lefthand Creek.' Second, the Haldi intake to the Left Hand Water District's system is located at a distance of about 29 km downstream of the Captain Jack Mill Site. Third, there are numerous residents on the site and at various distances between the site and the Haldi water intake that probably use water from Lefthand Creek or groundwater that is probably "under the influence" of Lefthand Creek. This final point – that the population at risk was not completely identified – was raised in our critique of the draft Remedial Investigation."

Response: Left Hand Creek is the name denoted on the USGS Topographic map and is used as the basis for the creek name in all RI/FS activities. Compliance with water quality standards will be monitored and achieved at the Point-of-Compliance (POC) located above the confluence with Puzzler Gulch. The evaluations of contaminant pathways beyond the boundaries of the Superfund site were not included in the Superfund investigation at the insistence of the Lefthand Watershed Task Force. The Lefthand Watershed Taskforce was the group appointed by Boulder County to provide direction for the cleanup efforts in the Left Hand Creek watershed, and supported the initial listing of the Captain Jack Mill site to be eligible for federal funding through the Superfund program.

The interaction and relationship of contaminant sites and the associated impact of the contamination sources on the entire watershed is part of a pilot EPA program titled "The One Cleanup Program." This program is designed to address contaminant sources in the Left Hand Watershed through a matrix of regulatory programs. This effort is still ongoing and monitoring is still being conducted and loading analyses are being updated over time. Other sources that affect downstream users are being evaluated/remedied through other programs as directed by the Lefthand Watershed Taskforce.

Comment 2: *Requests that there are Remedial Action Objectives for stream bed sediments.*

"The final Remedial Investigation does not consider remediation of stream bed sediments. We expect that the stream bed sediments will release metals over time and prevent achievement of one of the goals of the remediation, that exposure of aquatic life to contaminants is reduced."

Response: Remedial Action Objectives (RAOs) for sediments are established in the Surface Water RAOs: "Reduce the toxicity to bottom dwelling aquatic organisms living in or just above the sediment to levels that protect aquatic life." This goal states that sediments will be protective to fish and associated invertebrates. Improvements to the stream sediments will be accomplished by reducing metal loading from the surface water. Actual removal of sediments from the streambed would likely be more disruptive to ecological resources than the current conditions of the stream sediments.

Comment 3: *The site definition of Principal Threat Waste does not fit with site use. "The principal threat waste is defined by CDPHE as solid material containing lead in excess of 1460 ppm. The lead concentration of 1460 ppm is described as a CDPHE table value standard for industrial land use. This choice is not consistent with an assessment of human health risks for "children and adults in a residential setting" as stated in the Summary of Site Risks in the Proposed Plan."*

Response: Based on public comment, Alternative 2C will be implemented. It calls for excavation of all contaminated material above residential standards, and consolidates it into capped waste cells, preventing exposure to hazardous materials.

Comment 4: *Using lead levels as remediation guidance may not show entire site contamination. "We expressed concern that high concentrations of cadmium and zinc are not well-correlated with high concentrations of arsenic and lead in the waste rock and that identification of waste rock for remediation based on lead only would not provide adequate cleanup of waste rock contaminated by cadmium and zinc."*

Response: The chemicals of concern at the site that were determined to drive the removal action for surface contamination sources were arsenic, lead, and thallium. Surface source alternatives were developed to address these chemicals of concern. As contaminated waste rock will be excavated and consolidated, treated, and capped, significant source control will be provided to reduce runoff containing elevated levels of all metals of concern. Cadmium and zinc pose the greatest risk to aquatic life organisms and the subsurface source portion of the selected remedy treats any released water to standards which will meet the aquatic life standards and surface water quality standards for cadmium and zinc at the downstream point of compliance for Left Hand Creek.

Comment 5: *A remedial action objective that directly addresses fish populations is requested. "We request that the surface water objectives directly address fish populations at the site. Currently, fish populations at the Captain Jack Mill site are greatly reduced relative to fish populations upstream of the site. A remedial action objective that directly addresses fish populations is requested."*

Response: The current remedial action objectives include: "reducing the toxicity to benthic aquatic organisms living at the surface water/sediment interface or in sediment to levels that are protective of aquatic life, with the ultimate goal of attaining surface water standards to ensure long-term survival of fish in Left Hand Creek."

Comment 6: *Measurements of Principal Threat Waste vary between Alternatives 2A and 2B. "In Alternative 2A (off-site disposal and capping), the volume of the principal threat waste is identified as 9,000 cubic yards. In Alternative 2B, the volume of the principal threat waste is given at 5,050 cubic yards. Would the volume be different for the two alternatives?"*

Response: Alternative 2B only involves the excavation of 5,050 cubic yards of the 9,000 cubic yards of Principal Threat Waste, since the remaining material is currently in the former tailings ponds and would not need excavation in this Alternative. The "missing" 4,000 cubic yards of Principal Threat Waste material would automatically become part of the consolidation cell due to the location of the cell.

Comment 7: *No direct addressing of the buildings and mining infrastructure left on site. "We request that consideration be put into post-remediation uses of the site and how the final appearance of the site might limit productive use of the site."*

Response: With implementation of Alternative 2C, post remedial land use will be restricted only to the consolidation cells.

Comment 8: *Request more detailed explanation of why additional consolidation cells would be more difficult from a technical perspective. "The implementability of the Surface Contamination Sources Alternatives cites 'additional technical difficulties' for Alternative 2C. It is not clear why additional excavation and construction of additional consolidation cells would present greater technical difficulty."*

Response: Alternative 2C will be implemented based on public comment.

Comment 9: *Concerns about the success of installing a bulkhead and injecting caustic material. "Would the precipitated metals clog the tunnel and prevent circulation? Would the precipitated metals result in clogging that forces contaminated water into other mine tunnels connected to the Big Five Tunnel? Before endorsing this alternative, we would need more proof that this approach would be successful. Has this approach been used at any other abandoned mine sites? We request details on the sites at which bulkheads have been installed."*

Response: Sludge buildup will be monitored. The exact effects of the buildup are not known, so a robust monitoring program is part of the remedy. The State of Colorado is very interested in the results of the innovative remedy, with hopes of using the technology at other sites. As a result, the effects of the mine-pool mitigation program will be closely monitored.

The successful installation of a bulkhead has been done at Summitville Mine, the Rawley 12 Tunnel in the Bonanza District, Eagle Mine, Animas River, and Platoro Mine. The Eagle Mine had some initial seepage, but is now is operated in conjunction with a water treatment plant.

However, none of these sites has an in-situ acid neutralization program. The lack of in-situ neutralization precedent gives the Captain Jack remedy presumably beneficial results, although some degree of uncertainty since it is a "pilot" application.

Comment 10: *Remedy alternatives do not account for all of the groundwater sources loading metals into Lefthand Creek. "We are concerned that the groundwater sources of metals will not be eliminated by the Surface Contamination Sources Alternatives* *and that only a fraction of the metal input to Lefthand Creek will be reduced by the Subsurface Contamination Sources Alternatives."*

Response: During Remedial Investigation, groundwater levels were surveyed at elevations below those of Left Hand Creek between the Big Five and the Captain Jack. These data infer that a losing reach of the creek occurs along this segment. Under the surveyed hydraulic head, surface water would discharge to groundwater and metals loading to surface water should be reduced by groundwater flow away from the creek. Although not all load sources will be eliminated and there may be gaining reaches within the study area that are susceptible to metals loading on a seasonal basis, it is anticipated that the combination of a bulkhead in the Big Five Adit and capping the waste rock/tailings and sediment runoff control will reduce loads sufficiently to obtain water quality objectives.

Comment 11: *Disagrees with selection of 2B as Surface Contamination Sources remedy; LCTC prefers 2C over 2B. "We are unconvinced by the choice of Alternative 2B as a Preferred Alternative. We are concerned about the application of only a lead criterion based on industrial lands for identification of the Principal Threat Waste. We are concerned that capping will not reduce transport of metals to Lefthand Creek from groundwater sources between the Captain Jack Mill and the White Raven mine site. Based on the evidence presented in the Proposed Plan, we prefer Alternative 2C. This alternative moves more contaminated waste rock from the banks of Lefthand Creek, which we surmise would result in greater reduction in groundwater contributions of metals to Lefthand Creek. The cost of Alternative 2C is slightly less. The implementability seems similar."*

Response: Alternative 2C will be implemented.

23.4.4 Lefthand Watershed Oversight Group Comments

Comment 1: *Requests a baseline aquatic species analysis in order to compare the data with water conditions after the remedial action.*

"We would like to see some WET analysis conducted before the work gets underway to determine the lethality of the water to aquatic species. This is so we could get a baseline account of what aquatic species could survive in the creek under current status quo conditions. These baseline standards could then be compared to samples taken after the clean-up is complete and could be used to show the site has been cleaned up to standards that support aquatic life. Many people who live near the site have expressed specific concerns regarding the sites ability to support a healthy fish population. The LWOG would like to see data collected that would enable all of us working in this area to adequately express to folks who live there that their concerns are going to be addressed. We feel that collecting water at a handful of key locations above and below the site and running an LC-50 test would better allow CDPHE and the LWOG tell the complete story of how the conditions will be improved by running these tests."

Response: Baseline monitoring for the site will be completed during Remedial Design. Specific monitoring programs will be developed for the needed design needs.

23.4.5 Community Comments

Data

Comment 1: *Page 19, Line 18 of public meeting transcript: Interest in having the state (ATSDR or HMWMD?) incorporate downstream data into the evaluation of overall data and the ultimate decision-making process.*

Response: The Left Hand watershed is part of the EPA pilot "One Cleanup Program." Further, Captain Jack environmental data is included in the Left Hand Watershed data base, for use in long term watershed monitoring.

Historic Preservation

Comment 2: *Page 65, Line 13 of public meeting transcript: How will the work impact the site's buildings? What will be bulldozed and what won't?*
"How can you assure me that the buildings, particularly the Big Five Boarding House and the White Raven Mill Building, will not be impacted? Will the contracted be careful not to disturb that? How do we know that those buildings will not be disturbed?"

Response: All necessary protection efforts, such as fencing and signage, will be in place during construction and identified in the construction documents let for bidding. The collapsing wood structure at the White Raven portal will likely not be preserved. The building was not identified as a unique and historically eligible structure by the state-approved historical survey.

Comment 3: *Page 68, Line 3 of public meeting transcript: There are concerns that the work would change the historical landscape, moving dirt around to create a "layer cake" like Leadville.*
"My concern is that this is a historical landscape, and I don't want it to end up looking like Leadville with these big, wedding-cake configurations."

Response: The consolidation cells will resemble rounded mounds or hill slopes of grass / vegetation. These areas will be constructed with access-limitations to prohibit vehicle traffic to protect the vegetation to reduce future erosion.

Comment 4: *Written comment received from Betina Mattesen: "Boulder County has lost a lot of outstanding mining history due to landowner and agency ignorance and apathy. The cleanup process should preserve historic features as much as possible. Land disturbance of the area should be minimized to preserve the site's integrity. There may be an opportunity to interpret and educate the public about* *our important mining legacy. Safe, legal access to the area after cleanup is important to me. Thank you."*

Response: Preservation of site features will be addressed or assured with fencing and work exclusion zones. Much of the site is on private property, so access and impacts to specific areas will be up to the respective property owner.

Aquatic Life

Comment 5: *Page 63, Line 13 of public meeting transcript: What will be the downstream aquatic impacts (for example, the downstream beaver) of the remediation construction and operation?*
"During the process of actual excavation of all the materials, how far downstream could one expect for things to be impacted, especially in terms of the beaver dam?"

Response: Impacts to downstream riparian habitats will be minimized. Best Management Practices will be undertaken during construction to assure that unacceptable releases of sediment to the stream will be minimized.

Mining

Comment 6: *Page 79, Line 14 of public meeting transcript: Will this site still be able to operate as a gold mine, if someone wants to reopen it?*
"With the price of gold going up and people more interested in reopening gold mines, are you saying that now all of these workings are going to be flooded forever? And what if somebody wanted to start mining?"

Response: As part of any new mining operation, environmental impacts will need to be addressed. With the mine tunnel now being flooded, the potential mining operator would need to drain the mine and treat any discharge water to achieve all water quality criteria. In addition financial assurances would be necessary so that these impacts would be addressed. As with any new mining operation, mine water discharges would need to be treated to meet stream discharge permit requirements.

Surface Contamination Sources Alternatives

Comment 7: *Page 47, Line 11 of public meeting transcript: What are the chances of a flood affecting an onsite repository – particularly in the case of water coming up from underneath the capped repository cell?*
"What are the chances of a flood coming along and washing it away?"

Response: The design of the remedy will be to protect against at minimum the 100-year flood event.

Comment 8: *Page 61, Line 13 of public meeting transcript:*
"Would you like to mention where all that dirt is likely to come from?"

Response: Various sources for cap material will be evaluated prior to construction. In response to concerns about potential impacts to the Camp Frances historic area, CDPHE and EPA staff met with Boulder County staff and a local historic-interest representative to review the potential soil borrow area. It was discussed that the use of the area for soil resources could present substantial protection issues regarding historical elements. However, in the review we also discussed the quantity and availability of soil material, as well as the traffic impacts resulting from obtaining the required material at various borrow sources. The discussion touched on changes to the cost of the project when using "retail prices" of commercially-purchased soil material instead of a nearby borrow site. Boulder County Land Use and Historic Preservation staff advised CDPHE and EPA that, even when incorporating cost and traffic considerations, they preferred the cleanup effort not extract soil from the Camp Frances area.

The agencies will review the cost and impacts to the community from haul truck traffic on Left Hand Road in selecting borrow source areas. All borrow source areas will be properly reclaimed and revegetated upon completion of the work. However, prior to mining any soil, archaeological studies will be performed to evaluate potential sites for possible impacts.

Comment 9: *Page 62, Line 1 of public meeting transcript: How far below the capped waste is the water table? Are there concerns of it rising to the contamination within the cell? (e.g. rising levels from storms, runoff, and damming)*
"At the bottom of the depth to waste material – what's the minimum distance to groundwater on any of these capped sites? Is [the damming, raising the water table] something that could happen due to the beaver dams?"

Response: Groundwater was measured at approximately 15 feet below the ground surface in the vicinity of the proposed consolidation cell location. Rising groundwater tables could result from flooding or damming in the stream. The Remedial Design portion of the project will address the potential for groundwater levels to rise and potential groundwater control measures can be explored.

Comment 10: *Page 71, Line 16 of public meeting transcript: Will there be any possibility of people digging into the capped waste piles?*
"What's to prevent somebody from digging into that cap? Do you put up signs, fencing, anything up there?"

Response: At a minimum temporary fencing will be placed around the repositories until vegetative growth is self-sustaining. Long-term maintenance of the consolidation cells will be conducted by CDPHE. Environmental Covenants will be placed on these specific areas within the remedy-affected properties to protect the remedial features. The Environmental Covenants will prohibit digging into the caps without prior approval from CDPHE.

Subsurface Contamination Sources Alternatives

Comment 11: *Page 58, Line 5 of public meeting transcript: What happens with water treatment during winter months? Does the groundwater freeze as soon as it expresses out of the mountain surface?*
"Anything you're doing outside on a mountain– it wouldn't freeze up and spill over?"

Response: Water treatment that may be necessary outside of the adit-portal can continue year-round at the Captain Jack Mill site with possible reduced operations during the winter months. Freezing can be controlled with semi-active additions to the planned treatment, which can include heating coils around pipes or other design elements. Conversely, if water is able to stabilize within the mine tunnel without treatment outside the tunnel, freezing would not be an issue as the subsurface ground conditions would provide a fairly constant temperature range.

Comment 12: *Page 70, Line 20 of public meeting transcript: Mention of heavy water having historically flown out of Black Jack tunnel.*

Response: Since 2000 – the beginning of the Site Assessment process – flow from the Black Jack or the White Raven has not been observed. However, if conditions change and flow from these tunnels poses a problem in achieving cleanup standards, then additional remedial alternatives to address the new site conditions will need to be considered. The remedy for the Captain Jack site will undergo review every five years to assure that it is still protective and that site conditions have not changed.

Comment 13: *Page 75, Line 11 of public meeting transcript: Where will the water go once it is backed up in the tunnel by the bulkhead?*
"There's something troubling to me about the notion of backing up water, in so far as water is one of those implacable substances that will go through whatever you set up. And if you back it up there, it's just going to come out someplace else."

Response: A robust monitoring program is planned in order to evaluate the effects of the bulkhead and in-situ treatment program. If unacceptable hydraulic conditions arise from the program then operational modifications, including, as necessary, the second phase will be implemented.

Comment 14: *Page 87, Line 8 of public meeting transcript: Past rain events have created collapses. If CDPHE fills up the tunnel with water, there will likely be collapses.*
"With the 8-foot snowstorm we got a couple years ago, there was an amazing amount of water, and it actually led to all of these collapses that are around."

Response: A robust monitoring program is planned in order to evaluate the effects of the bulkhead and in-situ mine-pool mitigation program.

Remedy Objectives

Comment 15: *Page 30, Line 25 of public meeting transcript: Why clean up to "Industrial Land Use" if there are already established residences on the property? Why not clean up, then, to residential values?*
"So this is for industrial land use, and it's established that there are residences there?"

Response: Alternative 2C will be implemented. Under it, all contaminated material exceed the residential threshold will be excavated and consolidated into repositories.

Comment 16: *Page 39, Line 13 of public meeting transcript: How, if your goals are to reduce site contamination to industrial-level standards, can you meet the stated goal (RAO) of aquatic life protection? How do the two synch up?*
"I see a lot of mines where you reduce your levels to a certain discharge standard, but yet you're severely still impacting aquatic life. How do you consider that you're claiming advantage, but you're not looking at the previous baseline data?"

Response: Alternative 2C will be implemented. Compliance with ARARs will be achieved at the designated Point-of-Compliance.

Overall Evaluation of Alternatives

Comment 17: *Page 37, Line 11 of public meeting transcript: Essentially, why does CDPHE think that the groundwater remedy will stop AMD from going into the creek?*
"If you wanted to control surface water to groundwater input, how do you know whether surface water is impacting groundwater into the creek itself?"

Response: The remedy will control the major source of the Acid Mine Drainage by flooding major source-materials reducing their exposure to available oxygen, as well as reducing the pH of the mine pool. This should reduce the concentration of metals dissolved in the water, as well as minimize the process of dissolving additional metals into the water.

Comment 18: *Page 49, Line 6 of public meeting transcript: (Pete Gleichman) Why choose 2B over 2C when 2C seems to account for more waste at less cost?*
"2C takes care of 85,000 cubic yards at less expense than 2B, which takes care of 5,000 cubic yards, and your principal objection to 2C is aesthetics?"

Response: Alternative 2C will be implemented.

Logistics and Bureaucracy

Comment 19: *Page 93, Line 1 of public meeting transcript: Could work be put on the back burner and drag out like the BLM tunnel at Leadville? If the system failed, there are concerns that the agencies would let it fail until someone with political power got angry.*
"We are all witnessing the scenario in Leadville with that plugged mine, and it hasn't been very smooth. My concern is we don't have the political clout Leadville has to kick somebody in the shins."

Response: Unlike the situation in Leadville where the BLM denied their responsibility, CDPHE is responsible for the Operation and Maintenance of the selected remedy at the Captain Jack site in perpetuity.

Comment 20: *Page 97, Line 11 of public meeting transcript: Is there enough funding to finish the project – to see it through?*
"And you have plenty of funding to carry out this plan?"

Response: Construction funding will be provided by the EPA (90 percent) and the State of Colorado (10 percent), with the state responsible for 100 percent of Operation and Maintenance.

Comment 21: *Page 98, Line 22 of public meeting transcript: What is the time line for the project?*
"What's the projected time line on getting all of this completed?"

Response: The anticipated time line is:
Design: 2009-2010
Construction: 2010-2012
Monitoring: 20013-2014
Phase 2 (if necessary): 2015-2017

23.5 Concerns Relating to Remedial Design / Remedial Action

Historic Preservation Comments

Boulder County *"We'd like to request that the Big Five boarding house as well as the retaining wall/mill foundation on this site not be disturbed and that construction fencing be used to delineate these areas to keep machinery away from these features."*

Boulder Co. *"From our discussion on site it sounded like the Conqueror Mill Site wasn't going to be disturbed. If this isn't the case we'd like more detail and for it to be avoided to the extent possible."*

Boulder Co. *"[The Frances townsite] is an area that the county has been working to preserve and locally landmark. If fill is needed from near this area we'd like to be able to evaluate what area could be impacted as this has not been a part of the 106 process at this time."*

Boulder Co. *"We'd like for the Switzerland Trail Rail Spur to be left intact. If the RR grade is needed for accessing the area I would suggest avoiding major alterations or regrading of this feature."*

Ward *"The Town of Ward Historic Preservation Commission and local historians have expressed concern about the preservation of historic buildings, structures, and sites in the project area. We ask that the Big Five mine office building and the mill foundation wall be fenced and protected from any adverse impacts during the remediation process. We would also ask that the Switzerland Trail RR spur be left intact, and that Camp Francis not be impacted."*

B. Mattesen *"Boulder County has lost a lot of outstanding mining history due to landowner and agency ignorance and apathy. The cleanup process should preserve historic features as much as possible. Land disturbance of the area should be minimized to preserve the site's integrity. There may be an opportunity to interpret and educate the public about our important mining legacy. Safe, legal access to the area after cleanup is important to me. Thank you."*

Impacts on Downstream Aquatic Life

Public Meeting: *What will be the downstream aquatic impacts (for example, the downstream beaver) of the remediation construction and operation?*

Comparison to Leadville Controversy

Public Mtg: *"We are all witnessing the scenario in Leadville with that plugged mine, and it hasn't been very smooth. My concern is we don't have the political clout Leadville has to kick somebody in the shins."*

Request for Baseline Analysis of Creek Ecology

LWOG *"We would like to see some WET analysis conducted before the work gets underway to determine the lethality of the water to aquatic species. This is so we could get a baseline account of what aquatic species could survive in the creek under current status quo conditions. These baseline standards could then be compared to samples taken after the clean-up is complete and could be used to show the site has been cleaned up to standards that support aquatic life. Many people who live near the site have expressed specific concerns regarding the site's ability to support a healthy fish population. The LWOG would like to see data collected that would enable all of us working in this area to adequately* *express to folks who live there that their concerns are going to be addressed. We feel that collecting water at a handful of key locations above and below the site and running an LC-50 test would better allow CDPHE and the LWOG tell the complete story of how the conditions will be improved by running these tests."*

Consolidation Cells

Public Mtg: *What are the chances of a flood affecting an onsite repository – particularly in the case of water coming up from underneath the capped repository cell? "What are the chances of a flood coming along and washing it away?"*

Public Mtg: "Would you like to mention where all that dirt is likely to come from?"

24 References

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A

Administrative Record Index

Site Record Number *Record Title Security Level Doc Date Current Location*

Captain Jack Mill ADM/4.2./33 Administration - Grants & Cash Programs -**Unclassified 8/1/2003 HMWMD Records** Federal Grants - GRANT FOLDER - Captain Jack **Center** Mine RI/FS - Budget/Project Period 6/15/2003 thru 12/31/2006

Site **Captain Jack Mill** *Record Number* **ADM/4.2.1./52** *Within* **ADM/4.2./33** *Record Title* Administration - Grants & Cash Programs -Federal Grants - Applications - Captain Jack Mine RI/FS - Request for $886,711, funding period 10/1/02 thru 6/30/04 *Security Level* **Unclassified** *Doc Date* **9/9/2002** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.2./105** *Within* **ADM/4.2./33** *Record Title Administration - Grants & Cash Programs -Federal Grants - Awards - Captain Jack Mine RI/FS - Partial award $200,000, Budget/Project period 6/15/03 - 2/28/05, Assistant ID# V98896701-0* *Security Level* **Unclassified** *Doc Date* **6/12/2003** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.2./140** *Within* **ADM/4.2./33** *Record Title Administration - Grants & Cash Programs -Federal Grants - Awards - Captain Jack Mine RI/FS. 2nd award for $200,000. Assistant ID# V98896701-1* *Security Level* **Unclassified** *Doc Date* **8/20/2003** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.2./144** *Within* **ADM/4.2./33** *Record Title Administration - Grants & Cash Programs -Federal Grants - Awards - Captain Jack Mine RI/FS. 3rd award for $150,000.* Assistant ID# V98896701-2 *Security Level* **Unclassified** *Doc Date* **9/26/2003** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.2./161** *Within* **ADM/4.2./33** *Record Title Administration - Grants & Cash Programs -Federal Grants - Awards - Captain Jack Mine RI/FS. Assist ID#V 98896701-3 for additional $118,000. Budget/Project Period 6/15/03 -2/28/06* *Security Level* **Unclassified** *Doc Date* **2/9/2004** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.2./202** *Within* **ADM/4.2./33** *Record Title Administration - Grants & Cash Programs -Federal Grants - Awards - Captain Jack Mine RI/FS. Assistant ID# V 98896701-4 for additional $118,000. Budget/project period 6/15/03 thru 2/28/06* *Security Level* **Unclassified** *Doc Date* **6/8/2004** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.2./203** *Within* **ADM/4.2./33** *Record Title Administration - Grants & Cash Programs -Federal Grants - Awards - Captain Jack Mine RI/FS. Assistant ID#V 98896701-5 for additional $50,000. Budget/project period 6/15/03 - 2/28/06* *Security Level* **Unclassified** *Doc Date* **9/1/2004** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.2./271** *Within* **ADM/4.2./33** *Record Title Administration - Grants & Cash Programs -Federal Grants - Awards - Captain Jack Mine RI/FS. Assistant ID#V 98896701-6 for additional $232,000. Budget/project period 6/15/03 -12/31/06* *Security Level* **Unclassified** *Doc Date* **9/23/2005** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.2./312** *Within* **ADM/4.2./33** *Record Title Administration - Grants & Cash Programs -Federal Grants - Awards - Captain Jack Mine RI/FS. Assistant ID#V 98896701-7 Extends end date to 12/31/07 (6/15/03 - 12/31/07)* *Security Level* **Unclassified** *Doc Date* **1/17/2007** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.3./96** *Within* **ADM/4.2./33** *Record Title* Administration - Grants & Cash Programs -Federal Grants - FSRs - Captain Jack Mine RI/FS - Interim annual FSR for June 15, 2003 through September 30, 2004 *Security Level* **Unclassified** *Doc Date* **11/17/2004** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.3./134** *Within* **ADM/4.2./33** *Record Title* Administration - Grants & Cash Programs -Federal Grants - FSRs - Captain Jack Mine RI/FS - Annual FSR for October 1, 2004 through September 30, 2005 Agreement # V-988967-01 *Security Level* **Unclassified** *Doc Date* **12/22/2005** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/4.2.3./153** *Within* **ADM/4.2./33** *Record Title* Administration - Grants & Cash Programs -Federal Grants - FSRs - Captain Jack Mine RI/FS - Annual FSR for October 1, 2005 through September 30, 2006 Agreement # V-988967-01 *Security Level* **Unclassified** *Doc Date* **12/6/2006** *Current Location* **ADM/4.2./33 > HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/5./38** *Record Title* Administration - Contracts - Captain Jack - RI/FS Contract *Security Level* **Unclassified** *Doc Date* **2/6/2004** *Current Location* **HMWMD Records Center**

Site **Captain Jack Mill** *Record Number* **ADM/5.2.1./17** *Within* **ADM/5./38** *Record Title Administration - Contracts - Solicitation Documents - Amendment - Request for Qualification - correspondence / listings* *Security Level* **Unclassified** *Doc Date* **2/6/2004** *Current Location* **ADM/5./38 > HMWMD Records Center**

B

Cost Estimate for Selected Remedy

Alternative 2C: On-Site Consolidation Cell for Contaminated Soils

Captain Jack Mill Superfund Site Feasibility Study

CONSERVATIVE ESTIMATE OF MOST PROBABLE COST - CONCEPTUAL (-30% to +50%)

Alternative 2C: On-Site Consolidation Cell for Contaminated Soils

Item No.	Line Item	Est. Qty.	Unit	Unit Price	Extended Price	Description
CONSTRUC[illegible]						
[illegible]						
1	Mobilization, Bonding, Insurance	5	%	-	26,900.00	Typical percentage of overall construction
2	Construction BMPs (E&S Controls)	2	%	-	10,800.00	Typical percentage of overall construction
4	Clear & Grub repository area	1.96	AC*	2,500.16	4,900.00	Judgement**
5	Cleanup & Demobilization	1	LS*	22,000.00	22,000.00	Judgment
					64,600.00	
[illegible]						
4	Labor Crew	3	DAY*	986.74	3,000.00	Means*** crew B-10L (labor cost)
5	Dozer	24.00	HR*	102.91	2,500.00	Dozer, CAT D6RXL, with PAT & Ripper, per hr.
6	Excavator	24.00	HR	117.76	2,800.00	Excavator, CAT 330 C w/ Thumb, per hr.
7	Wheel Loader	80.00	CY*	2.34	200.00	Means 02-315-1500; 3/4 CY cap.
8	Road Base	80.00	CY	6.72	500.00	Class 6 Lafarge Aggregates estimate
9	Tandem Dump	3	DAY	346.49	1,039.47	Means 01-590-5250 rental
					10,000.00	
[illegible]						
10	Excavation of waste material	27,188	CY*	1.49	50,500.00	Means 02-315-424-1350; 5 CY track mounted F.E.
11	Haul to repository location	27,188	CY	2.59	70,400.00	1 mi RT, 20 CY dump; Judgment based on Means 02-315-490-1150
12	Compaction at repository location	27,188	CY	1.91	51,900.00	Means 02-315-320-0600; 8" lifts select fill
					172,800.00	
[illegible]						
13	Surveying	1	LS	6,500.00	6,500.00	Judgement - approx. 2 days
14	Grade Subgrade	9,500	SY*	0.67	6,300.00	Means 02-310-100-0012; Rough Grading, 12G, 1 Pass
15	Compact Subgrade	6,320	CY	1.91	12,100.00	Means 02-315-320-0600; 8" lifts select fill
16	Lime amendment	317	CY	50.00	15,800.00	Judgement (mixed in at 20% dosing rate to top 6-inches of capped area)
17	Geosynthetic Clay Liner	85,536	SF	1.04	88,900.00	Adjusted rate from EPA guidance on installed GCL per SF
18	Gravel (crushed rock apron)	283	CY	15.44	4,400.00	Quote per Lafarge Aggregates
19	Final cover system - rooting/seed bed layer	3,167	CY	0.76	2,400.00	Means 02-315-120-5020; 300 HP dozer, onsite soils
20	Final cover system - topsoil	1,584	CY	35.33	56,000.00	Means 02-050-150-0800 and 02-050-150-0900; 10 mile haul assumed
21	Final seeding	1.96	AC	1,136.44	2,200.00	Per value suggested by similar project
22	Providing Erosion Control Blankets	9,500	SY	2.84	27,000.00	Means 02-370-550-0010
23	Installing Lysimeter (2)	2	EA*	2,272.87	4,500.00	Per value experience at similar project in 2003, adjusted for inflation
					226,100.00	
[illegible]						
24	Surface water control system grading	3	DAY	3,735.45	11,200.00	Means crew B-10L w/ hyd.excavator - easy access - 1,000 lf
25	Surface water control structures	6	EA	568.22	3,409.31	1,000 lf @ 100 ft o.c. - temporary structures
26	Permanent surface water control grading	3	DAY	3,735.45	11,200.00	Means crew B-10L w/ hyd.excavator - easy access - 1,000 lf
27	Permanent surface water structures	6	EA	1,704.65	10,227.92	1,000 lf @ 100 ft o.c. - longer life structures
					36,037.00	
[illegible]						
28	Providing Decon Area and Subsequent Removal	1	LS	27,000.00	27,000.00	Judgment
29	Final Grading Excavated Areas	36,111	SY	0.67	24,100.00	Means 17-03-0102; Rough Grading, 12G, 1 Pass
30	Revegetation	15	AC	1,704.65	25,600.00	Per value suggested by similar project
					76,700.00	
SUBTOTAL FOR CONSTRUCTION					**586,237.00**	
31	Additional line items allowance	10	%	586,237.00	58,600.00	
SUBTOTAL FOR CONSTRUCTION WITHOUT CONTINGENCY					**644,837.00**	
32	Contingency	15	%	644,837.00	96,700.00	
SUBTOTAL FOR CONSTRUCTION WITH CONTINGENCY					[illegible]	
DESIGN COST ESTIMATE						
[illegible]						
33	Private property acquisition	1	LS	29,683.20	29,683.20	Based on average cost per acre for remote access areas from City of Boulder
					29,683.20	Multiplied by 2 for consolidation cell
[illegible]						
34	Engineering design & operation report	1	LS	80,000.00	80,000.00	Judgment
35	Permit Application and Associated Fees	1	LS	2,000.00	2,000.00	Judgement for federal, state, and local permits
36	Construction oversight	1	LS	150,000.00	150,000.00	Judgment
37	Administration	1	LS	20,000.00	20,000.00	Judgment
					252,000.00	
SUBTOTAL FOR DESIGN					**281,683.20**	
38	Additional line items allowance	5	%	281,683.20	14,100.00	
SUBTOTAL FOR DESIGN WITHOUT CONTINGENCY					**295,783.20**	
39	Contingency	10	%	295,783.20	29,600.00	
SUBTOTAL FOR DESIGN WITH CONTINGENCY					[illegible]	
OPERATION & MA[illegible]						
[illegible]						
40	Monitoring program plan	1	LS	15,000.00	15,000.00	Judgment
41	Monitoring	30	YR*	2,000.00	39,200.88	Judgment, Quarterly sampling and testing of lysimeters, surface soil, and surface water
42	Maintenance for Vegetation	30	YR*	1,500.00	29,400.66	Judgment
43	Recordkeeping	1	YR	15,000.00	15,000.00	Judgment
					98,602.00	
[illegible]						
44	State & Local notifications	1	LS	3,000.00	3,000.00	Judgment
45	General public notification	1	LS	3,000.00	3,000.00	Judgment
46	Trespass prevention measures	1	LS	3,500.00	3,500.00	Judgment
47	Permanent surface water control plan	1	LS	10,000.00	10,000.00	Judgment
48	Closure plan preparation, incl. final cover system	1	LS	30,000.00	30,000.00	Judgment
49	Post-closure plan preparation	1	LS	10,000.00	10,000.00	Judgment
					59,500.00	
SUBTOTAL FOR OPERATION & MAINTENANCE					**158,102.00**	
50	Additional line items allowance	5	%	158,102.00	7,900.00	
SUBTOTAL FOR OPERATION & MAINTENANCE WITHOUT CONTINGENCY					**166,002.00**	
51	Contingency	10	%	166,002.00	16,600.00	
SUBTOTAL FOR OPERATION & MAINTENANCE WITH CONTINGENCY					**182,602.00**	
TOTAL FOR D[illegible]						

ASSUMPTIONS & LIMITATIONS:

1 Pricing is for 2008 present value with 3 percent discount rate.
2 Annual costs are set at max. 1 year for activities associated with operation of the repository
3 Annual costs are set at 30 years for long-term monitoring activities that will continue after operations at the repository have ceased.
4 Annual plan implementation assumes one full- and one half-time employee to oversee repository operations.
5 All excavation costs are increased by 25% due to probable pressence of historical structures which may require additional excavation precautions and procedures

* UNITS:
AC = acre
CY = cubic yard
EA = each
LF = linear foot
LS = lump sum
SY = square yard
YR = year

**Professional judgement or estimation by Walsh E & E.

*** RSMeans Building Construction Cost Data 2005: Western Edition. Kingston, MA: RSMeans Company, Inc., 2003. and RSMeans Building Construction Cost Data 2007

Alternative 3B: Bulkhead and Mine Pool Mitigation at Big Five Adit with Phased Biochemical Reactor Treatment as Required

Captain Jack Mill Superfund Site Feasibility Study

CONSERVATIVE ESTIMATE OF MOST PROBABLE COST - CONCEPTUAL (-30% to +50%)

Alternative 3B: Bulkhead and Mine Pool Mitigation at Big Five Adit with Phased Biochemical Reactor Treatment as Required

Item No.	Line Item	Est. Qty.	Unit	Unit Price	Extended Price	Logic Notes
CONSTRUC[illegible]						
Mob[illegible]						
1	Bulkhead - See Alternative 3A for details				13,001.66	
For Mine Pool Mitigation						
2	Mobilization, Bonding, Insurance	5%	%	682,800.00	34,140.00	Typical percentage of overall construction costs associated with mitigation measures
3	Construction BMPs (E&S Controls)	2%	%	682,800.00	13,656.00	Typical percentage of overall construction costs associated with mitigation measures
4	Clear & Grub area	2.00	AC*	2,500.16	5,000.32	Engineering Estimate
5	Cleanup & Demobilization	1	LS*	21,218.00	21,218.00	Engineering Estimate
					87,000.00	
Con[illegible]						
6	Contractor's Mining Engineer / Project Manager	600	HR	90.18	54,105.90	
7	Project Manager, Per Diem	60	Day	91.24	5,474.24	
8	Administration	120	HR	47.74	5,728.86	
9	Pickup Truck (miners and project manager)	60	Day	50.92	3,055.39	
10	Office Trailer	3	MO*	291.75	875.00	
11	Office phone, computer, etc.	1	LS*	2,652.25	2,652.00	
					71,900.00	
[illegible]						
12	See Alternative 3A for details				**20,600.00**	
[illegible]						
13	See Alternative 3A for details				**19,100.00**	
[illegible]						
14	See Alternative 3A for details				**175,200.00**	
[illegible]						
15	See Alternative 3A for details				**8,400.00**	
[illegible]						
16	See Alternative 3A for details				**13,100.00**	
[illegible]						
17	See Alternative 3A for details				**46,000.00**	
[illegible]						
18	See Alternative 3A for details				**11,700.00**	
[illegible]						
19	See Alternative 3A for details				**22,400.00**	
[illegible]						
20	See Alternative 3A for details				**23,200.00**	
[illegible]						
21	See Alternative 3A for details				**22,200.00**	
[illegible]						
22	Injection and Extraction Wells (3 wells at 450 ft ea)	1,350	LF	400.00	540,000.00	Judgement
23	Pumps	10,000	LS	1.06	10,609.00	Judgement
24	Onsite Power	1	LS	50,000.00	50,000.00	Judgement
25	Pre-engineered buildings (tough shed type)	2	EA	5,000.00	10,000.00	Judgement
26	Remote monitoring system	1	Ls	50,000.00	50,000.00	Judgement
					660,600.00	
SUBTOTAL FOR CONSTRUCTION - PHASE ONE					**1,181,400.00**	
27	Additional line items allowance	10	%	1,181,400.00	118,100.00	
SUBTOTAL FOR CONSTRUCTION WITHOUT CONTINGENCY - PHASE ONE					**1,299,500.00**	
28	Contingency	15	%	1,299,500.00	194,900.00	
SUBTOTAL FOR CONSTRUCTION WITH CONTINGENCY - PHASE ONE					[illegible]	
DESIGN CO[illegible] PHASE ONE						
[illegible]						
29	Site Investigation for mine pool	1	LS	190,000.00	190,000.00	Costs provided by EPA
30	Direct measurement of AMD and subsurface spatial observation	1	LS	37,500.00	37,500.00	Costs provided by EPA
31	Tunnel Mine Pool Monitoring: Hardware	1	LS	172,400.00	172,400.00	Costs provided by EPA
32	Tunnel Mine Pool Monitoring: Installation Labor	1	LS	95,000.00	95,000.00	Costs provided by EPA
33	Tunnel Mine Pool Monitoring: Software & Ops Startup	1	LS	60,000.00	60,000.00	Costs provided by EPA
34	Bedrock-Groundwater Mine pool: Hardware	1	LS	327,650.00	327,650.00	Costs provided by EPA
35	Bedrock-Groundwater Mine pool: Installation Labor	1	LS	95,000.00	95,000.00	Costs provided by EPA
36	Bedrock-Groundwater Mine pool: Software & Ops-Startup	1	LS	80,000.00	80,000.00	Costs provided by EPA
					1,057,550.00	
Engineering[illegible]						
37	Bench and Pilot Studies	1	LS	60,000.00	60,000.00	Engineering Estimate
38	Permit Application and Associated Fees	1	LS	2,000.00	2,000.00	Judgement for federal, state, and local permits
39	Engineering design & operation report	1	LS	60,000.00	60,000.00	Engineering Estimate
40	Construction oversight and as-built drawings & manuals	1	LS	60,000.00	60,000.00	Engineering Estimate
41	Administration	1	LS	15,000.00	15,000.00	Engineering Estimate
					197,000.00	
[illegible]						
42	State & Local notifications	1	LS	3,182.70	3,182.70	Engineering Estimate
43	General public notification	1	LS	3,182.70	3,182.70	Engineering Estimate
44	Trespass prevention measures	1	LS	3,713.15	3,713.15	Engineering Estimate
45	Permanent surface water control plan	1	LS	10,609.00	10,609.00	Engineering Estimate
46	Post-closure plan preparation	1	LS	10,609.00	1,389.78	Judgment (3% discount)
					22,077.33	
SUBTOTAL FOR DESIGN PHASE ONE					**1,276,627.33**	
47	Additional Line Items Allowance	5	%	1,276,627.33	63,800.00	
SUBTOTAL FOR DESIGN PHASE ONE WITHOUT CONTINGENCY					**1,340,427.00**	
48	Contingency	10	%	1,340,427.00	134,000.00	
SUBTOTAL FOR DESIGN PHASE ONE WITH CONTINGENCY					**1,474,427.00**	

Alternative 3B: Bulkhead and Mine Pool Mitigation at Big Five Adit with Phased Biochemical Reactor Treatment as Required
Captain Jack Mill Superfund Site Feasibility Study
CONSERVATIVE ESTIMATE OF MOST PROBABLE COST - CONCEPTUAL (-30% to +50%)

Alternative 3B: Bulkhead and Mine Pool Mitigation at Big Five Adit with Phased Biochemical Reactor Treatment as Required

Item No.	Line Item	Est. Qty.	Unit	Unit Price	Extended Price	Logic Notes
OPERATIO[illegible]						
Impl[illegible]						
49	Mining Engineer (quarter time for 30 years)	520	HR	50.00	509,611.48	Judgement
50	Sampling costs	1	LS	5,000.00	98,002.21	Judgement
					607,613.68	
[illegible]						
51	Effluent Discharge Testing	4	QTR	362.83	28,446.34	Laboratory Estimates
52	Annual O&M Report	1	EA	1,500.00	29,400.66	Engineering Estimate
					57,847.00	
[illegible]						
53	Monitoring program plan	1	LS	20,000.00	20,000.00	Engineering Estimate
54	50% NaOH (30 years)	470	gallon	4.31	39,697.46	Nalco Quote and Engineering Estimate
55	Recordkeeping	1	YR	15,000.00	15,000.00	Engineering Estimate
					74,697.46	
SUBTOTAL FOR OPERATION & MAINTENANCE PHASE ONE					**740,158.14**	
56	Additional line items allowance	5	%	740,158.14	37,000.00	
SUBTOTAL FOR OPERATION & MAINTENANCE PHASE ONE WITHOUT CONTINGENCY					**777,158.14**	
57	Contingency	10	%	777,158.14	77,700.00	
[illegible]						
[illegible]						
[illegible]						
[illegible]						
58	Mobilization, Bonding, Insurance	5%	%	848,638.00	42,431.90	Typical percentage of overall construction costs associated with bioreactors
59	Construction BMPs (E&S Controls)	2%	%	848,638.00	16,972.76	Typical percentage of overall construction costs associated with bioreactors
60	Clear & Grub area	1.00	AC*	2,500.16	2,500.16	Engineering Estimate
61	Cleanup & Demobilization	1	LS*	21,218.00	21,218.00	Engineering Estimate
					83,100.00	
[illegible]						
62	Contractor's Mining Engineer / Project Manager	600	HR	90.18	54,105.90	
63	Project Manager, Per Diem	60	Day	91.24	5,474.24	
64	Administration	120	HR	47.74	5,728.86	
65	Pickup Truck (miners and project manager)	60	Day	50.92	3,055.39	
66	Office Trailer	3	MO*	291.75	875.00	
67	Office phone, computer, etc.	1	LS*	2,652.25	2,652.00	
					71,900.00	
Access Road C[illegible] Access						
68	Excavation Mobilization/Demobilization	1	LS	1,485.26	1,485.26	
69	Working Foreman	25	HR	58.35	1,458.74	
70	Operator	25	HR	47.74	1,193.51	
71	Dozer, CAT D5M or equivalent	15	HR	90.18	1,352.65	Dozer, CAT D6RXL, with PAT & Ripper, per hr.
72	Excavator, CAT 315L or equivalent	15	HR	90.18	1,352.65	Excavator, CAT 330 C w/ Thumb, per hr.
73	Road Base	120	Tons	6.10	732.02	Class 6 Lafarge Aggregates estimate
74	Tandem Dump Truck	25	HR	68.96	1,723.96	
					9,300.00	
[illegible]						
75	Excavation of waste material	3,000	CY*	1.49	4,455.78	Means 02-315-424-1350; 5 CY track mounted F.E.
76	Haul to consolidation cell location	3,000	CY	2.59	7,765.79	0.5 mi RT, 20 CY dump; Judgment based on Means
77	Compaction at consolidation cell location	3,000	CY	1.91	5,728.86	Means 02-315-320-0600; 8" lifts select fill
					18,000.00	
Bioche[illegible]						
78	Surveying	1	LS	12,730.80	12,730.80	Engineering Estimate
79	Grade Subgrade	5,625	SY*	3.33	18,738.15	Means 17-03-0102; Rough Grading, 12G, 1 Pass
80	Compact Subgrade	3,825	CY	1.91	7,304.30	Means 02-315-320-0600; 8" lifts select fill
81	HDPE Liner	15,000	SF	0.85	12,730.80	60 mil liner installed
82	Clay Liner	825	CY	24.93	20,568.20	Quote per Pioneer Sand Co. in Golden, CO (including
83	Clay (compacted)	825	CY	1.06	872.60	Means 02-315-310-5080; 12" lifts, 3 passes
84	3/4" Drainage Aggregate	225	CY	23.80	5,354.10	Per value experience at waste removal projec
85	Organic Substrate	1,000	CY	65.78	65,775.80	Experience at mine reclamation project
86	Limestone	700	CY	42.44	29,705.20	Experience at mine reclamation project
87	3 or 4 inch HDPE	1,000	LF	2.25	2,249.11	Hughes Supply, Inc. Quote
88	3 or 4-inch elbows	10	EA	32.30	323.04	Hughes Supply, Inc. Quote
89	3 or 4-inch tees	10	EA	38.99	389.88	Hughes Supply, Inc. Quote
90	Geofabric	15,000	SF	0.27	3,978.38	Per value experience at waste removal projec
91	Final cover system - rooting.seed bed system	405	CY	0.73	293.88	Means 02-315-120-5020; 300 HP dozer, onsite soils
92	Final cover system - topsoil	405	CY	33.66	13,632.97	Means 02-050-150-0800 and 02-050-150-0900; 10 mile haul assumed
93	Final seeding	0.25	AC	1,136.44	284.11	Per value suggested by similar project
94	Discharge Outlet	1.00	LS	9,548.10	9,548.10	Engineering Estimate
95	Liquid Substrate Bioreactor (multiplied by factor of 2 for above costs)				408,958.79	Judgement
					613,438.00	
Sul[illegible]						
96	Excavation of ponds	1,500	CY*	1.49	2,227.89	Means 02-315-424-1350; 5 CY track mounted F.E.
97	Liner and Piping	1	LS	10,000.00	10,000.00	Judgement
98	*Commercial off-site location*	128	CY	58.35	7,483.32	Assumed to be 25% of sludge precipitated in phase one
					19,700.00	
Building [illegible]						
99	Pre-engineered steel building (50-100 ft width blds joined)	15,000	SF	9.21	138,150.00	13 34 19.50 0700 with judgement 30% discount due to size
100	Hydrogen Sulfide Gas Control	1	LS	50,000.00	50,000.00	Judgement
					188,200.00	
SUBTOTAL FOR CONSTRUCTION - PHASE TWO					**1,003,638.00**	
101	Additional line items allowance	10	%	1,003,638.00	100,400.00	
SUBTOTAL FOR CONSTRUCTION WITHOUT CONTINGENCY - PHASE TWO					**1,104,038.00**	
102	Contingency	15	%	1,104,038.00	165,600.00	
SUBTOTAL FOR CONSTRUCTION WITH CONTINGENCY - PHASE TWO					**1,269,638.00**	

Alternative 3B: Bulkhead and Mine Pool Mitigation at Big Five Adit with Phased Biochemical Reactor Treatment as Required

Captain Jack Mill Superfund Site Feasibility Study

CONSERVATIVE ESTIMATE OF MOST PROBABLE COST - CONCEPTUAL (-30% to +50%)

Alternative 3B: Bulkhead and Mine Pool Mitigation at Big Five Adit with Phased Biochemical Reactor Treatment as Required

Item No.	Line Item	Est. Qty.	Unit	Unit Price	Extended Price	Logic Notes
DESIGN CO[illegible]						
[illegible]						
103	Private property acquisition	1	LS	43,044.08	43,044.08	Based on average cost per acre for remote access areas from City of Boulder
					43,044.08	Multiplied by 0.5 for corridor of mine tunnel
[illegible]						
104	Bioreactor cells	1	LS	15,000.00	15,000.00	Costs provided by EPA
105	Bioreactor Cell Monitoring: Hardware	1	LS	133,400.00	133,400.00	Costs provided by EPA
106	Bioreactor Cell Monitoring: Installation Labor	1	LS	60,000.00	60,000.00	Costs provided by EPA
107	Bioreactor Cell Monitoring: Software & Ops-Startup	1	LS	45,000.00	45,000.00	Costs provided by EPA
108	Short term baseline studies and system O&M (6-18 mos)	1	LS	75,000.00	75,000.00	Costs provided by EPA
109	Long term annual monitoring system O&M	1	LS	50,000.00	50,000.00	Costs provided by EPA
					378,400.00	
[illegible]						
110	Bench and Pilot Studies	1	LS	53,045.00	53,045.00	Engineering Estimate
111	Permit Application and Associated Fees	1	LS	2,121.80	2,121.80	Judgement for federal, state, and local permits
112	Engineering design & operation report	1	LS	120,000.00	120,000.00	Engineering Estimate
113	Construction oversight and as-built drawings & manuals	1	LS	120,000.00	120,000.00	Engineering Estimate
114	Administration	1	LS	25,000.00	25,000.00	Engineering Estimate
					320,166.80	
[illegible]						
115	Monitoring program plan	1	LS	20,000.00	20,000.00	Engineering Estimate
116	Recordkeeping	1	YR	15,000.00	15,000.00	Engineering Estimate
					35,000.00	
SUBTOTAL FOR DESIGN PHASE TWO					**776,610.88**	
117	Additional line items allowance	5	%	776,610.88	38,800.00	
SUBTOTAL FOR DESIGN PHASE TWO WITHOUT CONTINGENCY					**815,410.88**	
118	Contingency	10	%	815,410.88	81,500.00	
SUBTOTA[illegible]					[illegible]	
[illegible]						
119	Mining Engineer (remaining 3/4 time [not included in phase 1] for 30 years)	1560	HR	50.00	1,528,834.43	Judgement and per conversations with CDPHE
120	Environmental Scientist (part time for 30 years)	1040	HR	30.00	611,533.77	Judgement and per conversations with CDPHE
121	Sampling costs	1	LS	10,000.00	196,004.41	Judgement
					2,336,372.61	
[illegible]						
122	Monitoring system design	1	LS	50,000.00	50,000.00	Judgement
123	Laboratory Testing	4	QTR	1,957.36	153,460.52	Laboratory Estimates
124	Influent and Effluent Discharge Testing	12	MO	760.00	178,756.03	Laboratory Estimates
125	Annual O&M Report	1	EA	3,182.70	62,382.32	Engineering Estimate
					444,598.87	
Annual M[illegible]						
126	Quarterly Maintenance	4	QTR	265.23	20,794.11	Judgement
127	Hauling $0.75/mile/ton. 75 mile trip	100	ton	56.25	9,617.38	Engineering Estimate
128	Disposal	100	ton	26.52	4,534.70	Engineering Estimate
129	Replacement substrate and infrastructure	3	EA	535,139.26	914,957.78	Estimated at replacing 25% of substrate
					949,903.97	
[illegible]						
130	Quarterly Maintenance	4	QTR	265.23	20,794.11	Judgement
131	Hauling $0.75/mile/ton. 75 mile trip	10	ton	56.25	44,100.99	Engineering Estimate
132	Disposal	10	ton	26.52	20,794.11	Engineering Estimate
					85,689.21	
SUBTOTAL FOR OPERATION & MAINTENANCE PHASE TWO					**3,816,564.66**	
133	Additional line items allowance	5	%	3,816,564.66	190,800.00	
SUBTOTAL FOR OPERATION & MAINTENANCE PHASE TWO WITHOUT CONTINGENCY					**4,007,364.66**	
134	Contingency	10	%	4,007,364.66	400,700.00	
SUBTOTAL FOR OPERATION & MAINTENANCE PHASE TWO WITH CONTINGENCY					[illegible]	
TOTAL FO[illegible]					[illegible]	

ASSUMPTIONS & LIMITATIONS:

1. No permits will be required.
2. Pricing is for 2008 present value with 3 percent discount rate.
3. Annual costs are set at 30 years for long-term monitoring activities and operations.
4. All excavation costs are increased by 25% due to probable pressence of historical structures which may require additional excavation precautions and procedures

* UNITS:

EA = each
HR = hour
LF = linear foot
LS = lump sum
MO = month
SF = square foot
YR = year
CY = cubic yard

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Transcript from Proposed Plan Public Meeting

CAPTAIN JACK MILL SUPERFUND SITE PUBLIC MEETING
PROPOSED PLAN FOR REMEDY

JULY 2, 2008

6:00 P.M.

The following proceedings were held at the Municipal Dojo Room, Ward, Colorado, on Wednesday, July 2, 2008, commencing at 6:10 p.m.

PRESENTERS:
Tom Simmons
Christine Laberge
Angus Campbell

ALSO PRESENT:
Ken Wangerud
Stan Spencer
Dan Shepherds
Warren Smith
Russ LeClerc
Karen Edson
John Dalton
Daniel Lutz
Mary Scott

PROCEEDINGS

MR. CAMPBELL: I'd like to introduce myself. My name is Angus Campbell. I'm with the Colorado Department of Public Health and Environment. I'm the project manager for the Captain Jack Mill Superfund site.

And tonight we're having a dual meeting. We have ATSDR, which has given a grant to the health side of the Department of Health and Environment. Tom Simmons represents -- I'm not sure. Are you in EPI?

MR. SIMMONS: Health Assessor is technically the title.

MR. CAMPBELL: What is the branch?

MR. SIMMONS: Environmental EPI.

MR. CAMPBELL: Environmental Epidemiology, and they are under grant from the Association of Toxic Substance and Disease Registry.

MR. SIMMONS: Agency for Toxic Substances and Disease Registry.

MR. CAMPBELL: Which is based out of Atlanta. And, under statute, they are required to do a health assessment of all Superfund sites.

So we're fairly lucky at this site. We have two simultaneous government documents being generated at the same time, which is fairly unusual, actually.

Tom will be going first in his presentation,

and then Christine Laberge, from Walsh Environmental, who's under contract to my office, will present the Proposed Plan for the site cleanup, and then I will talk about the Preferred Alternatives.

This is the final step in the first phase of

Superfund that we will talk about later. This is the final steps or towards the final steps of the Remedial Investigation and Feasibility Studies.

Those studies were started in 2004, and most of the fieldwork was completed in 2006. There was some other work that we'll talk about in 2007 that was done by EPA.

Any questions on the agenda or concerns or anything?

With that, I'll open it up to Tom.

MR. SIMMONS: Thank you.

Good evening. Again, my name is Tom Simmons. I'm a health assessor with the Colorado Department of Public Health and Environment, and I'm here to go over the Health Consultations that were recently published on the Captain Jack Mill site.

To start off, I kind of wanted to introduce our program a little bit, and with all the government agencies and different entities involved with the site, it can become a little bit confusing.

The Colorado Cooperative Program for Environmental Health Assessment is a public health program which is housed within the Department of Public Health.

As Angus mentioned, we receive our funding from the Agency for Toxic Substances and Disease Registry, which is a federal public health agency. Generally speaking, we conduct the same activities that ATSDR does on a national scale here in Colorado.

The primary purpose of the program is to respond to environmental health-related issues, and this can range from in-depth public health assessments all the way down to kind of educating the public on health hazards associated with lead in toys. And, again, the overall goal is to protect public health.

Some of the activities that we conducted at the CJM site include the original health assessment which was finalized in April of 2006, and that was presented a couple years ago up at Camp Tahosa, for some of you that might recall.

The most recent documents -- well, in the original health assessment, the public health hazard was classified as indeterminant, based on kind of a lack of data out there. So there was a recommendation to review the data that was going to be collected during the

Remedial Investigation and Feasibility Study and then redo the assessment.

And to accomplish that goal, we published two Health Consultations: one that focuses on surface soil and groundwater, and the other that focuses on surface water sediment in fish.

One of the major components or activities of our program are the Public Health Consultations. And there's four major components to a Public Health Consultation, and that's to review the available data, evaluate the exposure pathways and contaminants of potential concern, evaluate the public health implication of those exposures, then recommend actions to protect the public health.

The first step, reviewing the environmental data, entails gathering all the data and then screening it with the environmental guidelines that are established by ATSDR and the EPA.

If the maximum effective concentration of a particular contaminant exceeds the screening value, then we evaluate that further. If it's below, it's specifically dropped from further investigation, since it's unlikely to result in adverse health effects.

The next step is to determine kind of the exposure pathways, the "how" and "if" people are actually

going to be exposed to contaminants found in on-site surface soils, surface water, et cetera.

And there's five elements to do this. This is termed an "exposure pathway." The first is the source of contamination, transport mechanism, a contaminated environmental medium, such as surface soil, surface water, sediment, and point of exposure or lack of exposure, and a receptive population.

Really kind of the important thing to take from this is that just having the contaminant there doesn't necessarily mean that somebody is going to come into contact with it and subsequently experience adverse health effects. So, overall, the point of this step is to determine the "how" and the "if."

The next step is to determine the public health implications of those exposures. To do this, we estimate exposure doses, which are then compared to health-based guidelines established in the scientific literature.

The health-based guidelines have built-in uncertainty factors based on the contaminant, what we know about the contaminant, and any uncertainty that revolves around that contaminant.

So if the doses are below the health-based guideline, then the basic conclusion is that this

exposure route is no apparent public health hazard. If it's above, we continue to evaluate further and go into the scientific literature and look at what we know about the contaminant, the known health-effect levels, and then make a judgment as to whether or not adverse health effects are likely to occur.

And then, kind of the last step is we recommend actions to protect the public health. This could range anywhere from the remedial aspect, which is kind of being discussed tonight, institutional controls, all the way down to conducting health education activities.

Now we're going to kind of get into some of the results, but before I do that, I want to introduce some of the areas of investigation. These were established in the RI/FS, or the Remedial Investigation for Feasibility Study, and I adopted the same things for the Health Consultations.

Up at the northernmost point is the Big Five area. You'll see the acronym BFV for that. Below that is Big Five to Captain Jack; that's BFC. Captain Jack Mill is CJM. White Raven is WHR, and White Raven to Saw Mill is WRS.

They'll be referred to throughout the remainder of the presentation, and I just wanted to let

you know exactly where those areas are.

Another thing I wanted to say is that, conducting risk assessment is not really an absolute science. Some of the health hazards that are identified during this process, they're not absolute risks, meaning that not every single person that comes into contact with these contaminants is going to experience adverse health effects.

It's really impossible to know, you know, if one person is going to experience these health effects, due to a variety of uncertainties and kind of individual variability, et cetera. So, I guess, overall, it's more of an indication that health hazards could possibly occur at the site.

So, with that, we get into the results from the conclusion. Surface soil seems to be the major environmental medium of concern. We found the most hazards associated with surface soil.

There's primary Contaminants of Concern. And what Contaminants of Concern are -- that means the estimated exposure dose for these contaminants has exceeded the health-based guidelines.

So we're kind of going into that step where we're looking at the scientific literature, determining what the health effects are, and if they are likely to

occur.

On site, we had arsenic risk, noncancer risk. They exceeded human-health effects level at the Big Five Captain Jack area, the Captain Jack area, and the White Raven to Saw Mill.

The estimated exposure doses are equivalent to health effects such as keratosis, hyperpigmentation, and some possible vascular effects.

In addition to that, theoretical cancer risks were also elevated above the acceptable cancer risk range of 1 excess cancer case per million exposed individuals to 1 excess cancer case per 10,000 exposed individuals.

And the highest that we saw, I believe, occurred in the Big Five to Captain Jack, and that was about a risk of 1 excess cancer case per 100 people exposed, which is pretty significant.

And then, copper also constitutes a public health hazard. This is particularly for children. The adult risk was below the known health effect levels. And then lead also is a public health hazard in almost every area of investigation.

For copper, the known health effect levels are kind of less serious effects, including gastrointestinal distress, nausea, vomiting, things like this.

Lead is kind of unique in terms of risk

assessment. Most of what is known about lead exposure is documented in terms of blood lead levels. So what we do is, we put information that we have from the site into a predictive model, and that spits out what the probability of having elevated blood lead would be.

In this case, we determined that the cutoff is greater than a 5 percent probability that children will have -- children or fetal blood lead in pregnant women will have a blood lead level of greater than 10 micrograms per deciliter.

At CJM, the risk ranged from 88 to 99 percent of all children have a chance of blood lead levels over 10 micrograms per deciliter.

And for pregnant women, I think the fetal blood lead was from 15 to 83 percent. That range is for different areas on the site.

UNIDENTIFIED SPEAKER: Tom, what does that mean? Does that mean you have to role around in the dust, or does that mean you have to breathe it every day?

MR. SIMMONS: Good question.

People incidentally ingest soil all the time. It can be from wind-blown particulates entering your mouth, touching soil and then eating food, smoking cigarettes, any kind of hand-to-mouth activity.

Generally speaking, construction workers and

children will ingest more soil than the average adult just because of the nature of their activities. Children tend to play in the dirt more often, and construction workers are digging in the dirt.

UNIDENTIFIED SPEAKER: So it has to be done over time, so it's not a one-time occurrence?

MR. SIMMONS: Well, actually, in this case, we estimated acute exposures that occur over one day. And to do that -- this is just for children that we evaluated a few.

So to do that, we kind of elevate the soil ingestion rate to 400 milligrams per day, which is not -- that's 4/10 of a gram; not a whole heck of a lot of soil. And the acute risks were still there for copper and arsenic. So it can happen over a one-day period.

We had an example brought up the other day about a peanut butter and jelly sandwich being dropped into the soil and then eaten. This is not really the type of thing that I was thinking of, but that's one

example of how that soil could get ingested.
UNIDENTIFIED SPEAKER: So that means, if a child could get that much in one day, if he was up there for five years, he'd be dead then, huh?
MR. SIMMONS: Not necessarily. As I said, it's hard to predict what any one person, what their

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health effect levels would actually be.
And these acute risks are more for less serious adverse health effects, like the nausea, vomiting, things like this.
I would expect, once that child moved out of the area, then the exposure ceases and kind of the contaminant in the body would start to decrease as well.
But, over time, we evaluated the exposures for six years as a child chronically exposed over six years, and for adults, we assumed 30 years of exposure. Death was not a result in any of our evaluations.
UNIDENTIFIED SPEAKER: Mostly learning disabilities and stuff like that, right?
MR. SIMMONS: It's possible, particularly from lead.
Moving on to the groundwater, the major Contaminants of Concern here were cadmium, copper, manganese, and zinc. Cadmium and copper did exceed the health-based guidelines but were below known adverse health effect levels.
Overall, manganese and zinc were kind of the major contaminants that would produce any risk there. Both of these have blood effects which may or may not even be noticeable to the individual without some type of blood test or something along those lines.

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The manganese -- the overall effect of both contaminants, interestingly, is a decrease in red blood cell production from the exposures that we've estimated.
Service water, again, incidental ingestion would occur during swimming, wading. I know you can't really swim in the on-site surface waters, but just playing in the water, you incidentally ingest small amounts of surface water.
At 50 mills per day -- that's an adult rate, and the child rate is 100 mills per day -- it constitutes no public health hazard for either case; for residents,

recreational users, or construction workers.

We also looked a intentional ingestion because, historically, there's been kind of a temporary resident population up there, and it was unclear to us where exactly they were getting their water from.

Also, a possibility is someone during camping might be using this water for drinking, so we evaluated that as a potential exposure path. We don't really think it happens, but just to be safe, and if it is occurring, then we evaluated it.

If that was the case and people are drinking surface water from the site, it would constitute a public health hazard for copper, noncancer health hazards.

Next we looked at the sediment. Similar to

incidental ingestion of soil, people would ingest small amounts of sediment, as well, by playing in the water, wading in it, et cetera.

Iron produced chronic health hazards in excess of the known health effect levels. Iron health effect levels in the end range with what we estimated would be gastrointestinal illness, as well as nausea and vomiting.

Copper again came up in sediment for acute high-rate, one-day exposures. Again, the health effects associated with copper are kind of the nausea and gastrointestinal stuff.

And then arsenic did not -- the theoretical cancer risk did not produce kind of a low -- they were within the acceptable cancer risk range.

So, where do we go from here? I guess what we do is make recommendations. We're not a regulatory agency. We can't force anyone to do anything. But the idea is to make the recommendations, and there are certain things that we can do ourselves to eliminate or reduce the exposure that's occurring.

And the first recommendation dealt with just supporting the Remedial Action. Something needs to be done up there to reduce the levels that we're seeing and the health hazards.

In the meantime, what we have done, we have

put up a sign to kind of warn recreational users and some of the residents to wash your hands when leaving the area and avoid some of the activities that would result in exposure.

And I don't know that the sign is still up, but we had produced a different sign. And the first sign was based of the first Health Consultation. The second sign was revised to include both Health Consultations.

And we also recommended that worker protection measures take place for anyone that's on site doing, whether it be residential construction. Kind of the people that will be doing the remedial work have their own set of guidelines and safety protocol to go through. It doesn't specifically address them more for people that would be up there doing outside work not related to the Remedial Action.

And we also recommend that some additional groundwater sampling be conducted. The groundwater data that we currently have available is somewhat limited. And we'd also like to see the relative bioavailability of arsenic and lead established.

And what bioavailability means is kind of the percentage -- you have a certain amount of contaminant in the soil or the water or what have you. Well, only a certain amount of that contaminant is going to be

available to your body. Only a small amount will be ingested. It ranges.

We kind of use, roughly, 50 to 80 percent as a conservative estimate of what it would be. And we'd just like to see that better established so that we can better determine what the health effects might possibly be.

MR. CAMPBELL: And we have done that. The arsenic was not concentrated enough to do those studies. But that information is in the Feasibility Study.

MR. SIMMONS: And next, this is how are we going to go about doing these things? And, again, this is kind of the first item in the Public Health Action Plan, is to continue to investigate, to continue to proceed with the cleanup.

Secondly, we'll modify the current sign, as I mentioned; and lastly, is to conduct health education activities, such as this presentation, fact sheets, et cetera to inform people what hazards are there and how they can reduce their exposures.

And there's our contact information. Anybody that needs to request a copy of the documents themselves, we brought a few. They're fairly large, so I only printed five per document. We also have CDs which contain both documents on there as well.

UNIDENTIFIED SPEAKER: I think we have a

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question in back.

UNIDENTIFIED SPEAKER: I do have a question.

Other than the home that sits there -- and I don't know if there's anyone living there -- why is the site even open for recreation, or is it? Or do people just go there anyway?

MR. CAMPBELL: It's private property.

UNIDENTIFIED SPEAKER: So you can't close it.

MR. CAMPBELL: And I think it's actually a county maintained road up to -- there's actually two residences on the site. One is vacant at this point, and the other one is kind up behind the mill. And I think the county maintains it up to that first culvert. So it is a county road.

UNIDENTIFIED SPEAKER: And, Tom, when you're talking about the groundwater and the sediments, is that actually in Lefthand Creek?

MR. SIMMONS: Kind of how we evaluate it is, we combine data from each one of those exposure areas, so this will include one particular area, like the Big Five. It's going to include sediment and water data from kind of the added drainage, the settling pond itself, and some areas along Lefthand Creek.

So we'll combine that data and perform a statistical analysis on it to see what the probable

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concentration might be.

UNIDENTIFIED SPEAKER: Some of those are shown on the posters here on the wall, too.

UNIDENTIFIED SPEAKER: Have you actually sampled further down the creek?

MR. SIMMONS: I have not done any sampling myself.

MR. CAMPBELL: We sampled all the way down to Saw Mill Road.

UNIDENTIFIED SPEAKER: But not beyond?

MR. CAMPBELL: Not beyond.

Now, I do believe CU has sampled all the way down to the Linvane Intake --

UNIDENTIFIED SPEAKER: Haldi Intake.

MR. CAMPBELL: -- Haldi Intake, and from Jamestown, and also from here. And I think that data's also available.

UNIDENTIFIED SPEAKER: Yeah. We had all that, too, on our website. I can give you a card, if you want.

MR. SIMMONS: And we did consider kind of evaluating off-site surface waters in Lefthand Creek, and I think (inaudible) had mentioned that had they were interested in seeing what the levels are downstream of the site.

It kind of seemed impractical, just because of

all the loaders that are occurring along that area. We wouldn't be able to attribute it to the site. We try to keep our work site-specific. I mean, I think the loader smelter is the first off-site loader.

MR. CAMPBELL: Which is a couple hundred yards down from the site.

UNIDENTIFIED SPEAKER: How long would the cleanup take?

MR. CAMPBELL: Okay. Well, that's the next stage, and we can start with that.

Thank you, Tom. Again, if you have questions on the health assessment, I think Tom's got his contact information.

That brings up the Superfund aspect of this meeting. I neglected to introduce some people, and I'd like do that before we move on.

My counterpart, Ken Wangerud with EPA is standing there with a bottle in his hand. Stan Spencer, from Walsh, is my contract manager for Walsh. Christine Laberge is here, and she'll talk to you later.

My supervisor is Dan Shepherds, in the doorway. Warren Smith, underneath the furnace there, is with our Community Involvement Office at the State. Russ LeClerc with EPA.

Karen Edson, here in the corner, with EPA's Community Involvement; John Dalton, in the doorway; and then Danny Lutz, who put it all together today, so thank you, Danny, for that.

And then I'd like to make special presentation to Mary Scott, who's sitting down next to the wall, who will be taking over the next phase. I am moving on to greener pastures once this phase of the project is completed.

This is a formal meeting, so we have a court reporter here to record the meeting and the questions. This will all be part of the public record.

Questions today will be formally addressed in a response and a summary. We'll take verbal questions, and we'll also take written questions. So we'll talk about that after the presentations.

Do you want to go around and introduce everybody here? We could do that real quick.

UNIDENTIFIED SPEAKER: I'd like to know.

UNIDENTIFIED SPEAKER: That sounds like a good idea.

MR. CAMPBELL: Elizabeth?

MS. RUSSELL: Hi. I'm Elizabeth Russell. I'm head of the Lefthand Creek TAG Coalition, which is the community group that's involved with the cleanup at the

site. And you'll hear from me later.

MR. WILLIAMS: I'm Mark Williams. I'm with Boulder County Public Health, and I live in Jamestown.

MS. PAXTON: Kay Paxton. I'm a resident here in Ward.

MS. GILLIS: Anne Gillis. I live north of Ward here.

MR. VINCENT: Dan Vincent.

MR. IRDLE: I'm Jan Irdle.

MS. PETTEM: I'm Sylvia Pettem. I live in the Bar K Ranch subdivision, but I'm also on the Historic Preservation Advisory Board, so I'm going to have a question about buildings.

MR. BURTON: Harry Burton. I'm the general manager of the Lefthand Alliance, which is just downstream of Mile 13, is where we're headquartered. So we've got about a three-mile stretch of mining claims and property owners that -- we're doing fire mitigation work, wood shed restoration, weed control, watching birds.

UNIDENTIFIED SPEAKER: Lawrence (inaudible). Town of Ward Water Board, Town of Ward LWOG representative.

MR. LAWRENCE: Pete Lawrence. I'm the mayor of Ward.

MR. WINDELBERG: Craig Windelberg.

MR. ELBREICHT: Aaron Elbreicht.

MR. PHELPS: Shannon Phelps. I'm also on the Lefthand Watershed Board and the TAG Board and run the Seacrest Group.

MS. MIXON: I'm Geneva Mixon, and I'm the coordinator for the Lefthand Watershed Oversight Group, also known as LWOG. And I'll say a few more words about that in a little bit.

MS. PETERSON: Kathy Peterson. I'm with Lefthand Water District, and we're the people who get our water from the Haldi Intake.

MS. TONIAZZO: I'm Jan Toniazzo. I work for Lefthand Water District, and I'm also on the TAG Board.

MS. SCHAUFLER: I'm Sue Schaufler. I live in Vermeda (phonetic), and I'm on the LWOG Board and TAG Board.

MR. BOWERS: Norman Bowers. I live in Ward.

MS. ROSSITER: I'm Shannon Rossiter with the ADHE.

MS. SCHARFF: I'm Karelle Scharff, and I'm a Ward Resident.

UNIDENTIFIED SPEAKER: I'm Lloyd, and I'm a resident here.

MR. CAMPBELL: Great. Thank you very much.

Christine?

MS. LABERGE: Well, thanks, everybody, for coming. This is a good crowd.

I'm going to go over the Remedial Investigation and Feasibility Study, or the RI/FS; the tasks and the processes that we there; go through a brief site history; talk to you about the extent of contamination; go through the Remedial Action Objectives, the alternatives, and how we evaluated and compared those alternatives, and then I'll turn the presentation back over to Angus, who will talk about the Preferred Alternative.

Some of this information was already presented in a meeting that we had back in May of 2006, so some of you may have been at that meeting, and some of the information that was presented there we're not going to go over in as much detail here, but we'll try to touch on everything.

In the Remedial Investigation, we did the historical research. We did mill buildings, hazardous materials evaluation. We did a wetland delineation.

There was a lot of sampling that took place: water sampling, groundwater, vegetation, sediment, soil, waste rock, tailings. We sampled a ton of things.

And then we actually went into the Big Five Tunnel and we did some underground work, looking at what

was underground there and some mine exploration.

We did a risk assessment, but I think most of the risk was covered by Tom, so I'm not going to go into the risk issues. If you have questions on that, Tom is probably the best person to ask.

And then the Feasibility Study is designed to take the information that we figured out in the RI. So we figure out, what's at the site? What does it look like? And then the Feasibility Study says, well, what are we going to do about it?

And the Feasibility Study looks at various alternatives that we can do, different cleanup options, how much they cost, how long they'll take, what that looks like.

Comments were received and were addressed on both the RI and the FS. And if you submitted comments on that, we do have some responses to comments in the back there. We also have responses to all of the EPA and CDPHE comments that were received. So you can look at those and see the iterations that these documents have gone through.

It's been a four-year process, so these have been very well developed with multiple drafts and multiple goes at it.

Tonight we're going to really focus on the

Proposed Plan and what the agencies are recommending that we do.

This is the way a Superfund project works. So, originally, you have the pre-remedial response process, and you do a preliminary assessment and you determine, all right, the site needs some help. You go then into is RI/FS phase, which we have completed, and we are now at that the Proposed Plan phase.

So the Proposed Plan has been written, and there are copies of it right over there. If people haven't gotten a copy, make sure that you get one today.

There's a page on the back that you can write your comments and submit them, and I believe you have until July 22nd to submit those comments.

MR. CAMPBELL: In addition, there are a few copies of the RI and FS on a disc form here.

MS. LABERGE: All right. So we do have those, as well.

After we get to this 30-day period and we've gotten all the comments, we're going to officially select the remedy, and we're going to write what's called the Record of Decision, or an ROD. And this is a legal document that says, here's the plan for the site.

Once that is written, then we'll go into remedial design. We'll design the alternative. Then we

will do the alternative, the Remedial Action. And then we'll monitor it and maintain it to make sure it's doing what it needs to do.

Here's a map of the area. I think pretty much everybody knows where it is. Here's Ward, right here, and this red outline is the site.

On the site -- Tom went through this a little bit, but there a several site the features. This is an aerial photo that isn't showing up as great on the overhead.

But there's the Big Five adit. An adit is a tunnel opening. You've probably seen it out there, if you've been to the site. It has some flowing water that comes out of there.

There's the Big Five waste rock tailings pile. That's the huge pile that is right underneath that flowing adit. And then there's a pond, and if you've been on site, that's pretty apparent right there.

Then there's a wetlands. And then further on down, here is the Captain Jack Mill area. This are some buildings there. And then this right here, where this pointer is, that's where Lefthand Creek flows.

This is an historic mine map. Right here is the Big Five Tunnel, and this is historically where the tunnel had gone. And there a several other tunnels in

the area. As you know, this site was heavily mined. So this shows just a little bit of historic mine tunnel structure.

The current conditions of the site, this is the Big Five Tunnel, and this is the water flowing out. Here's another view of that same issue.

This over here is the Captain Jack Mill area, and this is that Big Five waste pile that I was talking about. The adit is right on top of it. I think it's right back in there or so. So that's what the site currently looks like.

These are the underground conditions. These are pictures of when we went in the tunnel, and that's what it's looking like. You can see some of the water. You can see some of the bracings in there.

There has been some work done -- some exploration work done on the tunnel that we can talk about further if people have questions on it, but that was a joint project with the EPA. The EPA led a lot of that mining exploration work.

The areas of contamination, we have the Big Five area, the Captain Jack area, and the White Raven area. The contamination on the site, there's about 85,000 cubic yards of material that are quote unquote contaminated.

There's about 9,000 cubic yards of material that we're saying is principal threat waste, and that is waste that requires special handling and or special considerations, and I'll talk about that shortly.

The water that's flowing out of that Big Five adit is flowing at about 50 gallons per minute, and that has metal contamination in it, and it is acidic. It has a low pH.

UNIDENTIFIED SPEAKER: Is that going into a pond?

MS. LABERGE: There is an on-site pond there that's lower. It's down gradient of the Big Five pile. Right now, that drainage is coming out, and I think it's going down one of the sides of the pile and then it's going into the pond there. But it eventually is flowing into Lefthand Creek right now.

UNIDENTIFIED SPEAKER: That's what I was asking.

MS. LABERGE: It flows through some wetlands that are on site right now, as well, so it's not just a

direct shot directly into Lefthand Creek, but it eventually gets there, and that's part of the problem.
What we found out in the RI is that we don't want to just leave this happening there, because it's not a good situation.

Principal threat waste is, like I said, material that requires special handling. For this site, principal threat waste is defined as anything that is greater than 1,460 milligrams per kilogram of lead.
Now, there are lots of other Contaminants of Concern, and Tom talked about these. Most of those Contaminants of Concern are co-located with lead, which means, if you clean up the lead, you're also going to get those other contaminants.
Now, this value was chosen because the CDPHE has a Hazardous Materials and Waste Management Division that established table value standards for industrial land use, and a mining site is appropriate for industrial land use as a classification.
Now, it doesn't mean that anything below this threshold we're going to ignore or anything. It's just, above this threshold is considered a principal threat, and we're going to address it in a special way.
So I will talk about how we'll also address those other contaminated materials, but that's less contaminated than 1460.
Does anyone have a question on this concept? Because all the alternatives are kind of based on this.
UNIDENTIFIED SPEAKER: Well, I do.
So this is for industrial land use, and it's

been established that there are residences there.
MS. LABERGE: Right. This is not the cleanup, as in this is all the cleanup that we're going to do. Principal threat waste usually establishes a higher cleanup threat that says, this is the more dangerous type of material, the material that is a bigger concern. And so that material is treated a little bit differently because it poses more of a risk.
It's not to say that material less than that doesn't pose a risk, and that material is addressed in the other alternatives. It's just that there is a threshold defined as, you want to clean up the more

contaminated areas in a different way.
And I'll talk a little bit more about how that happens, but it doesn't mean that we're cleaning the whole site up for an industrial land use. It doesn't mean that we're ignoring everything that's left.
UNIDENTIFIED SPEAKER: Are they different scales, residential versus industrial? Are those numbers different?
MR. CAMPBELL: Yes.
UNIDENTIFIED SPEAKER: Which one is higher, and which one is lower?
MR. CAMPBELL: The industrial is higher.
MS. LABERGE: The industrial is higher.

UNIDENTIFIED SPEAKER: It's higher.
MS. LABERGE: Yeah. And I'll talk about the other numbers on what we have defined as contaminated, as well.
The sources of contamination are the underground mine workings, the ore piles, the ore materials that release acidic mine drainage, the open adit, exposed waste rock and tailings piles. Those are sources of metal contamination.
That's where Tom was talking about the copper and the arsenic and the thallium; that's where those things are coming from. They're coming from the tailings that are right there. Yeah.
UNIDENTIFIED SPEAKER: Did you say that the water coming out of the mine was not contaminated?
MS. LABERGE: No, the water that's coming out of the Big Five adit does have metals in it and does have a low pH, which means it's acidic water.
It's not a clear water that's fine to go into Lefthand Creek right now, and that's why we have alternatives that specifically address that drainage, because there is some contamination in that wear.
UNIDENTIFIED SPEAKER: And action-level contamination, if that was just what you were dealing with?

MS. LABERGE: What do you mean by "action-level contamination?"
THE WITNESS: That you would have to do something with.

MS. LABERGE: Yes. The concentrations in that water that is draining out of the Big Five, they're not appropriate to just leave draining. It's not a situation -- there's risk involved with it, as Tom talked about.

So the main contamination is coming from all these areas: the soil, the tailings, the waste rock, the mine-impacted water.

Based on our sampling, these are the values that came up. Now, arsenic, lead, and thallium were the main metals that posed a risk to human health based on our risk assessment. In soil and in surface water, these were the values that we measured.

So "ND" means it was not detected. So we took a lot of samples, and the samples that we took for arsenic range from they didn't find anything in it, to 10,000 milligrams per kilogram of arsenic.

So these are the ranges that a laboratory detected when we sent them the samples. So you can see that lead got up to 177,000, so that cleanup number or that 1460 tells you that we have material that's higher

than that, obviously. But these are the concentrations that we saw in our sampling.

UNIDENTIFIED SPEAKER: Are these some of the samples, then, that, as Tom mentioned, were kind of averaged as an aggregate for identifying risk?

MS. LABERGE: The risk assessment process -- and Tom can probably talk about this a little bit more, but it's a complex process that doesn't just take one sample value here and one sample value there. There's a lot of data that goes into that.

Did you want to expand on that, Tom?

MR. SIMMONS: I'm not for sure what your question is, Mark.

We use the same data that was collected in the RI/FS, but we'll break it down into those areas of investigation. And I think they kind of did a similar thing for the RI/FS.

But once we break it down into those areas, then we'll put it into a statistical package that kind of computes what the exposure point of concentration would be. That's based on the variation of the samples, how much variation you're seeing. You know, like, we'll kind of get -- 95 UCL is a typical one that we see, which UCL is Upper Control Limit.

UNIDENTIFIED SPEAKER: (Inaudible) represent

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the highest single-point concentration in any sample collected.

MS. LABERGE: Right. And do you remember that picture at the beginning --

MR. CAMPBELL: It's just to illustrate the range.

MS. LABERGE: It is just to illustrate the range.

Do you remember that picture at the beginning that had the five sections? So the Risk Assessment looked at those sections, specifically, and these are just ranges of the lowest value that was ever seen on the site and the highest value that was ever seen on the site.

UNIDENTIFIED SPEAKER: So was there a specific spot where you can identify 177,000 milligrams per kilogram of lead?

MS. LABERGE: There is a spot where that sample came from. I personally can't point to that, because I don't know exactly where that sample is, but it's in the RI, for sure, if you want the take a look at that. And you and I can look at it together, if you want, afterwards, and we can try to find it.

UNIDENTIFIED SPEAKER: I think there were some concentrated spills around the mill.

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MR. CAMPBELL: Yeah, I think that came from the mill site.

MS. LABERGE: Ken, go ahead.

MR. WANGERUD: For those who aren't familiar with all the metric terminology, you can think of those as parts per million.

MS. LABERGE: Yeah. Okay.

So the objectives of the whole cleanup alternatives -- why are we doing these alternatives?

The EPA has a circle process. All the regulatory agencies define Remedial Action Objectives, and they abbreviate it RAOs. So you might see that, and that is what we're trying to accomplish.

So for soils, tailings, waste rock, we're trying to accomplish reducing exposure to the principal threat waste, reducing exposure to arsenic, thallium, and lead from breathing, from incidental ingestion, from touching the surface rock. We're trying to reduce that exposure.

We're also trying to control or reduce runoff where water would contact those materials, like the soil or the waste rock, and then run off and contaminate something else.

For surface water, our objective is to reduce the instream metals concentration, ensure that the metals

concentrations don't degrade drinking water sources, and then reduce the toxicity from the standpoint of an ecological point of view for the aquatic organisms.

For groundwater, we want to control or reduce any contamination that a surface water that has high metals would bring into a groundwater source. So any surface water to groundwater migration, that's one of the things we wanted to control. And we wanted to ensure that contaminated groundwater doesn't harm human health.

UNIDENTIFIED SPEAKER: So, if you wanted to control surface water to groundwater input, how do you know whether surface water is impacting groundwater into the creek itself?

MS. LABERGE: That's a great question.

Our alternatives for the contamination that's on the surface, like the soil or the waste rock or all those things, we have approached it from the standpoint of source control, saying, all right, if we can eliminate the source of contamination, if we can move it or cover it or cap it, then the surface water that touches it won't become contaminated and therefore won't go into the groundwater.

So we're taking the standpoint of source control from our alternative. If we eliminate the source of the contamination, then we won't have surface water

that will be contaminated, and then it won't go into the groundwater.

UNIDENTIFIED SPEAKER: How for back from the mine is all this contamination coming from?

MS. LABERGE: It goes back a long ways. And we have some pictures up here that kind of show a theoretical cross-section. But those tunnels go back a long way.

And that rock is all exposed, and so water that's coming out of there gets those metals in that water. So that water that's coming out is continually exposed.

And I'll talk about this a little bit further. Our alternatives are broken down into, what do we do about the material that's on the surface, like the soil and the waste rock and all of that? And then, what do we do with the water coming out that's going to be continually contaminated?

And so I'll talk a little bit more about how we address that and how we change that, because that's a great point. You can't cover up a pile of rock and then say --

UNIDENTIFIED SPEAKER: Yeah, assuming you can stop the water.

MS. LABERGE: You got it.

So we have alternatives that specifically just address that water that's coming from the mine. So I'll talk more about that, but that's a really good point.

UNIDENTIFIED SPEAKER: One more question really quick. I'm just curious, in using the industrial standard or human health thresholds, basically, and then by mentioning that you're basically calling it an advantage to this plan will be that you're going to reduce aquatic life threats, how do you know that you're not going to get caught in the middle of that?

I see a lot of mines, and I can give examples of it, where you do reduce your levels to a certain discharge standard, but yet you're severely still impacting aquatic life. How do you consider that you're claiming advantage, but you're not either looking at the previous baseline data or --

MS. LABERGE: Yeah, I see your point. Does everybody understand his question? He's saying, what if you clean it up and make it safe for humans, but you didn't clean it up enough to make it safe for aquatic life? And that's a really good point.

When we implement an alternative, you evaluate, is it effective on meeting the RAOs? Did you accomplish your objective?

And so, part of the water alternatives,

there's a decision tree in there on, are we meeting the standards for surface water throughout? Is it safe for human health and for aquatic life?

Our surface source alternatives are designed to clean up that source with the material that is from a human-health standpoint, but that's not in the stream itself.

So the water that's going to come out of there, obviously, is not going to be bringing high levels of metals into the stream, because that source is controlled.

The water itself -- the water alternatives, we're going to be looking at, is it meeting the objectives in the stream? And there are sampling points that we've established that Angus will talk about a little bit more to determine, are we meeting the criteria.

UNIDENTIFIED SPEAKER: So the aquatic water standards, there will be removal for that?

MS. LABERGE: And Angus will talk more about the specific standards that we're trying to meet for the Preferred Alternative, and he'll talk about those sampling points.

Okay. So I defined that 1460 as, anything above it is the principal threat waste, but things below

it are also considered contaminated. And if they're above these numbers, they're considered contaminated.

Does everyone understand this window that we're talking about?

So if something is above 85 milligrams per kilogram of arsenic, it's considered contaminated material.

Lead has been established by exposure area based on the Risk Assessment. So based on --

MR. CAMPBELL: And also the bioavailability.

MS. LABERGE: And the bioavailability, correct.

So there would be different types of uses of these sites. There's different bioavailability of the lead. That's why these numbers are different here.

So if you're at a certain part of the site, if you're at 700 milligrams per kilogram of lead in this area, based on the bioavailability of that lead, that's not considered contaminated. But if you're at a different area with different parameters, that would be.

MR. CAMPBELL: And the threshold for lead, I believe, is 400 for residential use. So the White Raven there, that's assuming it's all bioavailable.

MS. LABERGE: Right.

All right. So the circle process requires us

to look at a no-action alternative. If we did nothing, would it meet the RAO? So would it meet the Remedial Action Objectives? And I think after hearing everything that I've said and what Tom said, everyone can say that, no, it won't. But that's in the RI/FS.

So if you look at the document, you'll see a no-action alternative, but that is not an alternative that CDPHE or EPA is realistically looking at doing, but I need to mention it.

For the surface source, like I said, we split these up into two sections of alternatives. So 2A, 2B, 2C, all the 2s address surface contamination sources.

And after the meeting, these posters right here, these three in a row show, graphically, what those alternatives look like.

2A is basically, get everything that has all the principal threat waste and truck it off site. 2B is, get all the principal threat waste and put it in an on-site repository, which is an area that all the material is in one place, and it's capped and consolidated so that it's somewhat buried on site under a cap so you can't get to it, and then dealing with the other stuff by capping that in place.

The third alternative is, you take everything that's contaminated and you put it into on-site

repositories. There would be multiple ones. So I'll talk about those in a little bit more detail.

2B is the one that both CDPHE and the EPA have agreed to be the Preferred Alternative. It doesn't mean that this will happen no matter what. You are invited and you're encouraged to comment on all the alternatives in the circle process.

For the water that's coming out of the adit, there are four alternatives we looked at.

The first one, 3A, is a bulkhead. A bulkhead

is basically a big concrete plug. You plug up the tunnel, and everything floods. And I'll talk more about what that means.
3B is a plug, but then treating that water that's all flooded into those tunnels, treating it, actually, and improving that water quality. And then there's a second phase to that alternative which would have additional treatment.
3C would be plugging the water but treating everything outside of the tunnel. And I'll go into that in detail as well.
3D is, plug the tunnel and build a full-scale water treatment plant.
All right. This is 2A. So if we walk through what this means, we would excavate the principal threat

waste. We'd remove it to an off-site landfill. We'd truck it off the site. Then we would cap the remaining contaminated materials in place.
So anything that's still considered contaminated but was less than that 1460 would be capped in place. And a cap is soil on top. We also would be mixing in lime, which would increase the pH, and it would help stabilize those metals.
We'd put soil on top, and we'd put vegetation, and that would reduce the exposure to that material and the ability for water to contact it and then move those metals off somewhere else.
We'd divert surface water runoff during the excavation and the capping so that surface water didn't just take all this material and move it somewhere else.
And there would be access controls: fencing, signage. And those controls would be used to minimize disturbance to the site and try to reduce the impact that you could have.
UNIDENTIFIED SPEAKER: Where's the offsite landfill?
MS. LABERGE: I believe -- do you remember, Stan, the one that we selected?
MR. SPENCER: One called CSI Conservation Services, which is out in Bennett. It's run by Waste

Management, and they take specific waste that's not hazardous waste but contaminated waste.

UNIDENTIFIED SPEAKER: Eastern Colorado; is that where it is?

MS. LABERGE: I believe so. Bennett.

MR. CAMPBELL: Just east of the airport.

MS. LABERGE: So if you look at what the cost would be, all of these slides are going to have these four costs. One's construction cost, design cost, O&M cost. But this bottom number is the one that kind of sums everything together in what's considered the Present Worth Dollars.

So if you have a future expenditure, it's brought back to what it would be in today's dollars, so that everything can be compared, apples to apples. So this would cost about $2.4 million.

Alternative 2B -- and Angus will talk more about this in detail -- it would cost about $1.3 million. It's different, because we would excavate all that principal threat waste, and instead of trucking it off site, we'd put it in a repository.

And the repository would be an area with all the materials together, and we would mix lime into the top of it. We would put a geosynthetic clay liner, which is a liner that prevents water from going down into the

material. Then we would put 12 inches of soil on top of that, and then we'd put 6 inches of topsoil on top of that to help plants grow and vegetation to take hold. So that's what that cap would look like.

There's a potential location for that right by the Captain Jack Mill site, and there are some pictures of that that Angus will talk about a little bit later.

2C is similar in cost. Now, all of these costs, I should mention, they're not to the dollar on this is exactly what it's going to cost. They are designed to be within a range, and it's possible that it could take a lot more or a little bit less. We try to make them as close as we can, but you never know what's going to happen.

This is very similar to 2B, that we're doing on-site repositories, but the main difference is we pick up everything, not just principal threat waste, and we put it in repositories.

Now, the disadvantage of this alternative -- because, on the surface, it looks great. It looks like, well, it's a little bit less money, and everything goes into a repository. The problem is, it would really have a huge impact on what the site would look like.

There would be actually three repository cells. It would be a lot to maintain. The contour, the

aesthetics of the site would change dramatically.

2B is an alternative that really focuses more on preserving what is there and helping things stabilize in place. Some of the contaminated material is already starting to revegetate, and so you would help keep that material in place but keep it safe.

So I'm going to move on to the water alternatives. Does anyone have any questions on the surface alternatives?

UNIDENTIFIED SPEAKER: So it's an on-site repository. What are the chances of a flood coming along and washing it away?

MS. LABERGE: There are a lot of things that we implement called "remedy protection," and there would be big channels around the repository to take the 100-year flood and divert it around.

There would be upstream controls so that you couldn't just have something that would come and wash it away.

Whenever I do a design, when I design repositories, I put in a thing that says, you need to put down that -- you know that orange construction fence that you see along the side of the road? I say, you have to lay that down right before you get to the last layer of the cap, so that if something's starting to erode, all of

the sudden you see orange and you now, wait a minute, we're into the cap here and we only have a little bit left.

So those are the types of things that CDPHE and EPA do all the time, too, from a practical standpoint, making sure that it's maintained, it's secure and safe. So there would be channels. There would be controls like that.

UNIDENTIFIED SPEAKER: So you did study where you were going to put them and put them in the least likely affected area?

MS. LABERGE: Well, and that's also part of the remedial design. These alternatives are conceptual

level, and this is what we think would be good.
When you get into the remedial design, that's when it's more specific on, this is what it's going to look like with grading. This is exactly where it's going to go. This is an idea of where it could go. It could go in that spot. But there might be additional studies in the design that say, you know what, let's move it down gradient just a little bit, because it just works a little better there.
Also, during construction, maybe you start digging and you find more contamination that you didn't think or you accidentally take a bunch more material

here, and the repository grows. Those types of things happen during construction.
So the exact location of the repository could change based on the design.
UNIDENTIFIED SPEAKER: I want to make sure I understand your criteria for selection of 2B over 2C.
2C takes care of 85,000 cubic yards at less expense than 2D, which takes care of 5,000 cubic yards, and your principal objection to 2C is aesthetics?
MS. LABERGE: No, and I'm glad you brought that up, because if that's the impression I gave you, I need to correct that.
There are a lot of alternatives -- there are a lot of evaluation criteria that you look at. And there are actually 9 criteria, and I can go into all of those later. And, actually, there is a slide.
But if you look at long-term effectiveness and permanent implementability, cost, short-term effectiveness, all those types of things --
UNIDENTIFIED SPEAKER: Right. I've seen the list.
MS. LABERGE: From an overall standpoint, it's not just aesthetics. It's a standpoint of implementability. You have the whole Big Five waste pile that's right on the corner of the stream.

UNIDENTIFIED SPEAKER: But, apparently, it can be implemented at a less cost than 2B. And I see that there's kind of a vague reference to technical difficulty with additional consolidation cell construction, but, nevertheless, your cost estimate is coming out less for this one.

MS. LABERGE: And if you look at the cost, I think it's really close. It's 1.344 and 1.249, so we're talking about a $100,000 difference, but it's in a percentage range. And I believe these cost estimates are negative 10 to plus 30.

Ken, did you want to also talk about that?

MR. WANGERUD: I wanted to say, he's raising a very, very good question. But I know that you've got some slides coming that lay out all of the ranking criteria.

MS. LABERGE: We do. And 2B and 2C were close; they really were. It's more of a standpoint of, what is going to be easy to maintain and keep safe on the site? What will be, overall, the better picture for the site?

It's not that we're only addressing the 9,000 cubic yards in 2B and we're addressing 85 in 2C. In 2B, we're also capping everything else. So there's a cap that going onto everything else; it's just not all in one

place.

So it's not like we only build the repository and we ignore the rest. We build a repository in 2B. It's a smaller repository, but we cap everything else. So it's still a very extensive fix, because you have all that soil and all that revegetation on everything else in the site.

MR. CAMPBELL: And I think the site would be much more usable with 2B than 2C.

UNIDENTIFIED SPEAKER: Well, maybe that will become a little more clear as we go along.

MS. LABERGE: And if you also have comments even after I go through it, maybe we can talk more after the meeting. And you should definitely submit a written comment, too, if you'd like to see some different things addressed.

All right. Here's the water alternatives. This is the concrete plug, the bulkhead. So approximately 470 to 670 feet into the tunnel, we would put a 10-foot thick concrete plug.

This would back up the water. It would flood all the inner workings in the tunnel. And what that would theoretically do is it would reduce oxygen that's in the tunnel. It would reduce that acidic environment.

There would be less metals that would be dissolved in the

water, and it would contain that source.

Now, when you plug up the tunnel, there is always the chance that, well, it could flow out somewhere else. And so there's a significant monitoring program that would be associated with this that would be looking at seepage, that would be looking at surface water, that would be looking all around to see if this water is just coming out somewhere else.

It's designed to contain this water, and it's designed to help this, but it wasn't the selected alternative, because the chances that it could just flow somewhere else and the water might not be of improved quality was a risk.

3B is the one that was selected as the Preferred Alternative. You have the bulkhead in 3A, but then we are going to put injection and extraction wells into the tunnel.

So you back up all the water into the tunnel, and then you put these injection wells. And what that would do is it would come down into the water that's flooded in there, and it would inject chemicals that would increase the pH. So the metals would fall out of the water. They would become less soluble, and they would fall out into the bottom of that tunnel, improving the water quality.

And there would be an injection and extraction loop. The water would be mixed. It's basically a treatment inside the mountain. We would be treating this water and improving the water quality.

And, obviously, that has a lot of monitoring that goes with it to determine if the water is leaking out somewhere, even if it's good quality.

There's a second phase to this alternative which could be implemented, and this is the decision tree on whether that's implemented.

If the treatment is stabilized but the Remedial Action Objectives, the RAOs, are not being met for surface water, then Phase II would most likely kick in. If treatment is stabilized, if the water quality is looking fine in the tunnel and you're meeting the RAOs, you might not need Phase II.

If the treatment hasn't stabilized, additional evaluation would take place, and Phase II might go ahead and be implemented anyway at that point. Angus will talk more about this alternative, as I mentioned.

The second phase of this is a biochemical reactor. So that plug that we put in has a hole in it, has a flow-through valve that can be open and shut.

So the water is treated inside, the water quality is improving, and let's say we're not meeting the

objectives in the stream. We open that valve so the water comes back and starts flowing out of the tunnel again, but it's theoretically better quality now because it's already been treated inside.

That water would then flow into biochemical reactors, and those biochemical reactors could be on top of the waste pile that's there now or at the base of the Big Five. And it's basically microorganisms that transform hazardous materials into nonhazardous materials.

Biochemical reactors have organic material in them, and it's designed to have the water flow into the reactor, get treated, and then kind of flow out. It's not totally a passive system, because it does require some maintenance.

Hydrogen sulfide gas can be produced by these, which requires management because it has an odor to it, but the process would significantly reduce the mobility of copper, lead, zinc, and other metals that we're worried about on the site.

After the biochemical reactors, it would go into a polishing treatment, check-up phase, which means it would flow into the on-site wetlands for additional treatment, and then it would flow into Lefthand Creek.

Now, once it gets into Lefthand Creek, it's

already gone through the neutralization treatment inside the mountain. It's already gone through the biochemical reactors. And those would be managed and maintained to see if they're working and replenishing the substrate and changing the treatment within those.

And then it's going to go through the wetlands. And, obviously, there's going to be a lot of sampling points to see if it's working. But that's Phase

II.

So if we put the plug in and everything works and we inject the sodium hydroxide or whatever we inject into the tunnel itself, everything works great, we might be done, but if it doesn't, this is Phase II. So it's a phased alternative.

UNIDENTIFIED SPEAKER: And the wetlands are in existence?

MS. LABERGE: They are in existence on site right now.

3C is very similar to 3B. We put the plug in, but instead of putting those wells in to inject the chemical there and do the treatment in the tunnel, we just put the plug in, and we open the valve. And so that water starts coming out, and we treat it on site.

We do neutralization in ponds on site. It goes into the biochemical reactors. It's still somewhat

of a passive treatment system, but it would require a lot more maintenance, because you're creating all that sludge. Where those metals would be dropping out and staying inside the tunnel, you're now doing that outside, and so there would be a lot of sludge to maintain.

The fourth alternative is a full-scale wastewater treatment plant, an active wastewater treatment plant at a cost of $19.7 million. And it means building a full building, treatment plant, and doing the whole works. This was not the selected alternative.

UNIDENTIFIED SPEAKER: Which one was?

MS. LABERGE: 3B, the phased one.

We used all these criteria to evaluate the alternatives: overall protection, compliance with applicable, relevant, and appropriate requirements, ARARs.

You guys are learning all acronyms tonight, right? This is so good.

UNIDENTIFIED SPEAKER: Can you say that again?

MS. LABERGE: Applicable, relevant, and appropriate requirements.

UNIDENTIFIED SPEAKER: Say that fast three times. Now you know why they call it ARARs.

MS. LABERGE: Right.

So all of these alternatives were evaluated.

And community acceptance is part of it, and that's why we do meetings like this.
So your comment about, I'd like to see 2C looked at more or 2B, that's part of this evaluation criteria, and that's one of the things that's taken into account. So that's one of the criteria that we look at.
Comparison of alternatives, we rated these and put them in different areas. You can see on implementability, 2B is more easy to implement than 2C. From a cost standpoint, 2C is a little bit less expensive.
Overall protection and compliance with ARARs, the only reason that 2C is rated above these is because it's going to be under a more stringent cap in the repository itself, but you have to remember that those areas are still being capped, the areas that are left in place. They're not in a repository.
So this is a subjective evaluation, too. Other people might look at this and say, well, I think all three of them should be in the high here.
For the subsurface alternatives, you can see where 3B was being rated here. You can see from the standpoint of cost, so that the two phases -- obviously, it's cheeper just to plug it without doing treatment, and it's very expensive to build a water treatment plant,

which is 3D.
At this point, I'm going to get a drink of water again, and it's up to Angus.
UNIDENTIFIED SPEAKER: So what happens between September and April with the outside water treatment?
MR. CAMPBELL: For the active water treatment plant?
UNIDENTIFIED SPEAKER: Yeah.
MR. CAMPBELL: We'd just have people up there operating it.
UNIDENTIFIED SPEAKER: So this is a viable -- it wouldn't freeze up and spill over?
MR. CAMPBELL: The bioreactor or the water treatment plant?
UNIDENTIFIED SPEAKER: From 3B to D -- you know, anything that you're doing outside on a mountain.
MR. CAMPBELL: I'm going to talk a little bit about that. In fact, why don't I start.
All right. Well, after many years of

discussion and study, EPA and CDPHE had a coming of reckoning, I guess, and this is what we have decided to propose to you as our Preferred Alternative to clean up the Captain Jack site.

For the surface soils, as Christine was saying, Alternative 2B is our preferred option. The

contaminated material here is outlined in red and blue and other various colors. The principal threat waste would be excavated and consolidated in this area here.

For those of you who've been up on the site, there's a big escarpment that was created due to road construction in the county right above the Black Jack Portal, which is right here. The upper tailings impoundment is located here. The mill is just off site of this picture. This is what was termed in the documents as the Foster Residence.

So we would use this area as our repository. Actually, it would look like this, at this point, with the portal sort of in the middle of two lobes. That would be capped with a cap constructed -- basically, the waste rock would be placed in an impoundment.

The upper portions of that waste rock would be amended with a caustic material to neutralize the acidity in that soil and minimize any water that could get through the rest of the cap, help minimize the oxidation of that ore material left in that waste rock creating more acid mine drainage, so trying to break that pathway from the soils to the groundwater, as we were talking earlier.

Above that would be a geosynthetic clay liner, and that is basically a geofabric, a fabric with a

bentonite layer in between another layer of fabric, and that would be sort of sewn together.

The material comes in big rolls, and you roll it out. It lends itself to easily constructing caps in alpine environments.

The other option would be to haul in clay, to compact the clay, and that gets to be pretty expensive.

If water does get through the upper portions of the cap, it hits that bentonite. And if you're familiar with bentonite, it expands when it gets wet, when it gets hydrated, and will seal itself off.

Above that, we'd have a select fill, sort of a root zone, as you may, and above that, a 6-inch growth medium, and that would be our vegetative cap.

We selected this alternative because we expect to substantially reduce the long-term risk, reduce that contamination, that rain water falling on that material, soaking through that waste rock and getting into the groundwater and surface water.

It's implementable. All being in one place, the principal threat waste would be easily maintained. And we've also considered it fairly cost effective.

And I'm going to go back here and talk about these other areas.

Where we excavated the rock, the material that

didn't meet the threshold for principal threat waste would remain, and then we would put a vegetative cap over that. We would use a caustic material in the remaining soil, and then on top of that, we'd put 12 inches of select fill, and on top of that a 12- to 6-inch growth medium.

So we would construct a less robust cap than the principal threat waste, and the geosynthetic clay liner would not be installed in that nonprincipal threshold waste repository's capping area.

MR. WANGERUD: Angus?

MR. CAMPBELL: Yes.

MR. WANGERUD: Would you like to mention where all that dirt is likely to come from?

MR. CAMPBELL: Yes. And we do believe that there are sources on site. One of the sources might -- actually, we probably could get some material here, but additionally -- I don't have a picture of it, but up above the Big Five Tunnel there's sort of a valley there. There potentially might be some source material there.

We would like to get it on site rather than haul it in, just because of the truck traffic on Lefthand Road, and it just makes sense in terms of cost to mine it on site or close to the site.

UNIDENTIFIED SPEAKER: Angus, on that diagram,

at the bottom of the depth to waste material -- the one that you just had -- what's the minimum distance to groundwater on any of these capped sites? I mean, is it

like a foot, a couple feet, or 20 feet?
MR. CAMPBELL: In terms of the depth to the groundwater?
UNIDENTIFIED SPEAKER: Yeah.
MR. CAMPBELL: Well, let me go back and talk about -- this area, all this contaminated material would remain in place. We would not dig that up. That would just be piled. Other principal threat waste would be piled on top.
UNIDENTIFIED SPEAKER: On top. Okay.
MR. CAMPBELL: Offhand, I don't know -- this is the upper tailings empilement. It is not in groundwater, so it's above groundwater. I don't recall the separation between the bottom of the tailings pile and the groundwater.
UNIDENTIFIED SPEAKER: Do you think there's any possibility of interface there at all?
MR. CAMPBELL: I suppose if surface water levels rose, yes. If you had some sort of damming action in the creek itself to raise that water level -- you know, this is all an alluvial valley, so the soil is very responsive to extreme water levels.

So if the water gets dammed in the stream, the groundwater comes up almost synonymously to the level of the surface water.
UNIDENTIFIED SPEAKER: Excuse me. Is that something that could happen due the beaver dams?
MR. CAMPBELL: Yeah, somewhat, I think. But a beaver dam is only -- the biggest one that I've ever seen is about this high (indicating).
There's a lot of flow that comes through that, and it's pretty high gradient. The beavers do build a dam in there, but their area of influence is not going to be real big.
UNIDENTIFIED SPEAKER: During the process of actual excavation of all the materials, how far downstream could one expect for things to be impacted, especially in terms of the beaver dam down the stream, which is not too far downstream from that?
UNIDENTIFIED SPEAKER: That's a good question.
MR. CAMPBELL: I'm not sure if I really understand it.
UNIDENTIFIED SPEAKER: Like fish and aquatic life.

MR. CAMPBELL: Well, we did not find any aquatic life in the whole stretch of the river in our investigation.

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UNIDENTIFIED SPEAKER: But past there, in Lefthand.

MR. CAMPBELL: We did find some, actually, just on -- there's a culvert here that kind of goes underneath Saw Mill Road. We found fish on the downstream side of that culvert. I think they found one, maybe two. It was a small number, and they were pretty small. So there is an impact in the stream on site.

UNIDENTIFIED SPEAKER: Yeah, and would there be more --

(Group conversation.)

MR. CAMPBELL: You mean during our construction?

UNIDENTIFIED SPEAKER: -- during this whole process?

MR. CAMPBELL: Well, we certainly will minimize any impacts to the environment during construction, but the equipment that would be used is not small.

There will be bulldozers, backhoes, front-end loaders. They'll have some impact. They'll be required to do storm water management practices, sediment fences, that kind of thing; minimize any release of sediment to the stream.

If we have a 100-year flood, there may be some

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impact off site. But they are going to be required -- whoever does the construction will be required to implement best management practices for storm water control.

Was that your question? I'm sorry.

UNIDENTIFIED SPEAKER: It is, yeah. I was just wondering about the wildlife downstream.

MR. CAMPBELL: Ken, did you --

MR. WANGERUD: No, you got to the point of his question.

MS. PETTEM: Okay. Well, my question is similar.

How can you assure me that the buildings, particularly the Big Five Boarding House and the White

Raven Mill Building, will not be impacted? I mean, will the contractor be careful not to disturb that?

You're talking about bulldozers and all sorts of -- moving soil around. How do we know that those buildings will not be disturbed?

MR. CAMPBELL: That building right there is sort of outside of the area.

MS. PETTEM: That's what I call the Boarding House.

MR. CAMPBELL: Okay. That's sort of outside of anything that we're going to touch. There'll be a

construction fence all around it.

MS. PETTEM: Will they be fenced off?

MR. CAMPBELL: Right.

MS. PETTEM: Okay.

MR. CAMPBELL: We did do an historical building inventory. That was submitted to the State Historical -- SHPO. I don't know the acronym. I apologize for that.

MS. PETTEM: State Historical Preservation Office.

MR. CAMPBELL: Thank you -- who approved or accepted our proposal. The only historically significant structure was the Commodore --

UNIDENTIFIED SPEAKER: Conqueror.

MR. CAMPBELL: -- Conqueror Mill, which is located down here. That will be outside of our area. We will not be touching that.

MS. PETTEM: They didn't consider this building significant?

MR. CAMPBELL: No, they did not, nor that wall, which I think is quite beautiful, actually.

MS. PETTEM: I consider I significant, so if it comes before the HPAB Board -- I just would like some assurance that those buildings -- even if you don't consider them significant, I would like some assurance

that they will not be bulldozed.

MR. CAMPBELL: I can assure you that one will not.

MS. PETTEM: Okay. All right.

MR. CAMPBELL: The White Raven, I'm not so sure that will be able to be protected.

UNIDENTIFIED SPEAKER: What about the houses that are there as well? The Foster House or whatever it is there?

MR. CAMPBELL: We're not planning to take any of those. The Mill building, I'm not so sure. That may be taken and capped or be made part of the remedy.

MR. WANGERUD: Is that Cornish wall you were referring to the same structure that this lady is speaking of, which is just downslope?

MR. CAMPBELL: She's talking about the Boarding House, and then as you go downslope from that, as Ken mentions, there's a wall that you can see when you drive up the road to get to this building. That was not significant, either, which is too bad, because I think it's kind of neat.

MR. WANGERUD: It wasn't significant, but my observation of the site from the plans that the State has put together is that there would be no reason to have to impact that wall, and it would be a tragedy to do so.

It's a beautiful thing.

MR. CAMPBELL: Oh, I agree.

MS. PETTEM: Well, I mean, part of my concern is that this is an historical landscape, and I don't want it to end up looking like Leadville with these big, wedding-cake configurations.

MS. LABERGE: I think that's why -- if I can jump in.

That repository that we're talking about in 2B, one of the reasons we picked that spot is that we could kind of push it against that existing slope that's already cut there.

MS. PETTEM: I think that makes a lot of sense. I'm more concerned when he said they were just going to go up the hill and start digging up the soil to bring down to do that.

MR. CAMPBELL: Oh, yeah. No, I think access would be made on top of the Big Five pile, and there's a road that kind of goes up the back side there.

MS. PETTEM: If you go further up, you've got the historic road, too.

UNIDENTIFIED SPEAKER: You also have Camp Frances, which is a significant local site.

MR. CAMPBELL: All of that needs to be investigated before you start mining anything. The scope of our historical survey did not include the Camp Frances area.

Certainly, there may be material up there, but there is significance -- maybe what we could do is do an archeological study and excavation.

MS. PETTEM: I would like to make some sort of comment, since you're inviting comments.

MR. CAMPBELL: Absolutely.

MS. PETTEM: So what would be an appropriate comment to address the historic features?

MR. CAMPBELL: I hate to make comments for me to answer. Certainly, any concerns you have with historical preservation would be a comment we would look at.

MS. PETTEM: Okay. I appreciate it. Thank you.

UNIDENTIFIED SPEAKER: Can I ask a quick question about this consolidation stuff, please?

MR. CAMPBELL: Sure.

UNIDENTIFIED SPEAKER: I was wondering the reason the designs do not include an impermeable base layer to these cells to prevent groundwater intrusion?

MR. CAMPBELL: Well, we weren't going to dig up the waste.

UNIDENTIFIED SPEAKER: So is this 9,000 of

principal threat waste, is it all consolidated right now, or are you going to have a lot of mini cells --

MR. CAMPBELL: No. That's material that's not located in the area that we're proposing for the cap or the consolidation cell. So there's 85,000 yards, but most of it is where we're proposing this consolidation cell could be.

UNIDENTIFIED SPEAKER: So you will be moving some of this waste from other areas?

MR. CAMPBELL: Other areas to the area, correct.

UNIDENTIFIED SPEAKER: I'd like to go back to that groundwater level, also. I worked in the Captain Jack during the '70s, and I've seen water flowing out of that tunnel, so the groundwater does get high.

MR. CAMPBELL: Out of the Black Jack Mine?

UNIDENTIFIED SPEAKER: Yeah, heavy water flows

out of there, on occasion.
MR. CAMPBELL: Well, we haven't seen it --
UNIDENTIFIED SPEAKER: It's a hard shaft to bail out, too. There's lots of water in that hill.
MR. CAMPBELL: If that does present itself as a problem, then we'll have to address it at a future date.
UNIDENTIFIED SPEAKER: So are you going to put

wells in this area -- test wells?
MR. CAMPBELL: There are wells there now. We would maintain them. If we destroy them due to the construction, we'd have them replaced.
Monitoring will be a big portion of this aspect of the remedy, and also 3B, which I'll be talking about in a minute.
UNIDENTIFIED SPEAKER: That consolidation cell, is that going to be on private land?
MR. CAMPBELL: The whole site is on private land. And, certainly, that is going to be a big effort that we'll have to address.
We will need to talk to private land owners and have to get access agreements in place before we did anything.
UNIDENTIFIED SPEAKER: Kind of along those lines, what's to prevent somebody from digging into that cap? Do you put up signs, fencing, anything up there?
MR. CAMPBELL: We would have to have covenants put in place on the title that would require any modification to our cap to be approved by the State.
UNIDENTIFIED SPEAKER: And then the design, I noticed in the plan here it said you might cap it with rock to keep rodents from digging into it, et cetera.
MR. CAMPBELL: Potentially. A lot of those

designs -- you know, I don't like a rock pile, so I think grassy slopes, trees look a lot better than a rock pile.
UNIDENTIFIED SPEAKER: And that vegetation layer is really going to prohibit anything from going deep into that, anyway.
MR. CAMPBELL: Yes, it will.
MS. LABERGE: I think we talked about a rock apron around so that rodents couldn't get underneath that liner, but those are all things that can be determined in

the design.

MR. CAMPBELL: Those will be the design. You know, how the nuts and bolts and how the bricks are going to be stacked will be all done in the next phase.

UNIDENTIFIED SPEAKER: And the final design will be brought to the public's attention?

MR. CAMPBELL: Yes, I do believe there is a public -- is there a public comment period? I don't believe there is for design. But, historically, the State has brought those forward.

We do always try to involve the community. It's important that you guys believe in what we're doing and it's good for you. So any time you have concerns, call me, call Dan, call Mary, call Ken.

UNIDENTIFIED SPEAKER: Drive up the road and say "Hi."

MR. WANGERUD: That's what meetings are for.

MR. CAMPBELL: Yeah. And I'm quite pleased with the turnout today, to tell you the truth, so I'm glad there is interest here.

This is your backyard, and all of us are environmental professionals, and we like this state and this country and this lifestyle here as well. So, I hate to use a cliche, but we're here to help.

MR. WANGERUD: We want to do the best for you.

MR. CAMPBELL: Yes. We want to do what you want us to do, and that's the purpose of this meeting. This is what we think is best, but tell us, how can we make it better? How can we address your concerns?

Before we get to that, though, let's start with the other chapter of the cleanup, Alternative 3B.

This is the plan view. This is the adit portal for the Big Five Tunnel. About 350, 400 feet back, there was a collapse that was fixed.

The history of this tunnel was that it was driven in the late 1800s, mined, operated during the late 1800s/early 1900s, fell into disuse in the last Gold Rush of the 1980s. It was reopened and mined.

This collapsed structure was encountered when they went back in and they mined around it. And then they mined all the way back up to here or opened up the

tunnel back to here, and there was a second collapse.

In 2007, EPA Emergency Removal came in and -- behind this collapse was impounded water. We were concern of a blowout. It was unengineered plugging with water behind it. This is a drinking water source.

So what we did is we went in and rehabbed this tunnel, made it safe for the miners to go in to drain down, and we drained down the water behind this collapse and removed the collapse and the whole tunnel was rehabbed somewhat.

Our proposal is to --

UNIDENTIFIED SPEAKER: How far back was it rehabbed?

MR. CAMPBELL: About 850 feet, which is right about where the California Raise is, if you're familiar with the countryside.

In this area, we found that rock to be best for a bulkhead. Certainly, that was nothing more than just a visual evaluation. A very significant and in-depth, detailed geotechnical evaluation needs to be made on the tunnel and the rock itself, but this area would be -- a bulkhead would be installed with a flow-through valve. That bulkhead will back up water into the mine workings there.

Just to get my bearings here, I can't find my

-- here we go.

UNIDENTIFIED SPEAKER: Excuse me.

MR. CAMPBELL: Yes.

UNIDENTIFIED SPEAKER: There's something troubling to me about the notion of backing up water, in so far as water is one of those implacable substances that will go through whatever you set up.

MR. CAMPBELL: Right. The path of least resistance.

UNIDENTIFIED SPEAKER: The path of least resistance. And if you back it up there, it's just going to come out someplace else. I mean, that's a given. I can't imagine that it wouldn't do that.

MR. CAMPBELL: You're right. What will happen is that -- the mine tunnel caved in. Boom. It acted as a drain. It was the path of least resistance for the groundwater. It lowered the water table.

We'll put the plug in. It will emulate -- it won't go back to exactly what it was, but the water will back up in the mountain to something what it was like before.

UNIDENTIFIED SPEAKER: So it will just filter through large amounts of dirt --

MR. CAMPBELL: Well, let me finish the story here.

When this is backed up, what we're going to do is install a treatment system, an in-situ treatment system, treatment in place. We're going to inject an acid-neutralizing agent into the mine tunnels at depth, create a circulation path to mix that acid-neutralizing agent in the mine tunnel to increase the pH.

And by doing that, the metals precipitate out and come out as that yellow sludge that you see at a lot of mining areas. That will be deposited inside the mining tunnel.

And, over time, with that reduced oxygen and increased pH, the water quality is going to be a lot better. It will be a hugely improved system.

Yes, we do think there will be some seepage. Now, whether it's here or over here or along Lefthand Creek, which is right here, we're not sure, but we're going to be looking for it.

And we have two treatment points. One's here around the Dew Drop Tunnel/Niwot cross-cut intersection. This will have a small building there with a well head and a pump and some power to it that we'll use as an inoculation point for that underground mine pool; that's what we term it.

There will be a second well somewhere in the vicinity that would have pipes associated with it, so you

could get that circulation of that acid-reducing material in the mine workings.

Now, yes, you're right. There will be water backing up. We want to know where it's going, because there's a lot of interconnectivity, as somebody mentioned earlier. There's a lot of workings underground there; over 10,000 feet is reported in some of the historical mine reports.

So we'll have monitoring points in the tunnel itself watching how the tunnel reacts to the plug and to the inoculation of that acid mine drainage. And we'll looking over the Columbia system, too, which is closer to

Ward. It's just kind of over the hill here.
UNIDENTIFIED SPEAKER: It's in Ward.
MR. CAMPBELL: Is it in Ward?
So we're going to be looking in here. We'll probably have some monitoring wells in some of these shafts, or close to them, looking for this mine pool.
I would not suspect it would ever come back here, but we want the make sure it doesn't.
Yes, Ken.
MR. WANGERUD: If I could add a point to what Angus is saying, because you have an excellent point. And part of the design challenge for this will be to carefully understand where the surface of that

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underground reservoir of water is rising and where it's moving, because one of the requirements is going to have to be that it's not allowed to just build up indiscriminately. There needs to be a maximum --
MR. CAMPBELL: There will be a maximum height --
MR. WANGERUD: -- pool elevation in that underground reservoir of water.
And there will be substantial -- you probably noticed that the design costs were substantial for this, because not only do we perceive utilizing wells, but using some other electronic geophysics methods to keep an eye on what's happening in the subsurface.
UNIDENTIFIED SPEAKER: And what about the sludge that builds up, presumably, at the dam?
MR. CAMPBELL: Well, it will be all in the tunnel. There's quite a bit of volume in there.
Over time, as the water rises, reduces the oxygen, there will be a decrease in the metals in that fluid.
UNIDENTIFIED SPEAKER: Yeah, but because it settles out as sludge, right?
MR. CAMPBELL: That, and as the water rises, you reduce the oxygen. Oxygen is a necessary component for the reaction for the acid mine drainage to be

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generated in the first place. So if you remove the oxygen from the chemical equation, then you don't get the generation of the acidic mine drainage in the first place.

UNIDENTIFIED SPEAKER: Okay.
MR. WANGERUD: You might also want to look at the Feasibility Study. We asked that very question of the Walsh environmental team, and they went back and had a geochemist do calculations on the sludge accumulation rate over time to put us in a comfort zone that we weren't proposing something that would overload and plug the whole system with sludge. So there are calculations you'll see in there that were quite comforting to us.
MS. PETTEM: This is probably not going to be a very well received question, but with the price of gold going up and people more interested in reopening gold mines, are you saying that now all of these workings are going to be flooded forever? And what if somebody wanted to start mining? Then what would happen?
MR. CAMPBELL: We can always deal. If assurances were made and guaranteed by anybody wanting to come in to the government agencies, I'm sure we could talk to them. Those assurances would be pretty steep, however.
MS. PETTEM: Essentially, you're cutting off

any possibility of future mining.
MR. CAMPBELL: No, I disagree with that.
MS. PETTEM: Well, okay.
UNIDENTIFIED SPEAKER: It would still remain in private ownership, right?
MR. CAMPBELL: Yes, it would.
MS. PETTEM: Yeah, but, I mean, the first thing you've got to do if you reopen the mine is drain it.
MR. CAMPBELL: Drain it, treat the water, make sure you don't exceed the stream water standards. And with the new mining rules implemented after Summitville, you need to be a little more robust in your reclamation and bonding of your operation.
MS. PETTEM: But it might be a little more difficult to reopen a mine in Ward. And I'm sure they'll offer a --
UNIDENTIFIED SPEAKER: It takes $10 million to get $1 million worth of gold out of the ground around here.
MS. PETTEM: But, I mean, the Cash Mine is operating on Gold Hill, and Caribou's --
MR. CAMPBELL: They're talking about opening

up Caribou again?

MS. PETTEM: They're talking about building a

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new mill there. And I just heard something about Sugarloaf, somebody on Sugarloaf wanting to do something.

So if the price of gold continues to go up, I can foresee somebody who owns one of these historic mines wanting to reopen one.

MR. CAMPBELL: If they want to take ownership and take everything off site --

MS. PETTEM: I just thought I'd share that.

MR. CAMPBELL: No, no, that's fine. Those questions need to be asked. And, certainly, it cannot be ruled out that that could happen. Future mining could happen, but it would be with some high verbal skill, to be frank.

UNIDENTIFIED SPEAKER: I assume they would have to sign covenants because they're not paying for the things that we're doing now, potentially.

MR. CAMPBELL: Yeah. And you start getting attorneys involved, it gets complex.

MS. PETTEM: But I mean for future -- I guess my --

MR. CAMPBELL: Well, the covenants will be protection of what's in place: our cap. You know, if they want to go in there and dig it all up and haul it away, then there's nothing left to be capped, I guess is my point.

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MS. PETTEM: The point I want to make, and I'll be very short, is that you're dealing with a specific area here in the California Gulch, but by plugging this up and flooding, you're impacting all of these other mine tunnels.

MR. CAMPBELL: I would argue that we're benefiting those tunnels now by taking all of that water. We don't want that water anymore. We're going to treat, and if it backs up into your workings, it kind of demonstrates that you have some responsibility there.

Okay. Again, this is a cross-section. The bulkhead, conceptually, would be installed here. We have the neutralization loop around the Niwot cross-section, intersection, crosscut intersection with the adit at the Dupont Tunnel.

There's also an opportunity for a second treatment point around the New California Raise. That's an option for us as well.
UNIDENTIFIED SPEAKER: So how far down from the highway do you plan on the injection well being?
MR. CAMPBELL: Our primary injection will be on the west side of the highway.
UNIDENTIFIED SPEAKER: On the west side?
MR. CAMPBELL: On the west side, by the Dew Drop Portal, somewhere over there.

UNIDENTIFIED SPEAKER: So you're planning on backing water up past the highway?
MR. CAMPBELL: We are assuming that water is flowing from up there down. So if we inoculate the water up there with a high pH agent, that will help neutralize the water downstream.
UNIDENTIFIED SPEAKER: Let me rephrase the question.
What is your assumption of where the back-up will quit?
MR. CAMPBELL: Well, we did a calculation on that.
MR. WANGERUD: The answer is right here, sir. The answer is this Figure 4-5 up here. And, essentially, the concept is that water would back up behind the bulkhead.
Think of the bulkhead as just a dam to create a retention pool, and at the top end of that retention pool will be back where the Niwot crosscut comes into the Big Five Tunnel, which is approximately a half a mile up gradient, so up on the mountainside.
UNIDENTIFIED SPEAKER: So just below the Peak-to-Peak is where you think the back-up will stop?
MR. WANGERUD: No, it will start just below Peak-to-Peak Highway, and water would be backed up a half

a mile to the west, up into the mountainside.
(Group discussion.)
MR. WANGERUD: That entire underground reservoir will be to the west -- essentially, to the west of the Peak-to-Peak Highway.
UNIDENTIFIED SPEAKER: Well, that's my concern, because our water comes from up here, on the

other side of the highway, and if it starts backing up and going off into other places, it could contaminate our water supply.
MR. CAMPBELL: Surface water supply?
UNIDENTIFIED SPEAKER: Our drinking water.
UNIDENTIFIED SPEAKER: We have groundwater, but our watershed is not impacted with that.
MR. CAMPBELL: I hear what you're saying, and the purpose of all of that intensive design and monitoring is to be able to keep a sharp eye on what's going on in the subsurface so that very thing you're concerned about would not ever happen. That's the point of it.
UNIDENTIFIED SPEAKER: The mines are essentially pipes. You can take over those pipes. When you fill up the pipe, it starts working its way up. And I was wondering if you had calculated a spot where you thought it would stop working its way up?

MR. CAMPBELL: About right here.
UNIDENTIFIED SPEAKER: I can't see.
(Group discussion.)
MR. CAMPBELL: About in here. Can you see that?
MR. SMITH: Oh, there it is. Okay, where's the Peak-to-Peak Highway?
UNIDENTIFIED SPEAKER: It's up above the Dew Drop, Warren.
MR. SMITH: So it's quite a ways west.
MR. SIMMONS: I would like to say that we only went in roughly 850 feet, so we don't know what the fracture flow permeability of that rock is. That's why we're going to do very extensive monitoring, because the flooding calculations are based on very limited knowledge.
UNIDENTIFIED SPEAKER: And there probably are pipes on the east side of the highway where that water will just come right out of there.
MR. CAMPBELL: It won't happen. We won't let that happen.
UNIDENTIFIED SPEAKER: If the water builds back to there, it will.
MR. CAMPBELL: The New California Raise, we think, is the lowest point in terms of openings to that

tunnel.
UNIDENTIFIED SPEAKER: Is that correct, or is there other ones we don't know about?
MR. CAMPBELL: That's the lowest one we know of right here. That will be behind the bulkhead.
So we'll be using that as a monitoring point. If water starts shooting out of here, then we've got big problems and we'll open the valve.
UNIDENTIFIED SPEAKER: Well, if water makes it up towards the Peak-to-Peak Highway, there's a couple raises up there to shoot it out of, too.
MR. CAMPBELL: Out of the Dew Drop?
UNIDENTIFIED SPEAKER: Below the Dew Drop.
MR. CAMPBELL: Below the Dew Drop. Okay.
UNIDENTIFIED SPEAKER: And there's that huge cave-in. I don't know if you've seen that huge collapse up there.
MR. CAMPBELL: No.
UNIDENTIFIED SPEAKER: That's what we call the New California.
MR. CAMPBELL: That's the New -- where there's a trailer there?
UNIDENTIFIED SPEAKER: Yeah.
MR. CAMPBELL: That's the lowest point that we know of on that system.

UNIDENTIFIED SPEAKER: Or the highest point?
MR. CAMPBELL: It's the lowest hole coming to the surface besides the adit portal, and we'll be monitoring that frequently.
UNIDENTIFIED SPEAKER: And if that starts flowing, he's saying they'll open up the valve.
MR. CAMPBELL: We'll open up the pipe.
UNIDENTIFIED SPEAKER: And part of the concern of the monitoring, with the 8-foot snowstorm we got a couple years ago, there was an amazing amount of water, and it actually led to all of these collapses that are around.
There's a couple at (inaudible) Hill. There's one that's right up at the top of town here that opened up. That one up there is opened up.
But anyway, as soon as you start putting water in these things, you're going to end up with these massive collapses. That's just nature. The mines there,

and then that 8-foot snowstorm caused three major collapses right in this area.
So you start filling water up in that mine, the chances of you getting other major collapses are really big.
MR. CAMPBELL: Well, we will be watching, and if we do cause anything like that, then we'll go back and

do Phase II, which will decrease that mine pool level and have the in-situ treatment. Maybe I should go on and talk about that next.
This is a picture of a biochemical reactor at the Leviathan Mine in California. We envision something similar to this. It's a similar environment in terms of elevation and snowpack. This might actually have more of a snowpack and less rain water than we get here in the Rockies.
But what we envisioned is the treated water -- if we need to do Phase II, and as Christine said, there's sort of a decision tree. I can go over those again, or we can just kind of talk about our concept in the construction.
If the Remedial Action Objectives are not being achieved, then we would implement Phase II. And that, essentially, will be a bioreactor, and it can be either an organic substrate or a solid substrate, such as this one, which is basically just cobbles, where you introduce a food source for bacteria -- alcohol, molasses, and sugars for the bacteria to eat in an anaerobic environment created by the acid neutralization in the mine pool itself -- "anaerobic" meaning oxygen deficient -- to create a habitat for bugs to eat the sulphates and produce sulphides and reduce toxicity and

mobility of those metals and actually precipitate out in a black sludge.
We envision this to be constructed under a building so we can manage both temperatures and any off gases that come from that anaerobic reaction, which would be hydrogen sulphide.
UNIDENTIFIED SPEAKER: So it wouldn't be open with this one?
MR. CAMPBELL: It would not.
And then there's a polishing pond. How that

all will be designed -- if we need to implement this, we would need to go ahead and do some treatability studies on the mine pool water, because the chemistry is going to change with the neutralization phase in Phase I.

So we'd need to do some studies on volume, how much water we need to treat. If we do have some springs that are unattended that are causing problems, we'll need to increase that flow, and we'll need to build a bigger bioreactor, essentially.

So all that will be done in the design phase. The way it's looking is that we'll go ahead and construct the soils remedy, Phase I of the groundwater remedy, the mine remedy, and then monitor the site for an extended period of time, a couple years; make sure that that mine pool -- see if we can get it to stabilize; see what kind

of additional treatment we need, if any.

And then, if we need additional treatment, we'll go ahead and do some treatability studies of what is the best treatment option and how to build the best bioreactor that we can. Anything you construct is going to need operation maintenance, as well.

We selected Alternative 3B because it allows us flexibility with a phased implementation. It also allows for in-situ treatment.

Colorado has a very rich history in old mining. There are many sites in the state that have similar situations such as the Big Five Tunnel with acid mine drainage coming out.

This is an opportunity for us to look at some somewhat innovative treatment systems by doing some in-situ treatment in the mountain itself to perhaps reduce some of those impacts from other mine sites.

So we, as a state, are pretty excited about this option; to be able to use the mountain and not have to build a big water treatment plant. Those would get very expensive. And we're trying to use nature as much as we can to our benefit.

So we think that this will be a good opportunity for us to evaluate this. By doing the in-situ treatment, there wouldn't be the costly and

labor-intensive sludge management issues that you get with a normal water treatment plant.

And that also uses a semi-passive treatment. That's sort of everybody's pie in the sky. You get these passive things that sound great, but in this environment, we haven't been able to construct anything quite like that.

This is semi-passive, so it's not as energy-intensive as a water treatment plant, but yet utilizes nature to help us get to our goals, and we feel that's cost effective.

UNIDENTIFIED SPEAKER: Angus, will you consider this cell that's being created a repository for other mines in the region?

MR. CAMPBELL: No.

UNIDENTIFIED SPEAKER: Okay.

UNIDENTIFIED SPEAKER: How fast of a response would you guys come in if any of these systems failed?

MR. CAMPBELL: The Superfund process -- you saw the little pipeline there -- has a Remedial Action and Operational Maintenance.

Once the Remedial Action is complete and it goes into Operations Maintenance, we monitor it. All these things, we monitor. Every five years after an action is completed, there is a review of how successful

that remedy is.

It's called a Five Year Review, and you go in, you look at the remedy, you look at the requirements that are on the environment out there -- the ARARs, as we talked about, which are stream water standards, essentially, for the site -- soil standards.

If those standards are not being met, then additional actions need to be taken. You can't predict that at this point. We don't walk away and say, See you, Ward, Colorado. Have a good time.

UNIDENTIFIED SPEAKER: So every five years, that's a standard thing, but if levels reach something sooner than that, you would act?

MR. CAMPBELL: If something manifests itself as being blatant, yeah, that would come up earlier, yes.

UNIDENTIFIED SPEAKER: But then, we all are witnessing the scenario in Leadville with that plugged mine, and that hasn't been very smooth.

I mean, the monitoring and what have you, that has not been smooth. Is has not been a panickless event at all.

MR. CAMPBELL: No, but it has been addressed, and it was addressed fairly quickly. It wasn't smooth; you're correct.
UNIDENTIFIED SPEAKER: And I know in

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newspapers you can't believe what you read and all that, but it sounded like it wasn't smooth at all.
MR. CAMPBELL: It took a quick kick to the shin to get something going, but it got going, and they addressed the problem.
UNIDENTIFIED SPEAKER: And then they're saying it isn't solved.
MR. CAMPBELL: Well, they implemented some action. They went in there, they drilled a big hole, and they're pumping the water out, and they're treating it. So I'd say, yeah, there is action being taken.
You're right, and the concern is there that we won't be watching what we built. I trust in my agency to stand up here and say, we will take care of what we build.
UNIDENTIFIED SPEAKER: My concern is we don't have the political clout Leadville has to kick somebody in the shins.
MR. CAMPBELL: You can come and kick me in the shin. You'll have enough political clout, then.
(Group discussion and laughter.)
UNIDENTIFIED SPEAKER: And you're going on to greener pastures. So it's not my problem.
MR. CAMPBELL: We believe this will protect you and help the environment. It would comply with the

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standards. We think it's cost effective, and it will use permanent solutions. And we will be treating waste, which will meet our legal requirements under Superfund.
However, all of this can be changed by your comments, so, please, you've been giving good comments. Keep them coming. Let us address your concerns. If we need to change something to address those concerns, we'll do it.
UNIDENTIFIED SPEAKER: I have kind of a political question, and I know that there have been some calls from some elements of both the current administration and some elements in Congress to eliminate the EPA altogether.

MR. CAMPBELL: I haven't heard that. These are the guys to answer that question. I don't think they're going anywhere. Ken?
MR. WANGERUD: No. It's an agency in Leadville.
MR. CAMPBELL: Okay.
UNIDENTIFIED SPEAKER: But we're not going anywhere. They may be talking about the Superfund program specifically, which is what Ken and I represent.
But, again, we have this site and many, many other sites across the country that we have to ensure that what we've done there is indeed still working as we

designed it and protecting us.
So there's always going to be something out there, and we continue to find sites, even though we think we got all the worst ones. We've been at this for quite a while. Sites still come along. So I don't think we're going anywhere.
UNIDENTIFIED SPEAKER: I worked on the Superfund program in 1979, and we're still here.
UNIDENTIFIED SPEAKER: So how was the Captain Jack selected?
MR. CAMPBELL: How was it selected?
UNIDENTIFIED SPEAKER: Yeah.
MR. CAMPBELL: It was a fairly large effort. There was a Lefthand Canyon Task Force -- I'm not sure if that's the right acronym.
UNIDENTIFIED SPEAKER: Lefthand Watershed Task Force.
MR. CAMPBELL: Lefthand Watershed Task Force. There's a process called site assessment, and we have people in our office that go out there and take samples, look for impacts to human health and the environment. It goes through a ranking system.
Lefthand Canyon has a lot of sources on it: Jamestown, the Slide Mine out on Gold Hill, and Gold Hill coming on up here. It was a very extensive effort with

the task force to identify sources of loading to the creek and potential funding sources for that.
In Jamestown and out of Gold Hill, there were two entities that were identified as being soluble enough to clean up the site on their own. Then there was the

EPA and Forest Service using the Removal Authority and cleaning up some of the other sites.

Captain Jack was a little bigger than a lot of those sites in terms of area, and there really wasn't any viable responsible party. So the task force recommended to the governor, I believe is how it worked -- and correct me if I got the sequence here wrong. But the EPA said, okay, well, we can list this on the Superfund based on the score.

The task force was implemented to look at all this stuff and said, we can address these this way, these sources this way, these sources that way.

On Captain Jack, we couldn't figure out any way the address it, so why don't we list that on the National Priorities List -- the Superfund List.

So the task force wrote a letter to the state. The state wrote a letter to the EPA saying, yes, we think Captain Jack is a good candidate for listing on the National Priority List. And that's how it was listed, in a nutshell. I mean, it was probably a little bit more

intriguing discussion.

THE WITNESS: And you have plenty of funding to carry out this plan?

MR. CAMPBELL: We bite and scratch and kick for all the funding we can get.

UNIDENTIFIED SPEAKER: What's the trajectory on the funding for Superfund cleanups?

MR. WANGERUD: Excuse me. Are we done with the formal public comment meeting?

MR. CAMPBELL: Ken brings up a good point. This is a formal meeting, so that's a valid question. Do we have funding? That's a Superfund question.

UNIDENTIFIED SPEAKER: Yeah, to carry this project through.

MR. CAMPBELL: That's a concern. You can't predict that. We will fight for it.

This is not a high-cost Superfund remedy. Yeah, millions of dollars, that's a lot of money, but compared to other sites in the nation, it's not a whole lot.

UNIDENTIFIED SPEAKER: Chances are, you'll have it?

UNIDENTIFIED SPEAKER: Well, let me do my best to answer that question.

There's two things that have to happen. We

have to get the Record of Decision finalized. We need to make the decision on what we are going to do -- so that's the Proposed Plan comment period -- and say, okay, this appears to be supported. This is where we want to go.

Once we get that Record of Decision, then we have to go through the design step, figure out exactly what we're going to build and how we're going to build it.

That's a pot of money that I have in the agency that the agency Region 8 Denver office has to allocate across the projects in the region. There's a number of projects.

So if you're asking, is there going to be money next year for us to start the design, the answer is yes. How expensive that design is, we've got rough costs, and whether or not I can afford to pay that all next fiscal year and get that entire design done, I can't answer that question.

But we'll have money to get started, and perhaps enough to do the entire design. If not, it will slide into the next fiscal year.

UNIDENTIFIED SPEAKER: So that leads me to, what's the projected time line on getting all of this completed?

MR. CAMPBELL: I can talk about that.

The design, with the geophysics that Ken was talking about, with geotechnical work, underground work, and surficial geophysical work, we anticipate to be a construction year. It will take about a year's time.

Then we build it the following year, maybe two years, depending on how funding goes. And then we're going to monitor that underground mine pool and see how it reacts to what we're doing to it. We think that will take probably two years' time.

UNIDENTIFIED SPEAKER: Then you go into Phase II?

MR. CAMPBELL: Then we make a decision at that point. We go into Phase II. If we have to go back and get some treatability money, we'll do that, and that will probably take another year.

And then construction of the bioreactors and buildings and infrastructure for all of that, I would say probably would take another year, maybe two.

UNIDENTIFIED SPEAKER: So did I count that right? That's about eight years.

MR. CAMPBELL: Eight to ten.

Yes.

MS. RUSSELL: I just have a quick question.

So we're the Technical Advisory Group, and we're supposed to submit comments, and we have some draft

comments from our technical adviser, Joe.

And you may have heard this, but we didn't know that the final RI/FS was out until last Thursday, and Joe is now in New Zealand for five months working remotely for us still, but we just wanted to know if there's any possible wiggle room for an extension on the 30-day comment period, so that we have time to look at the final RI/FS, which we've been asking for but didn't get.

MR. CAMPBELL: To be quite honest, the RI/FS was not completed until three weeks ago.

MS. RUSSELL: Okay. So we still have until July 22nd, no matter what?

MR. CAMPBELL: You can request an extension.

MS. RUSSELL: But how do we go about doing that? Do we talk to you? I mean, we may not need to.

UNIDENTIFIED SPEAKER: Just a formal comment to us saying, We need more than 30 days to respond.

MS. RUSSELL: Okay. Well, we got an e-mail from Joe, I guess, a couple days -- today or yesterday, saying that he really -- because we had submitted comments for the draft RI/FS, that we didn't even know if those comments were incorporated into any changes or anything like that.

MR. CAMPBELL: Right. I think we brought

copies of how we addressed some of those.

MS. LABERGE: Yeah, there's a Response to Comments.

MS. RUSSELL: Yeah, I'm going to get that and check it out.

But he just said that he really would like more time to be able to look through this and make sure that, as the community group that's working on this, that we can have some comments that are useful.

MR. WANGERUD: You know, we have a remarkable ability to communicate. I know he's in New Zealand, and we might be able to get through this. But I would think that, Angus, we should definitely hit up Mr. LeClerc here, and we need to go and sit down with him in New Zealand.

(Group discussion and laughter.)

UNIDENTIFIED SPEAKER: So the bottom line is, if you feel you need more than the 30 days that's allotted, you're really providing comments to the Proposed Plan. The RI/FS is finalized. We would be interested to see if you think we missed something, but that should be applied, hopefully, to the Proposed Plan.

MS. RUSSELL: Well, and the Proposed Plan references the RI/FS in numerous places, and we hadn't seen it yet. So our comments that we have right now,

which we have officially submitted in draft form, say that we need to see the RI/FS in numerous places before we can finalize our comments.

So that's it. And maybe he'll have time to do it, but that was just a little bit quick. That's all. Because that's a big document to look at, too.

MR. CAMPBELL: Yes, I am quite familiar with how big it is.

And I did bring some copies of the RI/FS in CD format, but there's only ten I brought. If people want more, let me know. If you want them -- are there still any there?

(Group discussion.)

MR. CAMPBELL: Oh, so there's some there still.

UNIDENTIFIED SPEAKER: They're not coasters.

(Group discussion.)

MR. CAMPBELL: We ran out of cases. I apologize.

MS. RUSSELL: Okay. Thanks, Angus. We'll talk amongst ourselves and get back to you.

MR. CAMPBELL: All right. Well, with that, I'll close the public meeting, unless there's any objection. Thank you very much.

(The proceedings were concluded at 8:23 p.m.)

REPORTER'S CERTIFICATE

STATE OF COLORADO)
)ss.
CITY AND COUNTY OF DENVER)

I, Sara A. Stueve, Professional Shorthand Reporter and Notary Public for the State of Colorado, do hereby certify that said public meeting was taken in shorthand by me and was reduced to typewritten form by computer-aided transcription, that the foregoing constitutes a true transcript of the proceedings had.

I further certify that I am not an attorney nor counsel nor in any way connected with any attorney or counsel for any of the parties to said action or otherwise interested in its event.

IN WITNESS WHEREOF, I hereunto affix my hand and notarial seal this 25th day of July, 2008. My commission expires March 25, 2012.

____

Sara A. Stueve
Professional Court Reporter
Notary Public