UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION 6

RECORD OF DECISION

MOLYCORP, INC.
QUESTA, NEW MEXICO

CERCLIS ID NO: NMD002899094

DECEMBER 20, 2010

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ACRONYMS AND ABBREVIATIONS

ac-ft	acre-feet
ACGIH	American Conference of Governmental Industrial Hygienists
Al_2O_3	aluminum oxide
AOC	Administrative Order on Consent (or Order)
ARAR	Applicable or Relevant and Appropriate Requirement
ARD	acid-rock drainage
ATSDR	Agency for Toxic Substances and Disease Registry
AVS	acid volatile sulfide
BERA	baseline ecological risk assessment
BLM	Bureau of Land Management
BMI	benthic macroivertebrates
BMP	best management practice
C. dubia	*Ceriodaphnia dubia*
$CaCO_3$	calcium carbonate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeters
cm^2	square centimeter
CMI	Chevron Mining Inc. – Questa Mine
CNS	central nervous system
COC	contaminant of concern / chemical of concern
COPC	contaminant of potential concern
CTE	central tendency exposure
CVP	concentrating photovoltaic
DOI	U.S. Department of the Interior
DROs	diesel-range organics
EA	exposure area
EEA	ecological exposure area
EMNRD	New Mexico Energy, Minerals, and Natural Resources Department
EPA	United States Environmental Protection Agency
ESI	expanded site investigation
ETO	ephemeroptera, trichoptera, odonates
F	Fahrenheit
FS	feasibility study
FSP	Field Sampling Plan
GI	gastrointestinal
gpm	gallons per minute
GROs	gasoline-range organics
GSI	ground water-to-surface water interaction
HCL	hydrochloric acid
HHEA	human health exposure area
HCO_3	bicarbonate

HDPE	high-density polyethylene
HHRA	baseline human health risk assessment
HI	hazard index
HQ	hazard quotient
IC	institutional control
IC_{25}	inhibition (of growth) concentration at 25 percent
IRIS	Integrated Risk Information System
Isco	Instrumentation Specialties Company
IX Plant	ion exchange water treatment plant
kt	kiloton
lb	pound
La	lanthanum
LC_{50}	lethal concentration at 50 percent
LOAEC	lowest observed adverse effects concentration
LOAEL	lowest observed adverse effect level
Lu	lutelium
LUC	land use control
LR	Lower River
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
M&E	Mechanical and Electrical
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
$\mu g/m^3$	micrograms of particles per cubic meter of air
MMD	Mining and Minerals Division
Molycorp	Molybdenum Corporation of America
Molycorp, Inc.	Molycorp (now Chevron Mining, Inc [CMI])
MoS_2	molybdenite
m/s	miles per second
µS/cm	microSiemens per centimeter
MSGP	Multi-Sector General Permit for Storm Water Discharge Associated with Industrial Activity
MSHA	Mine Safety Health Administration
NAAQS	National Ambient Air Quality Standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NIOSH	National Institute of Occupational Safety and Health
NMAC	New Mexico Administrative Code
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NMEMNRD	New Mexico Energy, Minerals, and Natural Resources Department
NOAEC	no observed adverse effects concentration
NOAEL	no observed adverse effects level
NOEC	no observed effects concentration
NPDES	National Pollutant Discharge Elimination System
NSR	New Source Review
NTU	nephelometric turbidity unit

O&M	operation and maintenance
ONRT	Office of the Natural Resources Trustee
Order	Administrative Order on Consent
OSE	New Mexico Office of State Engineer
PAHs	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PHREEQC	PHREEQC version 2 – computer program for simulating chemical reactions and transport processes in natural or polluted water
$PM_{2.5}$	particulate matter less than 2.5 microns in size
PM_{10}	particulate matter less than 10 microns in size
PMLU	post-mining land use
PSCR	Preliminary Site Characterization Report
QCC	Questa Community Coalition
RA	remedial action
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RCRC	Rio Colorado Reclamation Committee
RD	remedial design
RfD	reference dose
RG	remediation goal
RGC	Robertson GeoConsultants
RI	remedial investigation
RI/FS	remedial investigation and feasibility study
RL	reporting limit
ROD	Record of Decision
RME	reasonable maximum exposure
RR	Red River
RRE	rare earth element
R3G	Red River Remediation Group
SCD	Taos County Soil and Conservation District
SCEM	Site Conceptual Exposure Model
SDWA	Safe Drinking Water Act
SEM	simultaneously extracted metal
SLC	screening level criteria
SMCL	secondary maximum contaminant levels
SMCRA	Surface Mining Control and Reclamation Act of 1977
SMOW	Standard Mean Ocean Water
SO_4	Sulfate
SPLP	Synthetic Precipitation Leaching Procedure
SPRI	South Pass Resources, Inc.
SRB	Stability Review Board
SRK	Steffen, Robertson and Kirsten
SVOC	semi-volatile organic compound
SWPPP	Storm Water Pollution Prevention Plan
t	ton
t/kt	tons per kiloton (of rock)

TAG	Technical Assistance Grant
TAL	Target Analyte List
TBC	To-be-considered
TDS	total dissolved solids
TMDL	Total Maximum Daily Load
TRV	toxicity reference value
TSCA	Toxic Substances Control Act
UCL	upper confidence limit
UFL	Upper Fawn Lake
URS	URS Corporation
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
USGS Baseline Investigation	Questa Baseline and Pre-Mining Ground-Water Quality Investigation
VOC	volatile organic compound
WIS	Wildlife Impact Study
WQCC	New Mexico Water Quality Control Commission
ww	wet weight
WWTP	Wastewater Treatment Plant
Y	yttrium
yd^3	cubic yards
YOY	young of the year

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PART 1
THE DECLARATION

1.0 SITE NAME AND LOCATION

The Molycorp, Inc. (Molycorp) site, currently the Chevron Mining Inc. – Questa Mine (CMI) site (hereinafter the "Site") is located near the village of Questa, Taos County, New Mexico.

2.0 STATEMENT OF BASIS AND PURPOSE

This decision document, entitled "Record of Decision" (ROD), presents the "Selected Remedy" for the Site. The Selected Remedy is chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 U.S.C. § 9601 *et seq*. and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300.

This decision is based on the Administrative Record file for the Site, which has been developed in accordance with CERCLA § 113(k), 42 U.S.C. § 9613(k).

In accordance with the NCP, the United States Environmental Protection Agency (EPA) has consulted with the State of New Mexico and the federal and New Mexico natural resource trustee agencies during development of the Selected Remedy. The State of New Mexico concurs with the Selected Remedy.

3.0 ASSESSMENT OF THE SITE

The Selected Remedy is necessary to protect the public health and welfare and the environment from actual or threatened releases of hazardous substances, pollutants and contaminants into the environment. Such a release or threat of release may present an imminent and substantial endangerment to public health, welfare, or the environment.

4.0 DESCRIPTION OF THE SELECTED REMEDY

4.1 Overall Site Cleanup Strategy

The Selected Remedy focuses on engineering controls for source containment of waste rock at the mine site and tailing at the tailing impoundment as sources of acid rock drainage or tailing seepage that contaminates ground water, surface water, and sediment at the Site. The Selected Remedy also focuses on active ground water remediation (extraction, seepage interception) and treatment, soil removals to address polychlorinated biphenyl (PCB) and molybdenum contamination, and the dredging and removal of lake sediment to address metals contamination. By focusing on source containment and ground water remediation at the mine site, including seeps and springs at zones of ground water upwelling, the Selected Remedy will improve the water quality of the Red River.

The Selected Remedy takes into account the current and reasonably anticipated future land uses. It also takes into account the current and potential future uses of ground water resources at the Site, as well as New Mexico statutes and regulations for the abatement and protection of ground water as Applicable or Relevant and Appropriate Requirements (ARARs).

The Selected Remedy is consistent with the requirements and conditions for mining reclamation and ground water abatement set forth in the current New Mexico mining permit (TA001RE) and ground water discharge permits (DP-1055 and DP-933).

The Selected Remedy includes further ground water characterization at the tailing facility to evaluate the adequacy of the remedial actions and determine whether any expansion of the remedy or additional response actions are necessary to provide protection of human health and the environment. The Selected Remedy also includes additional pilot and treatability studies for remediation of the waste rock piles and monitoring of the effectiveness of the source containment and ground water components.

4.2 Principal Threat Waste

Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained and/or would present a significant risk to human health or the environment should exposure occur.[1] PCB-contaminated soil does not warrant consideration as principal threat wastes based on concentrations alone. However, the location of the PCB-contaminated soil in an active milling facility, with constant truck and foot traffic and periodic road grading and snow plowing operations, significantly elevates the potential for mobility of the PCBs. Therefore, in considering both toxicity and mobility, the PCBs in the Mill Area constitute a principal threat. The NCP at 40 C.F.R. § 300.430(a)(1)(iii)(A) establishes an expectation that EPA will use treatment to address principal threat wastes posed by a site wherever practicable.

4.3 Major Components of the Selected Remedy

The Site has been divided into the following five areas for clean up:

- Mill Area;

[1] Additional information for defining principal threat wastes can be found in USEPA (1991b) *A Guide to Principal Threat and Low-Level Threat Wastes*.

- Mine Site Area;
- Tailing Facility Area;
- Red River, Riparian, and South of Tailing Facility Area;
- Eagle Rock Lake.

EPA will remediate Site contamination in these five areas as one Site-wide operable unit. However, recognizing the practical limitations of undertaking such a large and complex remedy at one time with very large volumes of waste rock and tailing and because the Site is currently an operating facility, EPA will implement the Selected Remedy in phases as described herein.

The Selected Remedy is a combination of the following response actions selected for each of the five areas:

4.3.1 Mill Area

For the protection of human health, the component of the Selected Remedy for the Mill Area is:

Soil Removal [High Concentrations of PCBs greater than 25 Milligrams per Kilogram (mg/kg)], Off-Site Treatment and Disposal (Low Occupancy – Commercial/Industrial); Regrade, Cover, Apply Amendments, and Vegetate after Mill Decommissioning

The major components of the Mill Area remedy are as follows:

- Continue controlled access to the site (fencing, signage, etc.);
- Continue current worker health and safety program and hazard communication;

- Excavate soil contaminated by PCBs in concentrations above the Toxic Substances Control Act (TSCA) cleanup level of 25 mg/kg for low occupancy (commercial/industrial) use;
- Perform confirmation sampling;
- Import clean fill and grade;
- Transport PCB soils to EPA-approved off-Site facilities for treatment and/or disposal;
- Regrade, cover, apply amendments and vegetate Mill Area as part of mill decommissioning;
- Monitor plant growth performance to assess if molybdenum uptake from borrow material to plants inhibits vegetative success or poses risk to wildlife;
- Perform general maintenance of the Mill Area, including water quality monitoring for all wells, seeps, and springs at the Mill Area.

4.3.2 Mine Site Area

For the protection of human health and the environment, the component of the Selected Remedy for the Mine Site Area is:

Source Containment by Regrading and Re-Contouring Waste Rock Piles to Achieve a Minimum Interbench Slope of 3Horizontal:1Vertical (3H:1V) or 2H:1V, including Partial to Complete Removal of Waste Rock to Accommodate Slope Requirements, followed by Cover, Amendment Application and Revegetation; Surface Water (Seepage) Interception, Underground Mine Dewatering, and Ground Water Extraction; Water Treatment

The major components of the Mine Site Area remedy are as follows:

- Regrade and re-contour waste rock piles to achieve a minimum interbench slope of 3H:1V, with partial or complete removal of waste rock to accommodate slope requirement; cover, apply amendments and vegetate;
- For waste rock piles where 3H:1V interbench slopes are determined to be impracticable, regrade and re-contour waste rock piles to achieve a minimum interbench slope of 2H:1V; cover, apply amendments and vegetate;
- Construct and utilize on-site repository(ies) for waste rock, the location(s) to be determined during the remedial design;
- Continue controlled access (fencing, gate, and signage);
- Continue operating existing seepage interception and ground water withdrawal well systems, dewater underground mine, pipe water to mill and treat water[2]; pH adjust water until the water treatment plant is available to treat water;
- Continue collection and conveyance of waste rock pile seepage to subsidence area on interim basis until piping and collection systems constructed at which time water will be piped to the Mill Area for treatment;
- Install new seepage collection systems near the base of Capulin and Goathill North waste rock piles to enhance seepage capture; pipe seepage to the Mill Area and treat water; decommission Capulin Leachate Collection System;
- Install and operate new ground water extraction systems in lower portion of tributary drainages; pipe water to Mill Area and treat water;
- Construct and operate water treatment plant at Year 0 Construction of the remedial action and treat water;
- Water in the underground mine will be maintained at an elevation below the Red River in perpetuity;

[2] “Water Treatment” or to “treat water” at the mine site means the use of chemical precipitation utilizing the high-density sludge treatment process. This includes solids separation of the metal precipitated sludge with proper disposal before discharging the effluent.

- Temporary well drilling restrictions will be imposed by the New Mexico Office of the State Engineer;
- Provide temporary alternate water supply or point-of-use treatment system until attainment of ground water cleanup levels;
- Continue ground water and geotechnical monitoring and general site maintenance;
- Monitor performance of store and release/evapotranspiration cover systems to assess their effectiveness at reducing infiltration to levels that allow attainment of ground water cleanup levels;
- Monitor plant growth performance to assess if molybdenum uptake from borrow material to plants inhibits vegetative success or poses risk to wildlife;
- Monitor performance of the seepage interception and ground water extraction well systems to assess effectiveness at achieving ground water cleanup levels;
- Perform additional molybdenum characterization of Spring Gulch waste rock pile to assess suitability as borrow material for cover.

4.3.3 Tailing Facility Area

For the protection of human health and the environment, the component of the Selected Remedy for the Tailing Facility Area is:

Source Containment by Regrade, Cover and Revegetation of Tailing Impoundments; Upgrade Seepage Collection; Piping of Irrigation Water in Eastern Diversion Channel; Continue Ground Water Extraction with Additional Extraction Southeast of Dam No. 1(MW-4 and MW-17 Area); Water Treatment

The major components of the Tailing Facility Area remedy are as follows:

- Perform additional ground water characterization in the bedrock aquifer beneath and west of tailing impoundments , as well as in the bedrock and/or alluvial aquifer downgradient of Dam No. 1;
- Cover and revegetate tailing facility (and remove limited soil at the dry maintenance area at the cessation of tailing deposition);
- Replace the lower 002 seepage barrier with extraction wells and replace the upper 003 seepage barrier with a deeper barrier; treat water;
- Pipe unused irrigation water in the eastern diversion channel to prevent infiltration through historic buried tailing;
- Install and operate ground water extraction well system in alluvial aquifer southeast of Dam No. 1 and downgradient of historic buried tailing; treat water;
- Refurbish existing ion exchange plant or construct new water treatment plant at Year 0 Construction of the remedial action and operate to treat water;
- Temporary well drilling restrictions will be imposed by the New Mexico Office of the State Engineer
- Provide temporary alternate water supply or point-of-use treatment system until attainment of ground water cleanup levels;
- Control access to the site, including use of an exclusion fence to restrict access by deer and elk; provide wildlife drinkers;
- Continue tailing dust control measures;
- Perform air monitoring;
- Monitor water quality at Red River State Fish Hatchery;
- Monitor remedy performance to assess effectiveness in achieving ground water cleanup levels southeast and downgradient of Dam No. 1;

- Monitor remedy performance to assess effectiveness in achieving ground water cleanup levels downgradient of Dam No. 4 and Dam No. 1 in the alluvial and bedrock aquifers;
- Monitor performance of store and release/evapotranspiration cover system to assess effectiveness in reducing infiltration to levels that allow dewatering of the tailing piles and attainment of ground water cleanup levels;
- Monitor metals uptake in plant tissue;
- Monitor tailing piles for early detection of acid generation and metals leaching;
- Perform monitoring and maintenance of tailing dams;
- Continue ground water monitoring and general site maintenance.

4.3.4 Red River and Riparian and South of Tailing Facility Area

For protection of wildlife and livestock in the area south of the tailing facility and wildlife in the Red River riparian corridor, the component of the Selected Remedy for the Red River and Riparian and South of Tailing Facility Area is:

Removal of Soil and Tailing Spill Deposits and On-Site Disposal

The major components of the Selected Remedy for the Red River, Riparian, and South of Tailing Facility Area are as follows:

- Excavate soil contaminated with molybdenum south of tailing facility and tailing spill deposits along the Red River riparian corridor, including the large tailing pile at the Lower Dump Sump;
- Dewater soil in area south of tailing facility and stabilize excavated soil;
- Transport and dispose excavated soil and tailing at the tailing facility;

- Backfill excavations with alluvial soil.

Red River water quality is being addressed through response actions at the Mine Site Area to reduce Contaminants of Concern (COCs) entering the river from ground water at seeps and springs, including source control measures for the waste rock piles. However, the following performance monitoring of the Red River is included with the component of the Selected Remedy for the Red River, Riparian, and South of Tailing Facility Area:

- Perform physical, chemical and biological monitoring of the Red River to assess effectiveness of response actions at the Mine Site Area on improving Red River surface water quality and protecting aquatic life.

4.3.5 Eagle Rock Lake

For protection of the environment, the component of the Selected Remedy for Eagle Rock Lake is:

Inlet Storm Water Controls; Dredge Sediment and On-Site Disposal

The major components of the Eagle Rock Lake remedy are as follows:

- Install inlet controls to manage storm water entering the lake;
- Dredge and dewater sediment;
- Transport and dispose excavated sediment at an appropriate on-Site facility;
- Perform physical, chemical and biological monitoring to assess long-term effectiveness of Eagle Rock Lake remediation.

5.0 STATUTORY DETERMINATIONS

The Selected Remedy complies with the mandates of CERCLA § 121 and the regulatory requirements of the NCP. The Selected Remedy is protective of human health and the environment, complies with federal and state ARARs for the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

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

Because the Selected 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 remedial action to ensure that the remedy is or will be protective of human health and the environment. Such a review will be conducted every five years after the date of the initiation of the remedial action.

6.0 ROD DATA CERTIFICATION CHECKLIST

The information identified below is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for the Site.

- COCs and their respective concentrations.
- Baseline risk represented by the COCs.
- Cleanup levels established for the COCs and the basis for these levels.
- How source materials constituting principal threats are addressed.

- Current and reasonably anticipated future land use assumptions and current and potential future uses of ground water used in the baseline risk assessments and ROD.
- Potential land and ground water use that will be available at the Site as a result of the Selected Remedy.
- Estimated capital, lifetime operation and maintenance (O&M), and total present value costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- Key factors that led to selecting the remedy.

7.0 AUTHORIZING SIGNATURE

This ROD documents the Selected Remedy for contaminated soil, ground water, surface water and sediment at the Site. EPA selected this remedy with the concurrence of the New Mexico Environment Department (NMED, see Appendix A). The authority to approve this ROD has been delegated to the Director of the Superfund Division (EPA, Region 6).

Sam Coleman

Samuel Coleman, P.E.
Superfund Director
EPA Region 6

12/20/10
Date

CONCURRENCE PAGE
RECORD OF DECISION
MOLYCORP, INC

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Remedial Project Manager
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Chief, LA, OK, and NM Section
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PART 2
DECISION SUMMARY

1.0 SITE NAME, LOCATION, AND BRIEF DESCRIPTION

The Molycorp Inc. (Molycorp) site, currently the Chevron Mining Inc. – Questa Mine (CMI) site (hereinafter the "Site") is located near the Village of Questa in Taos County, New Mexico (see Site Location Map, Figure 1-1). The National Superfund Database Identification Number is NMD002899094.

The United States Environmental Protection Agency (EPA) is the lead agency for this decision document, which is entitled "Record of Decision, Molycorp, Inc., Questa, New Mexico" (ROD). The support agencies are the New Mexico Environment Department (NMED) and the New Mexico Energy, Minerals, and Natural Resources Department's (EMNRD's) Mining and Minerals Division (MMD). The federal and state natural resource trustee agencies involved with the Site are the U.S. Department of the Interior (DOI), U.S. Fish and Wildlife Service (USFWS), U.S. Department of Agriculture – Forest Service (U.S. Forest Service), DOI's Bureau of Land Management (BLM), and the State of New Mexico's Office of the Natural Resources Trustee (ONRT).

The Selected Remedy set forth in the ROD was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §§ 9601 to 9675 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300. This decision is based on the Administrative Record for the Site.

The Site consists of an operating underground molybdenum mine, milling facility, and tailing disposal impoundments (tailing facility) owned and operated by CMI, as well as other areas, where mining practices have resulted in the release or threatened release of hazardous substances, pollutants, or contaminants (hereinafter "contaminants")[3]. The mine site includes an historic open pit and nine massive waste rock piles. Other contaminated areas of the Site are the Red River and its riparian corridor, Eagle Rock Lake, and a residential and agricultural area south of the tailing facility where past tailing disposal practices resulted in contamination of soil, and ground water which has migrated beyond the mine site or tailing facility boundary. This Site-related contamination threatens both human health and the environment. The Site is located entirely within the Red River Watershed. Maps of the Mine Site Area and Tailing Facility Areas are depicted on Figures 1-2 and 1-3.

[3] A "release" is defined in CERCLA as any spilling, leaking, pumping, pouring, emitting, emptying discharging, injecting, escaping, leaching, dumping, or disposing of hazardous substances into the environment. "Hazardous substance" includes substances defined as "hazardous waste" under the Resource Conservation Recover Act, as well as substances regulated under the Clean Air Act, Clean Water Act, and Toxic Substances Control Act. In addition, any element, compound, mixture, solution, or substance may also be specifically designated as a "hazardous substance" under CERCLA. "Pollutant or contaminant" is defined in CERCLA as any element, substance, compound, or mixture that, after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, will or may reasonably be anticipated to cause illness, death, or deformation in any organism.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Chevron Corporation acquired Molycorp through a corporate merger with the Union Oil Company of California (UNOCAL) in 2005. UNOCAL had owned Molycorp since 1977. In 2007, Chevron Corporation combined its mining subsidiaries Molycorp and the Pittsburg and Midway Mining Company to become CMI. In this ROD, the name "Molycorp" is used when referring to activities which occurred prior to about 2007.

2.1 History of Mining and Milling Activities

Molycorp (originally the Molybdenum Corporation of America) began mining the Site in 1919. Major periods of mining activity included three distinct operational phases:

- **1919 – 1958** Mining was conducted by conventional underground methods. Small-scale underground mining operations were conducted until 1923 when Molycorp built the milling facility. By 1954, the underground workings extending over 35 miles at 14 production levels. By this time, all but the three lowest production levels were designed to drain ground water by gravity out the Moly Tunnel above the elevation of the Red River.

  The historic mill, a 40-ton per day capacity floatation mill, operated from 1923 to 1958, and the historic tailing was also placed in this location during the same time period, prior to construction of the current tailing facility. Historic tailing was deposited in two tailing impoundments located adjacent to the old mill. Of the estimated 280,000 tons of tailing placed at the mill, approximately 80,000 tons were remilled, while 200,000 tons of tailing remain on site.

- **1964 – 1983** The second phase of mining was conducted using open pit methods after intense exploration drilling and drifting (near horizontal mining) in the late 1950s led to the discovery of a near surface, large tonnage, low-grade ore body averaging 0.17 percent molybdenite. A floatation mill with a capacity of 10,000 tons per day was constructed (present mill) in the mid-1960s to process the ore and the first of the tailing dams was constructed together with the nine-mile long tailing pipeline to transport tailing from the mill to the new tailing facility. In 1969, the mill was expanded to 15,000 tons per day and striping was increased to 120,000 tons per day. By 1975, exploration drilling had defined another large and comparatively-rich ore body (third ore body) extending southwest beneath the open pit.

- **1983 – Present** The current phase of mining of this third deposit began in 1983 using underground block-caving methods, and the mill was expanded to 18,000 tpd. This method creates a surface disturbance (subsidence area) above the underground ore extraction areas. The mining of this third deposit was temporarily discontinued in 1992, resumed in 1996, and continues today.

2.2 History of Tailing Disposal Activities

2.2.1 Tailing Pipeline

After the molybdenum is extracted at the mine through milling and concentrating operations, the spent tailing is transported as slurry in two 14-inch pipes to the tailing impoundments at the tailing facility. The tailing pipeline originally consisted of two 10-inch pipes of 3/8-inch thick steel. However, the pipes were found to wear from the abrasion of the tailing slurry. Over 230 reported tailing spills occurred from 1966 through 1991 along the Red River floodplain, mostly as a result of the abrasion. The pipes were eventually replaced with 14-inch outer diameter, rubber-lined steel pipes with victaulic couplings and 14-inch dresser couplings. Only three spills have been reported since 1996. The pipeline only carries tailing slurry when the mill is operational. The remainder of the year, water collected from mine dewatering, supply wells, and seepage collection systems and extraction wells is pumped through the pipeline in order to maintain the integrity of the pipeline and for dust suppression at the tailing facility. Water or slurry is pumped through the tailing pipeline at a flow rate of up to 2,800 gallons per minute (gpm) per pipe.

There are two emergency basins currently located along the pipeline corridor: the Upper Dump Sump and Lower Dump Sump. The Upper Dump Sump is located adjacent to the Red River and across State Highway 38 from the CMI administrative area at the mine site. The Lower Dump Sump is located adjacent to the Red River on Old Red River Road. The sumps are simple containment structures constructed for tailing management during maintenance of the pipeline. The Lower Dump Sump is lined with concrete. The Upper Dump Sump is a bowl-shaped depression lined with an impermeable membrane. It is fenced off for restricting access. If a problem develops with the pipeline, such as a blockage or break, the current practice is to empty the pipe into the sumps, repair the problem with the pipeline, and then clean out the tailing from the sump and truck it to the tailing facility for disposal. Monitoring wells have been constructed at both sumps for monitoring ground water quality.

2.2.2 Tailing Facility

Disposal of tailing at the tailing facility began in 1966 with the construction of Dam No. 1. Dam No. 4 was constructed in 1971. During the period from 1971 to 1991, tailing was deposited behind Dam No. 1 and Dam No. 4. The diversion channels along the west and east perimeter of the ponds were constructed in 1975 to divert surface water flow around the facility to the Red River. Molycorp built the ion exchange plant in 1983 to remove molybdenum from decant water below Dam No. 4 before discharging the water to the Red River via Pope Creek. Before then, waste water discharges to the Red River were untreated. Water from the ion exchange plant was piped to a holding pond (Pope Lake) before being discharged to Pope Creek and the Red River. This discharge was permitted as Outfall 001 under the EPA's National Pollutant Discharge Elimination System (NPDES) Program in 1993 (see Section 2.5, below). In 1991, Dam No. 5A was constructed. Tailing deposition ceased in 1992 with the temporary shutdown of mining operations, but recommenced in 1996 behind Dam No. 5A. Tailing deposition is currently active behind Dam No. 4. Well over 100 million tons of fine-grained tailing have been deposited at the tailing facility since its construction in 1966. The thickness of the tailing deposit varies from over a few tens of feet to over 200 feet. A map of the tailing facility features is depicted on Figure 2-1.

CMI uses several different operational methods to control dust at the tailing facility. Tailing is deposited into small cells of approximately 100 acres and a water cover is used to the extent practicable. In addition, soil binders (*i.e.,* emulsion/tackifiers), soil cover, and straw mulch are used in areas where water cover cannot be maintained. Snow fencing is also used to disrupt the wind currents and reduce windblown dust. Long-term air quality monitoring (particulate matter greater than 10 microns in size or PM_{10} monitoring) is also performed at six stations surrounding the perimeter of the facility.

A one-megawatt solar energy facility and alternate cover depth pilot demonstrations are being constructed on the northeastern portion of the tailing facility by CMI and Chevron Technology Ventures in 2010 under a permit amendment to New Mexico Ground water Discharge Permit DP-933. The pilot demonstrations will be conducted for a period of five years. The solar facility includes 173 solar panels, electrical distribution systems, control buildings, weather stations and other related equipment and access roads. The cover depth pilot demonstration will evaluate alternate thicknesses of 1, 2, and 3 feet for a monolithic (store-and-release) soil cover composed of local alluvium soil for protection of human health and the environment. The solar and cover projects will be located on approximately 21 acres of surface area which has been partially reclaimed with an interim six-inch soil cover and vegetation after tailing disposal ceased in 1980.

2.2.3 Tailing Potentially Used as Bedding for Municipal Water Supply Piping

For many years local residents have stated that mining tailing was used as bedding material for municipal water supply piping and other utility lines within the village of Questa. On numerous occasions when the municipal water supply pipes needed repair, a bedding material consistent with typical tailing was encountered during excavation of the water pipes. On November 17, 2003, the Taos County Soil and Conservation District (SCD) excavated a trench from Hunt's Pond to the Red River in order to drain water and sediment from the pond. The purpose was to remove algae and other organic matter from the pond. The contractor for SCD performing the excavation notified Molycorp of the discovery of tailing within the trench. Molycorp officials visited the site and reported observing a material that "appeared to be tailing" at three locations in the trench: a thin (1- to 2-inch deep) layer on the bottom of the trench, and a one-foot thick band along both walls of the trench near the bottom of the excavation. The tailing material was removed from the trench and disposed at the tailing facility. A small sample was taken to the Molycorp assay lab for analysis. The results of the analysis showed the molybdenum sulfide content was consistent with typical tailing. See Tailing in Hunt's Pond, Section 3.7.4, below.

2.3 Current Water Management Practices

2.3.1 Water Management – Mine Site

CMI performs collection, conveyance, and operational processes or disposal methods for mine water, storm water, and surface water (seepage) under New Mexico ground water discharge permits and NPDES storm water and discharge permits.

2.3.1.1 Underground Mine Water Management

Water in the underground mine is managed by a series of dams, ditches, and piping on the lowest haulage level at an approximate elevation of 7,120 feet. Water that collects is conveyed by centrifugal pumps and sump pumps toward the east to a primary collection sump and dam near the bottom of the decline, a tunnel connecting the mill to the underground mine workings. From this location, water is pumped through a pipeline up the decline to the surface, and then to a sump (Sump 5000) adjacent to the mill. Mine water and tailing (when the mill is operating) are combined at Sump 5000 and enter the tailing pipeline. The tailing pipeline receives underground mine water on a continuous basis independent of milling operations.

At the mill, water from the underground mine and other collected water[4] is used as makeup water for transporting tailing as slurry to the tailing facility during milling periods or to maintain a continuous flow of water in the tailing pipeline for maintenance purposes and for dust suppression at the tailing facility during non-milling periods. The continuous flow of water minimizes expansion/contraction of the pipeline. Because the milling process is an alkaline process which uses lime, the collected water and leachate are not pH-adjusted before mixing with the tailing. During non-milling periods, the collected water requires lime to be added to adjust the pH of the water between 6.0 to 9.0 standard units to meet NMED Ground Water Discharge Permit DP-933 requirements. All of this water is ultimately disposed at the tailing facility pursuant to DP-933.[5]

[4] Other water includes approximately 520 gpm of seepage-impacted alluvial ground water collected at the ground water withdrawal well system along the roadside waste rock piles and spring collection systems at Spring 13 and Spring 39. These systems are operated as Best Management Practices under EPA NPDES Permit No. NM022306.

[5] CMI is currently in violation of DP-933 for failing to submit a proposal to reduce the volume of mine water discharged to the tailing impoundments. DP-933 requires that the proposal shall consider, but not be limited to, alternatives of water treatment, pipeline burial and alternative dust control measures. DP-933 also requires that the proposal include a schedule for implementation of the water reduction measures.

2.3.1.1.1 Water Balance for Underground Mine Workings

A water balance analysis for the underground mine workings shows that the majority of the water in the upper Goathill Gulch drainage ends up as inflow to the underground mine. The balance shows inflows to the underground mine are approximately equal to the pumping discharge, indicating that inflows are mostly accounted for and that little water flowing to the underground mine is not captured.

Seepage from Capulin and Goathill North waste rock piles, as well as storm water which comes into contact with mining waste is conveyed to locations at the mine site (*i.e.,* open pit, subsidence area, toe of roadside waste rock piles) where it is allowed to infiltrate into the subsurface in accordance with CMI's NPDES Storm Water Pollution Prevention Plan (SWPPP) for preventing the discharge of such effluent to the Red River. Most of the effluent discharged to the open pit and subsidence area likely reaches the underground workings. The purpose of the SWPPP is discussed further under the NPDES Multi-Sector General Permit for Storm Water Discharges, Section 2.5.2 below. The current allowance and future disallowance of such practices under NMED ground water discharge permits is discussed under Ground Water Discharge Permits, Section 2.4.2 below.

2.3.1.2 Storm Water and Surface Water (Seepage) Management

CMI operates several storm water and surface water (seepage) collection, conveyance, and disposal systems to control discharges at the mine site in accordance with the NPDES Multi-Sector General Storm Water Permit (MSGP) NMR05GC01 and NMED ground water discharge permits DP-1055[6] and DP-1539[7]. The storm water systems are depicted on Mine Site Storm Water Management Map (Figure 2-2).

[6] Conditions 21 and 22 of DP-1055 require that CMI develop new methods for disposal of collected storm water and seepage which shall be other than the current practice of allowing infiltration into waste rock, alluvium or fractured bedrock. Conditions 21 and 22 also state that NMED will not approve the current disposal practices.

[7] The purpose of DP-1539 is to control the discharge of water contaminants at the North Storm Water Detention Pond System from which contaminants may move directly or indirectly into ground water. Storm water and leachate from the Blind Gulch and Sulphur Gulch North waste rock piles are directed to the Detention Pond.

2.3.1.2.1 Capulin Canyon Leachate Collection System

The Capulin Canyon leachate collection system was constructed in 1992 and includes the seepage collection system in upper Capulin Canyon and two storm water catchments in lower Capulin Canyon. Prior to its construction, seepage and impacted storm water were allowed to flow freely down the Capulin Canyon drainage. The seepage collection system consists of an upper seepage catchment and lower pumpback pond. The upper seepage catchment is a small unlined catchment (sump) constructed about a half mile down drainage from the toe of Capulin waste rock pile that collects leachate from the rock pile, as well as storm water runoff. The average rate of discharge of leachate from the Capulin Waste Rock Pile is approximately 15 gpm. Some of the seepage collected in the unlined sump likely infiltrates to ground water. The lower pumpback pond is a larger lined collection basin with a concrete headwall anchored into bedrock. It is located 1,500 feet down drainage from the seepage catchment and collects seepage mixed with storm water that overtops the catchment during storm events.

The seepage and storm water collected by the Capulin Canyon collection system are conveyed to Goathill Gulch through a near horizontal, eight-inch diameter borehole that was driven through the ridge separating Capulin Canyon and Goathill Gulch. A pump is used at the pumpback pond to lift the collected water to the diversion borehole, while water collected at the catchment is fed to the borehole by gravity. The collected water discharges from the borehole to the Goathill Gulch drainage at a point near the toe of the Goathill North waste rock pile. The discharge rate at the end of the borehole ranges from zero to 33 gpm with an average of 18 gpm. The discharge water commingles with the storm water and seepage from the upper Goathill Gulch drainage and flows down the drainage to the subsidence area. It then infiltrates and percolates downward into the underground mine workings, where it is collected as part of CMI's mine dewatering effort and sent to the mill for use in transporting tailing slurry or pipeline maintenance and dust control at the tailing facility.

During large storm events or when the pump froze in winter, the capacity of the pumpback pond was exceeded at times and the collected seepage and storm water mixture would overflow into the natural drainage below, with some of this water infiltrating into the colluvium within the drainage. To improve the operating efficiency and prevent the pump from freezing, the system was upgraded in 2005/2006. The upgrade included sediment traps, two submersible dewatering pumps, and a concrete vault to house the pumps and a heater. The upgrade also included a new high-density polyethylene liner for the pumpback pond because the old one had multiple leaks.

As discussed below, the Capulin Canyon collection system also receives storm water collected near where Capulin and Goathill North waste rock piles meet near the top.

Two unlined storm water detention basins are located near the mouth of Capulin Canyon, approximately 700 feet upstream of the confluence with the Red River. The two detention basins are designed to collect storm water runoff from primarily the middle and lower portions of the canyon.

2.3.1.2.2 Storm Water Pipeline from Goathill North to Capulin Canyon

In 2004, Molycorp began implementation of a mitigation plan to stabilize the Goathill North Waste Rock Pile (see Goathill Interim Reclamation below). One component of that plan was to divert non-impacted storm water near the top of the waste rock pile. This diverted storm water is drained by gravity through a 12-inch diameter high-density polyethylene liner pipeline across the Capulin waste rock pile and empties into the Capulin Canyon drainage below the toe of the waste rock pile.

2.3.1.2.3 Open Pit

The open pit collects storm water from the existing pit walls, surrounding areas above the pit walls, and ground water seepage within its hydraulic capture zone. The open pit also receives storm water runoff from portions of the Blind Gulch and Sulphur Gulch South waste rock piles via the North Detention Basin and the roadside waste rock piles via the 8,920 and 8,720 elevation bench Diversions. The runoff collects in the bottom of the pit in an intermittent pond where it evaporates or infiltrates into the old underground mine workings. A vertical borehole connects the old underground workings to the active underground mine 700 feet below. The leachate is collected in the active underground mine as part of the mine dewatering efforts and pumped to the mill via the decline.

2.3.1.2.4 <u>North Detention Basin and Roadside Waste Rock Pile Drainage Diversions</u>

The North Detention Basin is located at the base of the Blind Gulch waste rock pile (see Figure 2-2). The basin is designed to collect and store storm water runoff from the Blind Gulch waste rock pile and northeast facing slope of Sulphur Gulch South waste rock pile near the open pit. The basin is lined with high-density polyethylene with a geotextile above and below the liner. The design capacity is based on a 100-year, 24-hour storm event. The purpose is to store impacted storm water within the lined basin to eliminate contaminants that may move directly or indirectly to ground water. The basin is to be operated in a manner which maintains a minimum of two feet of freeboard in the detention pond. In the event that freeboard limits are approached during extreme precipitation events, storm water shall be transferred to the open pit, which negates any benefits for having a lined storage basin. When storm water is transferred, it is pumped through a high-density polyethylene pipeline to an unlined diversion channel that leads to the open pit.

Unlined drainage diversions have also been constructed along each bench of the roadside waste rock piles (*i.e.,* 8,920 and 8,720 Diversions) which convey storm water to the open pit. As a result of these diversion ditches, storm water runoff above the first bench of these waste rock piles either infiltrates into the piles or is diverted to the open pit, while runoff below the first bench drains to unlined catchments at the base of each pile. Storm water that collects at the base of the roadside rock piles infiltrates rapidly to ground water through the coarse fill material and rock used to construct the catchments or evaporates. No ponded seepage from the roadside rock piles has been observed at the toe of the piles.

A stability analysis of the roadside rock piles performed by CMI's contractor, Norwest Corporation, in 2005 showed that the catchments at the toe of the piles had partially filled in with waste rock material from years of erosion and, therefore, might be inadequate to contain potential small, near-surface slides or slumps. In 2006, the berms were raised as much as 30 feet and the catchments re-contoured.

2.3.1.2.5 Other Storm Water Catchments

Other various catchments and conveyances are located throughout the lower elevations of the mine to detain storm water and prevent the water from discharging directly to the Red River. Several of these are unlined, earthen berms that collect storm water and allow it to either evaporate or infiltrate the subsurface. These earthen berms have been placed near the administration buildings in Goathill Gulch and at the base of Goathill Gulch near State Highway 38. Two catchments have also been constructed at the mill yard. An earthen-lined catchment is located near the laboratory and a concrete-lined catchment at the mill complex. When the storm water collected at the mill yard catchment reaches a high level, it is pumped to the mill and used as make-up water. The concrete-lined catchment is permitted under NPDES Permit No. NM022306 as the 005 Outfall for periodic discharge to the Red River (see NPDES Authorization to Discharge Permit, Section 2.5.1 below).

Three earthen-lined catchments were also constructed downstream of Goathill South and Sugar Shack West waste rock piles along two drainages of Slick Line Gulch. In 2008, these catchments were combined into a single earthen-lined sediment basin designed as a flow through basin. This sediment basin collects impacted storm water from the Sugar Shack West Waste Rock Pile and surrounding areas.

2.3.1.2.6 General Waste Rock Pile Conveyances

In general, storm water conveyances for the waste rock piles follow mine site roads. In addition, Goathill North waste rock pile has three earthen-lined benches across its regraded surface that functions to convey storm water off the rock pile surface. The Sugar Shack

West Waste Rock Pile includes six benches across the rock pile that conveys storm water runoff to an adjacent earthen-lined ditch which drains to the earth-lined sediment basin.

2.3.1.3 Seepage Interception Systems and Ground Water Withdrawal Well System Water Management

In February 2003, Molycorp began operation of the seepage interception systems at Spring 13 and Spring 39 and a ground water withdrawal well system at the toe of the roadside waste rock piles as Best Management Practices required under NPDES Permit NM022306. The systems at Spring 13 and Spring 39 flow approximately 20 and 80 gpm, respectively. The ground water withdrawal well system collects approximately 420 gpm from three wells located downgradient of tributary drainages beneath the roadside waste rock piles. The total volume of contaminated ground water collected by these systems is approximately 520 gpm.

The seepage-impacted ground water is sent to the mill and used as makeup water for transporting tailing slurry to the tailing facility during milling periods or pH adjusted with lime and used for pipeline maintenance and/or partial dust suppression at the tailing facility during non-milling periods pursuant to NMED Discharge Permit DP-933.

A detailed description of the seepage interception systems and ground water withdrawals well system is provided under NPDES Best Management Practices, Section 2.5.1.2 below.

2.3.1.4 Water Usage/Disposal at Mill

CMI's water management activities for mining and milling operations consist of the underground dewatering system, water collection systems, and fresh water supply to the mill. Diversion of Red River water is the largest single source of fresh water make-up to the mill, followed by the mill wells and Columbine wells. The Lab Well at the mill and the Columbine domestic well near the confluence of the Red River and Columbine Creek are used to supply the mill and mine facilities with potable water. Water from those wells is not used in milling operations.

The underground dewatering system captures natural ground water inflow to the mine and seepage from Goathill Gulch and Capulin Canyon drainage to the subsidence area. As discussed above, CMI operates water collection systems (ground water withdrawal well system and seepage interception systems) as Best Management Practices under NPDES Permit NM0022306.

The underground mine dewatering and water collection systems are designed to operate on a continuous basis. The underground mine dewatering operation produces water at a rate of approximately 250 gpm. The water collection systems produce water at a combined rate of approximately 520 gpm. The total volume of water collected from these systems is 770 gpm. This water is contaminated with elevated concentrations of metals and acidity (low pH). Pipeline and pump systems convey this water to Sump 5000 adjacent to the mill. The Sump 5000 also receives tailing slurry discharge from the mill. The sump ultimately connects to the tailing pipeline system.

When the mill is operating, the tailing slurry averages 32 to 35 percent solids leaving the floatation process. The tailing slurry enters the Sump 5000 and is diluted to 27 to 30 percent solids with the addition of the metals-laden acidic water from the mine water collection systems. The tailing slurry is alkaline from the milling process and buffers the acidic water from the mine when blended. Therefore, no lime neutralization is necessary prior to discharge to the tailing facility via the tailing pipeline.

During non-milling periods, CMI continues to dispose of the 770 gpm of contaminated water via the tailing pipeline to the tailing facility. However, such disposal serves two operational purposes: pipeline maintenance and partial dust suppression at the tailing impoundments. At the Sump 5000, the acidic water is pH-adjusted with lime to meet DP-933 permit requirements; then blended with additional unimpacted water (*i.e.,* from Red River surface water and production wells) and discharged to the tailing facility at combined flow rates which can exceed 2,000 gpm. Based on sample analytical results, the blended water delivered to the tailing facility is known to be contaminated with several metals at concentrations exceeding New Mexico water quality standards.

Flow in the pipeline is maintained during non-milling periods for the following reasons:

- Prevent sedimentation and blockage of the pipeline due to settled tailing solids;
- Maintain pipe seals and fittings in working order;
- Maintain constant temperature to minimize movement from thermal expansion and contraction of each pipeline; and
- Prevent freezing of water in low spots in the pipe during winter operations.

The total monthly volume of water delivered to the tailing facility varies according to mill operations and, to a lesser extent, seasonal climate variations. Table 2-1 shows the volume of water delivered in 2009 on a monthly basis, with a total of over 773 million gallons. Table 2-2 shows the sources of the water used and the volumes collected from each source for 2009. Figure 2-3 depicts a water balance schematic for the mine, mill, and tailing facility.

TABLE 2-2
SOURCES OF WATER AND VOLUMES COLLECTED FROM THE MINE SITE IN 2009

Source of Water Used at Mine	**Volume (gal.)**
Red River Surface Water	138,917,156
Alluvial Aquifer Production Wells	245,112,649
Water from Underground Workings	140,835,730
NPDES Water Collection Systems	248,413,690
Total:	**773,279,225**

2.3.2 Water Management – Tailing Facility

Tailing and process water are currently discharged at the Dam No. 4 (western) impoundment at a flow rate ranging from less than 1,000 to over 2,400 gpm (based on 2009 milling and non-milling monthly water volumes). This equated to over 773,000,000 gallons of water and slurry that were discharged to the impoundments in 2009. Process water is discharged at the Dam No. 5A impoundment and the decant pond during non-milling periods. Process water is also discharged to the Dam No. 1 (eastern) impoundment where an approximate 40-acre pond is maintained for dust suppression.

Water conveyed to the tailing facility is lost either through evaporation, entrained in the tailing, infiltrates into the subsurface or is collected by the seepage interception system. The majority of the discharged water seeps into the subsurface and contaminates ground water because the tailing impoundments are unlined. The largest percentage of the seepage occurs at the Dam 5A impoundment and decant pond at the base of the Guadalupe Mountains, where it eventually enters the volcanic aquifer. Seepage also occurs through the active tailing depositional area of the Dam No. 4 impoundment. This seepage enters the volcanic aquifer and migrates to the south-southwest, where tailing seepage-impacted ground water has been detected in monitoring wells south of Dam No. 4 and along seeps and springs within the Red River Gorge. A relatively small portion of the tailing seepage also occurs at the Dam No. 1 impoundment because tailing deposition ceased in the mid-1980s and minimal water is discharged at this impoundment.

2.3.2.1 Seepage Interception System

Some of the tailing seepage is collected by a seepage interception system which has been operational since 1975. The system consists of shallow rock-filled trenches and seepage barrier drains, as well as ground water extraction wells. The trenches and drains are constructed to depths of approximately 20 feet. The system collects approximately 550 gpm. Most of this contaminated water (400 gpm) is discharged to the Red River via Outfall 002 pursuant to EPA NPDES Permit NM022306, while the remainder (150 gpm) is pumped back to the Dam No. 5A impoundment to reduce the manganese load discharged through Outfall 002. This recirculation of the contaminated water is to achieve compliance with the NPDES permit discharge limit for manganese.

Tailing seepage that is not collected by the seepage interception system has resulted in elevated concentrations of molybdenum and sulfate in the shallow portion of the alluvial aquifer south of the tailing facility. This uncollected seepage is the result of bypass of the seepage interception system and/or leaks in the Outfall 002 discharge pipe.

2.3.2.2 Water Balance

An operational water balance was estimated for the tailing facility in 2003. It was estimated again in 2006, as the amount of water delivered to the tailing facility from the mine site had nearly doubled from 1,700 gpm (3.8 cfs) in 2003 to 3,290 gpm (7.3 cfs) in 2006. The components of the water balance include the water delivered to the tailing facility from the mine site, the consumptive losses from evaporation and retained moisture, water collected by the seepage interception systems south of Dam No. 1, water pumped back to the Dam 5A area from the seepage interception systems, water discharged at Outfall 002, and the uncollected seepage.

Table 2-3 provides a summary of the 2003 and 2006 water balances. As shown on this table, of the approximately 3,290 gpm (7.3 cfs) of water that was delivered to the tailing facility in 2006, approximately 500 gpm (1.1 cfs) either evaporated or were retained as moisture in the tailing leaving approximately 2,790 gpm (6.2 cfs) available as total seepage. The seepage interception and pumpback systems collected approximately 550 gpm (1.2 cfs) of seepage and native ground water. Of this amount, 280 gpm (51%) of the water collected are estimated to be captured tailing seepage and 270 gpm (49%) are estimated to be native ground water. Of the 550 gpm of water collected, 150 gpm are pumped back to the Dam No. 5A impoundment and 400 gpm are discharged to Outfall 002.

Approximately 2,736 gpm (5.5 cfs) of the total seepage are uncollected and able to migrate from the impoundments to the alluvial aquifer or basal bedrock (volcanic) aquifer.

Based on the water balance, the amount of tailing seepage unaccounted for in 2003 was 1,285 gpm. This amount increased to 2,736 gpm in 2006, when the amount of water delivered to the tailing facility from the mine site doubled. This water balance shows that over 75 percent of the water delivered to the tailing facility is unaccounted for and, therefore, assumed to seep to ground water underlying the facility.

The seepage rate from the Dam No. 1 impoundment is estimated to be 220 gpm (0.5 cfs), which is about 8 percent of the total seepage at the tailing facility. The seepage rate from the active depositional area behind Dam No. 4 is estimated to be 830 gpm (1.8 cfs) and represents approximately 30 percent of the total seepage. The majority of seepage (62 percent) is estimated to occur at the Dam No. 5A impoundment and the decant pond at an average rate of 1,740 gpm (3.9 cfs).

2.4 State Regulatory and Enforcement Activities

Until the late 1990s, the mining, milling, and tailing disposal operations at the Site were mostly unregulated by New Mexico. Difficulties encountered by NMED in developing ground water discharge permits with Molycorp under New Mexico's Water Quality Act led the Governor of New Mexico to request that EPA place the Site on the NPL in 2000 (see CERCLA Enforcement Activities, Section 2.7, below). Soon thereafter and concurrent with the commencement of EPA's CERCLA activities, NMED and Molycorp continued negotiations on the discharge permits for both the tailing facility and mine site. A discharge permit was first issued for the tailing facility in 1997, and a discharge permit was issued for the mine site in 2000. In addition, MMD issued a mining permit under the New Mexico Mining Act in 1998. These and other New Mexico permits are discussed below.

2.4.1 Mining Permit

On December 31, 1998, MMD issued Mining Permit TA001RE for Molycorp to conduct mining and reclamation operations pursuant to the New Mexico Mining Act, NMSA 1978, § 69-36-1 *et seq*. On February 1, 2001, MMD issued Permit Revision 96-1 to incorporate the closeout plan for the tailing facility. On June 3, 2002, MMD issued Permit Revision 96-2 to incorporate the closeout plan for the mine site. Pursuant to NMSA 1978 § 69-36-1 to § 69-36-20, the closeout plans specify reclamation to a condition that allows for the re-establishment of a self-sustaining ecosystem following closure which is appropriate for the life zone of the surrounding area, unless conflicting with the approved post-mining land use. The closeout plans provide for a waiver of such requirement for open pits or waste units if it is not technically or economically feasible or environmentally unsound and if measures will be taken to ensure that the open pit or waste unit will meet all applicable federal and state laws, regulations, and standards for air, surface water and ground water protection following closure and will not pose a current or future hazard to public health or safety.

2.4.1.1 Tailing Facility Closeout Plan

The Questa Tailing Facility Revised Closeout Plan was completed in 1998. The post-mining land use established in the closeout plan for the tailing facility is wildlife habitat and self-sustaining ecosystem. Requirements of the closeout plan included the draining of the surface ponds and shaping of the tailing surface topography to result in positive drainage and elimination of ponding, removing of the tailing piping, covering the tailing impoundment with a minimum of 36 inches of alluvium and revegetation. The dams and dikes will be closed out with their current and future developed shapes and profiles. Gravel alluvium having a high resistance to sheet erosion will be used to cover the tailing and construct the dam slopes. Monitoring inspections will be conducted at least annually pursuant to the New Mexico Office of State Engineer requirements. Inspections will cover erosion, seepage, deterioration and vegetation development related to the dam embankments.

The cover is to be designed as a "storage" cover that will limit infiltration of precipitation into the underlying tailing. It will also provide a substrate for establishment of a self-sustaining ecosystem and provide for protection of wildlife. The revegetation shall consist of four plant community types: woodland community, mixed woodland and shrub community, shrub community, and grass/forbs community. Monitoring and maintenance shall also be performed, including annual inspections covering erosion, seepage, deterioration and vegetation development related to dam embankments pursuant to State Engineer requirements and the performance of tailing cover and revegetation. The monitoring of vegetation will continue for a minimum of 12 years.

2.4.1.2 Mine Site Closeout Plan

The mine site closeout plan was submitted by Molycorp in June 2001. As part of the submittal, Molycorp requested a waiver for the open pit in accordance with New Mexico Mining Act Rules (§§ 19.10.5.506 and .507.B), which requires application for a waiver if the requirement to achieve a post-mining land use or self-sustaining ecosystem cannot be met. MMD approved the open pit waiver in May 2002. The closeout plan was revised on August 1, 2005.

MMD approved the open pit waiver based partly on concerns raised by Molycorp about potential environmental impacts associated with reclamation of existing pit walls or backfilling the pit. The potential impacts identified by Molycorp in 2001 included (1) exposing hydrothermal scars (discussed below) in the pit and under existing rock piles, (2) environmental impacts resulting from creation of off-site borrow areas, and (3) potential air quality impacts resulting from pit backfilling. Additionally, the Director of MMD determined that the open pit would not pose a current or future hazard to public health or safety if certain conditions are met. To comply with these conditions, Molycorp (now CMI) must implement institutional controls to restrict access with fencing and warning signs around the perimeter of the open pit and guard stations to be staffed to prevent trespass. CMI must also monitor the stability of the pit walls and propose response measures to address instability, if necessary, and evaluate reclamation options for areas within the pit that may be impacted by subsidence.

The post-mining land use established in the closeout plan for the permit area is forestry for the mine site and mill area and light industrial for portions of the mill area to be used for long-term water treatment operations. Closeout plan requirements include reclamation of the waste rock piles and open pit, surface water runoff and seepage collection, water treatment plant construction, monitoring, and financial assurance. A separate closeout plan for subsidence areas was completed on December 1, 2004. The plan proposed that all current and future subsidence areas be reclaimed through natural regeneration, rather than engineered reclamation. A review of the geology, watershed data, and predictive modeling showed that future land deformation from subsidence would not create depressions as large as the existing Goathill Glory Hole and not materially alter the quantity and quality of ground water. MMD approved the closeout plan for the subsidence areas on April 4, 2006.

The due date for submitting a revised comprehensive closeout plan, with updated financial assurance requirements, for the entire mine site was postponed by MMD until six weeks after EPA issues the CERCLA ROD to ensure the coordination of reclamation and remediation activities.

2.4.2 Ground Water Discharge Permits

NMED has issued several ground water discharge permits to CMI: DP-1055, DP-1539, and DP-132 for the mine site and DP-933 for the tailing facility. These permits were issued pursuant to the New Mexico Water Quality Act, NMSA 1978 §§ 74-6-1 through 74-6-17, and the New Mexico Water Quality Control Commission (WQCC) Regulations, 20 NMAC Chapter 6, Part 2 (November 15, 1996). The discharge permits contain conditions to prevent and control discharges of water contaminants from the mine site and tailing facility into ground water and surface water. The purpose of these discharge permits is to protect all ground water at the Site having an existing concentration of 10,000 mg/L or less of total dissolved solids (TDS) for present and reasonably foreseeable future use as domestic and agricultural water supply and protect those segments of surface water which are gaining[8] because of ground water inflow and to abate pollution of ground and surface water.

Molycorp initially objected to any discharge permit for the Site, arguing that NMED lacked the legal authority to issue a discharge permit under the Water Quality Act. NMED notified Molycorp, on January 12, 1995, that a discharge permit was required for the waste rock piles at the Molycorp Questa Mine. NMED stated that seepage moves directly and indirectly into ground water from the mine rock piles, and that analytical results of ground water samples collected from seeps along the banks of the Red River downstream from the waste rock piles indicate that New Mexico ground water quality standards had been exceeded as a result of waste rock seepage. On May 11, 1995, Molycorp submitted to NMED a proposed discharge plan. Over the next several years, NMED requested additional information from Molycorp to support the discharge plan proposal. Not until April 29, 1999, did NMED determine that the discharge plan application was administratively complete.

On November 10, 1998, NMED sent Molycorp a notice of violation stating that the company was in violation of the Water Quality Act for discharging pollutants into ground water without a discharge permit, and for failure to submit a complete discharge plan. On December 9, 1998, Molycorp appealed the notice of violation to the WQCC arguing, among other things, that a discharge permit was not required. On January 27, 1999, the WQCC dismissed Molycorp's appeal on several grounds.

For several months in late 1999 and early 2000, NMED and Molycorp pursued settlement negotiations to address discharge permit and Site remediation issues. These negotiations were not successful.

On May 5, 1999, the Secretary of NMED determined that there was "significant public interest," as provided in New Mexico regulations, and therefore that a public hearing would

[8] A gaining stream is a stream that receives water emerging from a submerged spring or other ground water seepage which adds to its overall flow water.

be held on the proposed discharge permit for the Molycorp Questa Mine. NMED held an adversarial evidentiary hearing on the proposed discharge permit (DP-1055) before a hearing officer over 8 days from May 31 through June 2 and July 5 through July 9, 2000. During the hearing, Molycorp continued to argue that a discharge permit was not required.

After the hearing, and after EPA had proposed to list the Site on the NPL, Molycorp proposed to reconvene settlement discussions. In November 2000, NMED and Molycorp entered into a settlement, including an agreed discharge permit. The agreed discharge permit included provisions for closure of the mine site upon cessation of operations, and for the posting of financial assurance to ensure that closure would be completed. That permit remains in effect, and is currently up for renewal. DP-1055 is discussed in more detail in Section 2.4.2.1 below.

Subsequently, NMED issued a second discharge permit to Molycorp for the tailings facility (DP-933). DP-933 is discussed in more detail in Section 2.4.2.3 below.

2.4.2.1 Mine Site Discharge Permit DP-1055

Ground Water Discharge Permit DP-1055 was originally issued by NMED to Molycorp in November, 2000 for the mine site. It is currently up for renewal. In issuing the permit, NMED found that Molycorp was discharging leachate from the waste rock piles (dumps), open pit, historical tailing impoundments, and storm water impoundments exceeding state water quality standards that may move directly or indirectly into ground water, causing exceedances of water quality standards in ground water. Under DP-1055, CMI is permitted to discharge water contaminants subject to certain conditions established for monitoring, reporting, investigations, operations, abatement, closure, and financial assurance. These conditions include the following:

- **Investigations** – CMI is required to conduct several investigations to ensure that operations and closure meet all regulatory requirements, including waste rock characterization, surface erosion and stability analysis of waste rock piles, vegetation test plots to investigate cover/revegetation alternatives, borrow material and rooting zone evaluations for cover/revegetation alternatives, and a hydrologic water balance for the mine and Red River watershed.

- **Mine Dewatering** – Condition 20 requires CMI to continue to maintain its mine dewatering system to maximize capture of leachate from the mine workings and open pit and ensure contaminated ground water at the mine does not result in further contamination of ground water and its subsequent impacts to surface water.

- **Capulin Canyon Leachate Collection and Disposal System** – Condition 21 requires that CMI upgrade and maintains the Capulin Canyon Leachate Collection and Disposal System in a manner that prevents the contamination of ground water and its subsequent impact on surface water. The leachate collection and disposal system must be designed to contain the flow caused by a 100-year, 24-hour storm event, or an alternate design approved by NMED with each impoundment appropriately sized and lined. Additionally, a new method of disposal of the collected leachate must be developed and shall be other than the current practice of discharging leachate into Goathill Gulch and allowing it to percolate through the subsidence zone into the underground mine. Condition 21 also states that NMED will not approve the current disposal method.[9]

- **Storm Water Storage and Disposal** – Condition 22 requires that CMI upgrade and maintain its storm water treatment systems so that storm water from the mine site is being stored and disposed of in a manner that prevents the contamination of ground water and its subsequent impacts on surface water. Storm water retention impoundments must be designed to contain the flow caused by a 100-year, 24-hour storm event or an alternative design approved by NMED, with each impoundment appropriately sized and lined. Additionally, a new method for disposal of the collected storm water must be developed and shall be other than the current practice

[9] In 2001, CMI submitted a conceptual plan to NMED for upgrading the Capulin Canyon leachate collection and disposal system and storm water storage and disposal pursuant to DP-1055 Conditions 21 and 22. To date, NMED has not approved or commented on this conceptual plan.

of allowing infiltration into waste rock, alluvium or fractured bedrock. Condition 22 also states that NMED will not approve the current disposal method.

- **USGS Questa Baseline and Pre-Mining Ground Water Quality Investigation** – As part of the requirements for CMI to abate pollution of ground water and surface water in accordance with WQCC regulations, CMI was required to fund a background study (Condition 24) to be performed by the United States Geological Survey (USGS) in conjunction with NMED to determine background concentrations of contaminants in ground water. Because the mine site is located in a highly mineralized region, pre-mining concentrations of some metals in ground water, as naturally-occurring background concentrations, could be anomalously high and exceed the numeric criteria of the New Mexico ground water quality standards. Since no ground water at the mine site had been chemically analyzed before mining, the USGS was to infer the pre-mining ground water quality by an examination of ground water quality in a nearby, or proximal, analog site in the Straight Creek drainage basin located a few miles upriver of the mine site. Twenty-seven reports prepared by USGS scientists contain details of investigations on the geological, hydrological, and geochemical characteristics of the Red River Valley. This information is summarized in the report entitled "Questa Baseline and Pre-Mining Quality Investigation, No. 25. Summary of Results and Baseline and Pre-Mining Ground water Chemistry, Red River Valley, Taos County, New Mexico, 2001 – 2005."

- **Abatement Plan** – Condition 23 requires that CMI abate pollution of surface water and ground water in accordance with WQCC Regulations at 20 NMAC 6.2 Subpart IV.

- **Closure Plan** – Conditions 30 – 32 require CMI to implement the components of an approved Closure Plan, including:

    - *Waste Rock Pile Regrade* – All waste rock piles must be regraded to slopes of no steeper than 3 horizontal to 1 vertical (3H:1V). In the event underlying slopes exceed 3H:1V, the waste rock may instead be regraded to slopes of no steeper than 2H:1V, to the maximum extent practicable. Regrading must include the construction of surface water diversion ditches every 100 to 200 vertical feet on the waste rock piles faces. Relocation in combination with regrading may be necessary to meet slope requirements.

- *Waste Rock Pile Cover and Revegetation* – All waste rock piles determined to have potential for generating acid leachate must be covered with a minimum of three feet of non-acid generating growth medium, to the maximum extent practicable. All covered piles must be revegetated to ensure long-term stability of the cover and reduce infiltration[10] to the maximum extent practicable.

- *Collect, Treat, and Disposal of Contaminated Water* – Waste rock leachate, impacted ground water, water pumped from the underground mine, and collected storm water, if such water exceeds the standards set forth in 20 NMAC 6.2.3103 or NMED-approved background concentrations, must be collected, treated and disposed until all ground water standards and/or NMED-approved background concentrations for ground water are achieved and maintained at all monitoring locations or places of withdrawal for two years.

- *Water Treatment* – A water treatment plant using lime neutralization and having an operating capacity of no less than 394 gpm must be constructed and maintained at the mine site for the long-term treatment of collected leachate and water. By-product treatment sludge must be stored on site in lined impoundments.

- **Financial Assurance** – Under the financial assurance requirements of Condition 33, CMI has executed a financial assurance instrument in the amount of $129,000,000 for the cost of a third party to implement the closure plan. CMI must establish a trust fund in the amount of $36,000,000 to cover the cost of long-term

[10] NMED is currently revising its definition of infiltration reduction.

water treatment if CMI is unable, unwilling, or otherwise fails to properly operate and maintain its water treatment and seepage capture system(s).

2.4.2.2 North Storm Water Detention Pond System Discharge Permit DP-1539

In February 2007, NMED issued Ground Water Discharge Permit DP-1539 for the North Storm Water Detention Pond System located between Sulphur Gulch North and Sulphur Gulch South waste rock piles at the mine site. It consists of the North Detention Pond and all piping that directs impacted storm water to the open pit. The permit was actually issued after the North Detention Pond was constructed by CMI to address storm water runoff in accordance with the SWPPP developed under the NPDES Multi-Sector General Permit for Storm Water Discharge Associated with Industrial Activity (MSGP) No. NMR05GC01. The North Detention Pond stores leachate and storm water from the Blind Gulch and Sulfur Gulch North waste rock piles. Under DP-1539, CMI is required to maintain a minimum freeboard (two feet) in the detention pond. In the event the freeboard limits are approached during extreme precipitation events, CMI shall transfer the excess storm water to the open pit, where it will evaporate or infiltrate into the underground workings and subsequently be collected as part of the underground mine dewatering. The collected water will be pumped to the mill, treated, and discharged to the tailing facility.

2.4.2.3 Tailing Facility Discharge Permit DP-933

The original Discharge Plan for the tailing facility was approved in 1997 and NMED issued a modified Discharge Permit DP-933 to include a closure plan and financial assurance requirements in 2000. A permit renewal and modification for DP-933 was issued in February 2008. The modification includes the additional discharge to the facility of effluent from storm water collection, ground water withdrawal wells (GWW-1, GWW-2 and GWW-3), and seepage interception systems at the mine site (see NPDES Permits, Section 2.5, below). Modification of DP-933 also includes lining of the Upper Dump Sump and abatement of ground water contamination in excess of water quality standards set forth in § 20.2.6.3103 NMAC. Similar to DP-1055, DP-933 permit conditions call for

CMI to develop a closure plan for reclamation and storm water and seepage interception systems.

Under modified DP-933, CMI is permitted to discharge up to 22,000 tpd of tailing solids to the impoundments. Water from various sources at the mine site is also discharged to the tailing facility via the tailing pipeline. This water includes water pumped from the underground mine workings, water diverted from the Red River, storm water collected at the mine and mill site, water pumped from the CMI production supply wells, water and tailing removed from the Upper and Lower Dump Sumps, ground water collected from extraction wells GWW-1, GWW-2, and GWW-3, and seepage from the collection systems at Springs 13 and 39 near the mine site. Prior to discharge, certain sources of impacted water require pH adjustment with lime at the mill to attain a pH of between 6 and 9 standard units. The maximum discharge rate for mine water is 12,960,000 gallons per day.

In issuing modified DP-933, NMED made several findings, including (1) that ground water beneath the tailing facility is of sufficient quality (concentrations of total dissolved solids [TDS] are less than or equal to 10,000 milligrams per liter [mg/L]) to require protection from discharges under the Water Quality Act and WQCC Regulations, (2) the tailing facility is located at a place of withdrawal of water for present or reasonably foreseeable future use within the meaning of WQCC Regulations at 20.2.6.3103 NMAC, (3) tailing seepage and mine water discharged to the tailing facility moves directly or indirectly to ground water and causes pollution at concentrations in excess of state standards, and (4) CMI is required to prevent and abate ground water and surface water pollution pursuant to §§ 20.2.6.3107 and 3109 NMAC.

Under DP-933, CMI is allowed to operate the facility subject to several conditions, including but not limited to the following:

- **Tailing Discharge** – CMI shall manage all discharges to ensure positive drainage and to minimize dust from the tailing by discharging to small operating cells (approximately 100 acres) until the designed height of an operating area is reached, followed by placement of an interim dust cover or other suitable dust control.

- **pH Adjustment of discharges** – All discharges to the tailing facility from the mill must be pH adjusted to between 6 and 9 standard units.

- **Investigation for Reducing Volume of Water to Tailing Facility** – Within 180 days of the effective date of DP-933, CMI was required to submit to NMED for approval a water management report addressing discharges of mine water to the tailing facility. The report was to include 1) a description of the current water management activities, 2) a description of alternate water activities that could reduce the volume of water discharged and available to infiltrate through the tailing impoundments, and 3) a proposal for reducing the volume of mine water discharged to the impoundments, to the extent practicable. On September 4, 2008, CMI submitted a water management report containing the first two required components.

    - *Notice of Violation*: In a letter dated May 7, 2010, NMED sent CMI a notice of violation of the Water Quality Act, the WQCC regulations, and DP-933 for failing to comply with Condition 7 of DP-933, which requires that CMI submit a proposal to NMED to reduce the volume of mine water discharged to the tailing impoundments. CMI did not provide a proposal. CMI stated in the report that none of the alternate activities evaluated for reducing the water volume were cost effective.

- **Abatement of Ground Water Pollution** – If NMED determines that the remedial measures required by EPA pursuant to CERCLA are inadequate to satisfy requirements of § 20.6.2.3109 NMAC, NMED may require CMI to implement additional measures to abate ground water contamination at the tailing facility.

- **Closure** – Upon cessation of tailing disposal operations, CMI is required to implement the closure plan, including (1) surface shaping to ensure positive drainage and eliminate ponding, (2) an evaluation of tailing settlement prior to placement of cover, (3) covering with a minimum of 36 inches of alluvium to serve as a water storage and release cover for minimizing infiltration of precipitation into the underlying tailing and subsequent discharge of tailing leachate into ground water and surface water, (4) revegetation to optimize effectiveness of store and release cover by promoting evapotranspiration, and provide cover stability from wind and erosion, (5) removal of the tailing pipeline and closure of associated sumps, and (6) continue to operate seepage interception and ground water abatement systems.

- **Financial Assurance** – Until revised financial assurance is approved by NMED, CMI must maintain financial assurance in the amount of $23,027,393 to cover the cost of a third party to implement the closure plan.

Additionally, under DP-933, any collected tailing seepage, extracted contaminated ground water, and decant water from the tailing which is not discharged to the Red River pursuant to the existing NPDES permit issued by EPA may be pumped back to the tailing facility.

2.4.3 Office of the State Engineer Permits

The design, construction and maintenance of the earthen dams at the tailing facility are regulated by the New Mexico Office of the State Engineer, Dam Safety Division under permits File Nos.: D-532-Dam No. 1, D-408-Dam No. 4, and D-531-Dam No. 5A. In addition to regulating dams at the Site, the Office of State Engineer also regulates well drilling and water withdrawal.

2.4.4 Other State Permits

Other New Mexico permits issued to CMI for the Molcorp mine under environmental programs include the New Source Review (NSR) Air Quality Permit 0201-M3, issued by NMED through its Air Quality Bureau and the Radioactive Materials License GA139, issued by NMED through its Radiation Control Bureau. In addition, Molycorp has notified the NMED Hazardous Waste Bureau that it is a small quantity generator of hazardous waste, No. NMD002899094.

2.4.5 State-Directed Reclamation Studies

Under Mining Permit TA001RE and ground water discharge permits DP-1055 and DP-933, CMI has conducted several reclamation studies, including a waste rock water balance study, a revegetation test pilot study for designing a cover system for the waste rock piles, and a stability study of the waste rock piles. Concerns with the potential instability of the waste rock piles were raised by the state regulators and other key stakeholders.

2.4.5.1 Waste Rock Water Balance Study

An infiltration test plot program was conducted for the waste rock water balance study to determine net infiltration into existing mine site waste rock piles. The study included construction of four closed lysimeters as well as several weathering stations across the waste rock piles, with primary locations associated with the lysimeters. The test plots were built in August 2000. The objectives of the study were to measure climatic conditions and in situ material properties and calibrate a soil-atmosphere model to predict net infiltration. Monitoring data collected from this study are reported annually.

2.4.5.2 Revegetation Test Plot Study

A draft work plan for performing a revegetation test-plot study was submitted to MMD and NMED in June 2002 in accordance with requirements of Mining Permit TA001RE and Ground Water Discharge Permit DP-1055. The purpose of the study was to develop optimal designs to satisfy conditions set forth in both permits. Under Mining Permit TA001RE, the design would be for construction and growth of self-sustaining vegetation, including the testing of alternative treatments, to meet the goal of establishing a forest ecosystem during reclamation. For DP-1055, the test plots would need to have a minimum of three feet of cover and be designed to reduce infiltration to the maximum extent practicable. A goal of the study was to determine the suitability of the Spring Gulch waste rock as a potential growth medium and its resistance to erosion. Another goal was to evaluate the effects of plant cover in reducing cover infiltration by water removal. After several joint letters were sent to Molycorp by MMD and NMED with technical comments on the draft work plan, a revised final work plan was approved by MMD but not NMED.

NMED expressed a number of concerns with the proposed study that Molycorp never adequately addressed. NMED expressed a concern that using Spring Gulch waste rock as cover material might not meet the specific minimum grain size requirements. Additionally, NMED required empirical data from the study to adequately measure infiltration. Such data would be necessary for NMED to assess the effectiveness of the plots in limiting infiltration into the underlying acidic waste rock. The rate of such infiltration is a critical performance criterion for assessing the adequacy of the study in demonstrating protection of ground water. Another concern was that the study was too limited in scope and would not test a broad enough range of reclamation techniques for cover and revegetation, considering the length of time it would take to complete the study (up to 12 years). Finally, there appeared to be an overall disagreement as to the purpose of the study and the need to collect data in support of future NMED decision-making on reclamation technologies for the mine site.

Without NMED approval, construction of the test plots was completed in 2003 under the direction and oversight of MMD. A total of 21 replicated test plots were constructed on 3H:1V, 2H:1V or non-sloping areas covered with 0, 1-foot or 3-feet of Spring Gulch waste rock. Treatments included microbial inoculants, density of tree-attendant nurse plants, seeding methods (for non-tree species) and, in some plots, the use of phosphate fertilizer. At the urging of various regulatory and non-regulatory stakeholders, additional non-replicated demonstration plots were added to the program to examine a variety of soil amendments, fertilizer application and ripping treatments.

Based on a review of the results through the 2009 growing season, it has been observed by EPA and others that unamended Spring Gulch waste rock does not appear to provide a suitable growth medium, nor is it likely to minimize infiltration through the cover, which would be a requirement of DP-1055 for protection of ground water. For vegetation production, the most promising results are found in demonstration plots amended with organic materials. To date, MMD has made no determination on the success of the revegetation test-plot study in meeting the conditions of Mining Permit TA001RE. The study is currently ongoing and CMI performs annual monitoring.

2.4.5.3 Storage Cover Test Plot Study

A storage cover test plot study was conducted as part of the 2003 revegetation test plots at the mine site. Four storage cover lysimeters were constructed in sloped test plots to allow comparison of parameters such as waste rock slope angle and cover thickness. The construction was completed in November 2003. Monitoring data collected for this study are reported annually.

2.4.5.4 Wildlife Impact Study

The Wildlife Impact Study was conducted to evaluate plant uptake of metals at the tailing facility, as required by New Mexico Mining Permit TA001RE 96-1 and Ground water Discharge Permit DP-933. The objective of the study was to investigate the toxicity and bioaccumulation potential of molybdenum and other metals to plants and animals that may come into contact with tailing or consume vegetation growing on covered tailing. The Wildlife Impact Study was performed from 2002 to 2004.

2.4.5.5 Waste Rock Pile Stability Study

See discussion under Section 2.10, Previous Reclamation Activities, below.

2.4.5.6 Root Zone Evaluation

A root zone evaluation was conducted by CMI in July 2008 under the direction of MMD and NMED to determine root-growth patterns and growth characteristics of various aged conifer trees growing in acidic waste rock material at the mine site, including Spring Gulch waste rock (the proposed borrow source for cover at the waste rock piles). One of the key goals of the study was to describe tree development in response to pH, salinity, and metals content of the growth media. Numerous tree root systems were exposed for sampling with a backhoe or by hand. Trees were excavated at four general locations: (1) the top bench of the Capulin Waste Rock Pile, (2) the lower bench of the roadside waste rock piles, (3) 3:1 test plots and platform demonstration plots within the 2003 test plot program, and (4) an undisturbed area at the lower slopes of Goathill Gulch. Root systems were described with respect to growth pattern, root density, root size, and presence of mycorrhizae. Soil samples from targeted depths within the rooting zone were collected and analyzed for metals, ph, and electrical conductivity to correlate with any effects observed.

The observations of rooting patterns indicate that there was a consistent pH control on root development. When soil pH was approximately 3.8 and higher, there appeared to be no consistent chemical limitation to root growth. When the pH was less than 3.8, root development was usually inhibited. Limited laboratory sampling and imprecise reporting and correlation of laboratory results to field observations led to few conclusions about salinity and metals effects on tree growth that were acceptable to MMD or NMED. The benefits of this study were limited to a general understanding of pH effects on tree growth.

2.5 National Pollutant Discharge Elimination System Permits

2.5.1 NPDES Permit for Discharge to Red River

EPA first regulated discharges of effluent from the Molycorp facility to the Red River in 1977 under the Clean Water Act, 33 U.S.C. §§ 1251 to 1387, NPDES program. EPA issued Molycorp NPDES Permit NM0022306 – Authorization to Discharge under NPDES. The current NPDES permit became effective in 2006 and expires in 2011.

2.5.1.1 Permitted Outfalls

Under NPDES Permit NM0022306, there are currently four permitted outfalls, two at the tailing facility (Outfalls 001 and 002) and two at the mine site (Outfalls 004 and 005).

- **Outfall 001** – Outfall 001 is an intermittent discharge at the outlet of Pope Lake near the base of Dam No. 4. In the past, effluent from the impoundments was decanted to Pope Lake where it was treated by the ion exchange plant. The ion exchange plant began operation in 1983 and the treated water was discharged to the Red River below Pope Lake. The plant has not operated in recent years and there has been no discharge through Outfall 001 for over 10 years. Pope Lake has been dry over the same time frame.
- **Outfall 002** – Outfall 002 is the largest permitted discharge from the tailing facility and is a continuous discharge. Outfall 002 discharges effluent comprised of a mixture of tailing seepage and contaminated ground water collected by a system of extraction wells and seepage interception drains south of Dam No. 1. An extension of the Outfall 002 system was previously identified as Outfall 003. It consists of an extraction well and two seepage barriers that collect tailing seepage from the eastern flank of the Dam No. 4 impoundment. The Outfall 003 system discharges into and becomes part of the Outfall 002 discharge. Effluent from this collection system flows via gravity through a pipeline and discharges at the bank of the Red River. Annual average discharge from Outfall 002 is currently about 550 gpm.
- **Outfalls 004 and 005** – Outfalls 004 and 005 are permitted intermittent discharges for periodic mine drainage that consists of mine-contacted surface storm water runoff to the Red River. Outfall 004 is located near the unlined catchments at the toe of the roadside rock piles on the mine site. Outfall 005 is located at the mill.

2.5.1.2 Best Management Practices for Seepage Collection

Under Best Management Practices required for NPDES Permit NM0022306 (Part II – Other Conditions, Section A) two seepage interception systems and a ground water withdrawal system were installed in 2002 to comply with the prohibition against the discharge to the Red River of pollutants traceable to point source mine operations.

- **Seepage Interception Systems** – Two seepage interception systems were constructed along the north bank of the Red River channel at Spring 13 and Spring 39 near the mine site. Spring 13 is a seepage zone located on the north side of the Red River just east of the mouth of Capulin Canyon. Spring 39 is a seepage zone located on the north side of the Red River just east of the mouth of Goathill Gulch. Both seepage areas are where aluminum hydroxide precipitation occurs. The locations of Springs 13 and 39 are depicted on the Mine Site Features Map (Figure 2-4).

  The seepage interception systems are designed to collect shallow alluvial seepage. They consist of perforated French drains placed approximately 1.5 feet below the low water level of the river. The drains flow via gravity to concrete vaults where the water is pumped through the pipeline to the mill. The French drain at Spring 39 was originally 400 feet long. The system was upgraded in 2005 to include a second drain next to the original drain. The flow from Spring 39 system averages about 80 gpm. The French drain at Spring 13 is approximately 1,000 feet long. The flow from the Spring 13 system averages approximately 20 gpm. The two systems have reduced but not eliminated the load of metals and other inorganic chemicals entering the Red River.

- **Ground Water Withdrawal Well System** – In 2002, three ground water withdrawal wells (GWW-1, -2, and -3) were installed just downgradient of the toes of the three Roadside Waste Rock Piles (Sugar Shack South, Middle, and Sulphur Gulch South) to capture potential discharges from point source mine operations through a hydrologic connection below the Sugar Shack waste rock pile. The locations of GWW-1, -2 and -3 are depicted on the Mine Site Features Map (Figure 2-4). These wells collect acidic, metals-laden water impacted by acid rock drainage from the waste rock piles and thereby, prevent such water from flowing downgradient and entering into the Red River at zones of upwelling at the Spring 39 area.

The wells are designed to extract alluvial ground water along the north side of the Red River at a rate that is approximately two to three times the estimated ground water flux to the Red River alluvial aquifer from the Sulphur Gulch watershed to the Sugar Shack South watershed. The extracted water is pumped to the mill and used as makeup water to transport tailing slurry via the pipeline to the tailing facility during milling, or pH adjusted with lime and piped to the tailing facility for disposal pursuant to New Mexico Discharge Permit DP-933. The pH adjusted water is used for pipeline maintenance and dust suppression at the tailing facility.

The water pumped from each withdrawal well is a mixture of Red River alluvial ground water and waste rock/scar leachate from the pre-existing drainages north of the river. Average pumping rates for GWW-1, -2 and -3 are approximately 100, 80, and 240 gpm, respectively, with a total pumping rate of 420 gpm.

2.5.2 Multi Sector General Permit for Storm Water Discharge

Storm water discharges have been regulated at the facility since 1992 under the EPA NPDES program pursuant to the Clean Water Act. The current MSGP permit (NMR05GC01) became effective in 2008 and expires in 2013. After submitting a Notice of Intent on January 5, 2009, CMI received authorization for coverage under the current MSGP to continue discharging to the Red River in accordance with 40 C.F.R. §122.26 and the SWPPP.

2.5.2.1 Storm Water Pollution Prevention Plan

CMI's current SWPPP provides for the collection and conveyance of storm water from the Sugar Shack South, Middle, Sulphur Gulch South and Blind Gulch waste rock piles to the open pit. The control measures established in the SWPPP include (1) preventing mine property storm water discharges to surface water and (2) managing storm water runoff that could or has come into contact with mining related areas (by discharging to the subsurface via the open pit). The SWPPP objectives do not include redirecting storm water away from mining waste to prevent contamination of storm water, nor take into consideration the avoidance of ground water contamination. CMI is required to consider such control measures in developing the SWPPP (see Section 2.1.1 of the MSGP).

2.6 History of Federal and State Investigations

A 1966 baseline water quality survey of the Red River stated that the chemical quality of the river was exceptional and that the water was suitable for a wide range of beneficial uses, including domestic, industrial, recreational, and trout propagation (U.S. Dept. of Health, Education, and Welfare, Federal Water Pollution Control Administration 1966). In 1971, EPA conducted a study of the Red River and concluded that the chemical quality and biological conditions of the Red River remained very good, but that occasional breaks in the Molycorp tailing pipeline had resulted in some degradation of river quality and biota (USEPA, 1971). Also in the early 1970s in the course of routine population studies, the New Mexico Department of Game and Fish discovered that fish were conspicuously absent in the middle reach of the Red River along the mine site, where thriving populations had once existed [New Mexico Department of Game and Fish Surveys of Red River (1960 and 1988)]. Specifically, 1960 fish census data indicated approximately 572 fish per mile in the river, whereas the 1988 fish census found no fish in this reach of the river.

Beginning in the late 1970s, EPA, the BLM and other various state and federal agencies began documenting major impacts to Red River water quality and aquatic biota due to significant metals contamination from mining and mining-related activities (see Garn 1985;

USEPA 1982; WQCC 1990 and 1992; NMED Surface Water Quality Bureau, 1996; and Allen 1999). In 1992, the New Mexico WQCC submitted a report to the United States Congress documenting elevated levels of numerous metals within the vicinity of the mine site, including cadmium, copper, lead, silver, and zinc. Since that time several other reports were prepared and submitted to by various state and federal agencies, all further establishing significant metals contamination in the Red River due to uncontrolled runoff from the mine and to seepage from contaminated ground water that also has been affected by mining operations. According to an Expanded Site Investigation (ESI) that NMED conducted in the mid-1990s, the mine waste rock and tailing impoundments contain hazardous substances and releases of these hazardous substances to ground water and surface water at the Site had occurred. A hydrological study completed by EPA indicated a probable hydraulic connection between the tailing impoundments and the Red River, as well as between the mine waste rock, natural weathering features (known as hydrothermal alteration scars), and seepage discharges to the Red River (USEPA, 1998).

2.7 National Priorities Listing

The Site has been proposed for listing on the NPL, in accordance with CERCLA.

2.8 CERCLA Enforcement Activities

In a letter to EPA dated April 1, 2000, New Mexico Governor, Gary Johnson, requested that the Site be placed on the EPA's NPL of Superfund sites. The Governor's letter followed months of unsuccessful negotiations between Molycorp and NMED to reach a settlement for the investigation and remediation of the Site under the New Mexico Water Quality Act.

Although the Site is an operating facility, nothing in CERCLA precludes EPA from taking response actions at such a facility. Nor does CERCLA limit response actions at facilities covered by state actions under state laws, such as NMED and MMD actions under the New Mexico Mining Act and New Mexico Water Quality Act.

2.8.1 CERCLA Special Notice Letter

The EPA issued a Special Notice Letter to Molycorp on November 6, 2000, to perform the RI/FS under CERCLA § 122(e), 42 U.S.C. § 9622(e). Molycorp responded to the Special Notice Letter on February 8, 2001, and acknowledged its willingness to conduct and finance the RI/FS.

2.8.2 Administrative Order on Consent for RI/FS

An Administrative Order on Consent for RI/FS (Order) was entered into by EPA and Molycorp on June 9, 2001, for Molycorp to perform a remedial investigation and feasibility study (RI/FS). The objectives of the RI/FS included (1) determining the nature and extent of contamination[11] and any threat to the public health, welfare, or the environment caused by the release or threatened release of contaminants at or from the Site, by conducting a RI, and (2) determining and evaluating alternatives for remedial action to prevent, mitigate or otherwise respond to or remedy any release or threatened release of contaminants at or from the Site by conducting a FS. In the Order, EPA found that waste rock, airborne dust, tailing, runoff, and leachate released from the Site may have potentially contained hazardous substances, including cadmium, copper, lead, silver, zinc, arsenic, chromium, cobalt, and sulfuric acid. EPA also found that such substances, under certain conditions of dose, duration, or extent of exposure, may produce adverse health and environmental effects.

EPA also found that numerous spills from the tailing pipeline had occurred. A 1981 Site Inspection report by EPA referred to “constant” breakage of the tailing pipeline. In 1996,

[11] Contamination is defined in the Order to include any medium (*e.g.*, soil, sediment, water, air) where any hazardous substance, pollutant, or contaminant has come to be located.

Molycorp reported to NMED that 239 leaks in the tailing pipeline had occurred from 1966 through 1991.

EPA further found that shallow ground water and surface waters draining the Site, like the Red River, have potentially been impacted by acidic, metals-laden waters released by mining operations.

Figure 2-5 depicts a timeline of mining activities and EPA and New Mexico enforcement activities.

2.9 CERCLA Remedial Investigation and Feasibility Study

Molycorp conducted the RI/FS from 2001 to 2009 under the direction and oversight of EPA, as supported by NMED and MMD. As part of the RI/FS, EPA performed the baseline human health risk assessment (HHRA) and baseline ecological risk assessment (BERA) for the Site from 2003 to 2009.

2.9.1 Remedial Investigation

The RI/FS was conducted in phases, beginning with project scoping and development of the RI/FS work plans. As part of scoping, EPA's technical team conducted a Site visit in October 2001 with other federal, state, and Molycorp officials. Initial RI/FS work plans were developed by Molycorp in late 2001 and 2002 and field activities commenced with a Site reconnaissance by the sampling teams in August 2002. Environmental media were initially sampled from August 2002 through 2004, including soil, sediment, surface water, ground water and air. Terrestrial biota and aquatic biota were also sampled for risk assessment.

As the initial environmental data were collected and evaluated, additional work plans were developed to characterize areas of the Site further. Several RI/FS work plan addendums were prepared in 2004 and 2005 to collect additional data, including focus sampling at seeps and springs along the mine site reach of the Red River and characterization of the roadside waste rock piles. Additional monitoring wells were installed at the tailing facility in 2005 and 2008.

The Final RI Report (RI Report) was submitted to EPA on July 3, 2009, and revised on November 24, 2009 (URS 2009a).

2.9.2 Risk Assessment

EPA initiated the risk assessment in June 2003. The following three risk assessment memoranda were developed as part of the risk assessment process:

- Risk Assessment Memorandum 1: Selection of Chemicals of Potential Concern
- Risk Assessment Memorandum 2: Delineation of Exposure Areas
- Risk Assessment Memorandum 3: Exposure Point Concentrations and Site Conceptual Exposure Models

The HHRA Final Report and BERA Final Report were completed in May 2009. EPA completed a re-evaluation of the risk assessment for the tailing facility as an addendum to the BERA in November 2009. The results of the EPA HHRA and BERA are discussed in Section 7.0 of this ROD.

2.9.3 Feasibility Study

The FS was started in January 2007. In 2009, CMI raised several technical and legal issues related to the FS and invoked the dispute resolution provisions of the Order. These issues included legal limitations on selecting rock pile relocation as a final CERCLA remedy, factor of safety for the roadside waste rock piles, use of institutional controls, and point of compliance or place of withdrawal for ground water remediation. EPA met with CMI, NMED and MMD officials several times in May and June, 2009, to resolve these issues. A summary of the resolution of FS issues was prepared by EPA, NMED and MMD on June

24, 2009, and agreed to by CMI. The summary and all other documents related to dispute resolution are contained in the Administrative Record file for the Site. The Final FS Report was submitted in August 2009 and a revised Final FS Report (FS Report) was submitted on November 16, 2009 (URS 2009b).

2.10 ATSDR Public Health Assessment

The Agency for Toxic Substances and Disease Registry (ATSDR) completed a public health assessment for the Site on February 28, 2005, in fulfilling its requirements under CERCLA and the NCP, 40 C.F.R. § 300.400(f). A copy of the public health assessment is contained in the Administrative Record file for the Site.

2.11 Previous Removal Actions

2.11.1 Tailing Removal

In 2002 and early 2003, Molycorp removed tailing from an area near the Upper Dump Sump under the direction and oversight of NMED. Approximately 8,650 cubic yards (yd^3) were removed and disposed at the tailing facility.

2.11.2 Underground and Aboveground Storage Tank Removal

In 2004, Molycorp removed two underground storage tanks containing gasoline and used oil and 53 old aboveground storage tanks, along with visibly stained soil associated with past releases from the tanks under the direction and oversight of NMED. The underground and aboveground storage tanks were located in the Aboveground Storage Tank Containment Area at the old open pit shop (former truck shop) at the mine site. Soil was contaminated with gasoline- and diesel-range organics (GROs, DROs), volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). The maximum depth of excavation in the vicinity of the aboveground storage tanks was 12 feet. Confirmatory soil sampling from the aboveground storage tank excavations indicated residual concentrations of DROs ranged from 30 to 2,000 mg/kg. The maximum depth of excavation beneath the underground storage tanks was 25 feet. Confirmatory sampling from the underground storage tank excavations showed low level of some VOCs and PAHs. NMED required no further action.

All petroleum-contaminated soil was shipped off-Site for disposal at a permitted facility in Colorado. The tanks were cleaned, then transported (either intact or cut into sections) to a recycling facility in Colorado.

A release from Diesel Fuel No. 2 aboveground storage tank, located west of the mechanics and electrical (M&E) shop, was discovered in December 2002. Molycorp repaired the leak and conducted an investigation of the vertical and horizontal extent of the contamination. Soil borings were drilled to a maximum depth of 120 feet below ground surface and three wells within 100 feet of the releases were sampled for GROs, DROs, VOCs and PAHs. Analytical results indicated that the release contaminated soil to a depth of 60 feet, but did not significantly affect ground water. Annual monitoring of the ground water in the vicinity of the spill (MMW-48A) continues today.

2.12 Previous Reclamation Activities

2.12.1 Goathill North Waste Rock Pile Interim Stability Mitigation

The Goathill North Waste Rock Pile was constructed in the upper Goathill Gulch characterized by hydrothermal alteration scar materials and an underlying historic landslide. Movement of the waste rock pile foundation associated with the initial development of an active landslide occurred between 1969 and 1973 and continued to occur after more than 30 years since its initiation. The weak foundation conditions were attributed to the scar materials that are more susceptible to weathering, as well as a shallow water table in the weathered zone which contributed pore pressures to trigger slide movements.

An independent Mine Rock Pile Stability Review Board (SRB) formed at the direction of MMD in the early 2000s determined that the Goathill North Waste Rock Pile was unstable, thus posing a serious risk to mine workers, as well as the residents of Questa, should a landslide occur. In a memorandum dated June 4, 2003, the SRB raised concerns with the potential for static liquefaction flow failure that could be triggered by adverse saturation and ground water effects associated with an extreme precipitation or runoff event. Such event could accelerate basal movement on the existing shear plane causing a large-volume, high-velocity flow slide. The SRB called for immediate action to mitigate the instability of the waste rock pile. On June 6, 2003, Governor Bill Richardson of New Mexico ordered an assessment of the mine rock stability in Questa.

Consequently, CMI, through its contractor, Norwest Corporation, conducted the interim stability mitigation. The purpose of the mitigation was to control the sliding movements that were occurring within pre-sheared materials near the weathered bedrock contact with natural colluvium and/or mine rock materials. The interim mitigation, which was conducted from 2004 to 2005, consisted of a balanced cut and fill regrade of approximately one million yds^3 of waste rock to achieve slopes of between 2H:1V to 3H:1V. All of the cut and fill work was done with dozers pushing material in a down slope direction. Stable and unstable portions of the pile were cut, with fill placed as a toe buttress in an erosion gully where the shear surface daylights. The upper portion of the waste rock pile was removed down to bedrock. A subsurface drain system was constructed below the toe to collect seepage and reduce potential instability. A permanent flume was installed with a flow measuring device to monitor the outflows from the drains. An interim drainage system was constructed on the regraded surface in order to minimize erosion while the fill settled and monitoring was collected to verify the success of the mitigation. The calculated factor of safety values for basal shear surface and critical slip surface are 1.35 and 1.30, respectively. It should be noted that the factor of safety for the two slip surfaces are averaged values calculated from three individual cross-sections projected through the Goathill North Waste Rock Pile. The cross-section with the lowest factor of safety values for basal shear surface and critical slip surface are 1.17 and 1.14, respectively.

In February 2009, CMI submitted to NMED and MMD a "Goathill North Reclamation Plan." In a joint letter dated March 11, 2009, NMED and MMD disapproved the plan, stating that it would not meet all of the relevant requirements of the New Mexico Mining Act and Water Quality Act or potentially the anticipated CERCLA action. The concerns identified by NMED and MMD included the following:

- Recent slope inclinometer data showed that the foundation materials were still moving since the waste rock pile was regraded and a discrete shear surface may be developing in the foundation material. It is likely that the continued creep of the waste rock pile material itself combined with movement of the foundation will result in numerous large fissures and cracks. If a discrete shear surface is developing, this could lead to accelerated movement of the waste rock pile, a new land slide slip surface and an unstable slope surface for reclamation. Reclamation of such a waste rock pile will likely need extensive maintenance. It is a concern that on-going fissuring and cracking of the waste rock pile surface will significantly impair the integrity and performance of the cover, and as a result, the cover may not be protective of ground water.

- CMI utilized the underlying waste rock as a component of the evapotranspirative cover system. Additionally, the plan failed to recognize that a primary goal of the reclamation was to reduce or eliminate infiltration, to the maximum extent practicable. Under DP-1055, NMED required that the cover system minimize infiltration into the waste rock and the cover must consist solely of non-acid generating material. The waste rock is acid generating or potentially acid generating and, therefore, could not be considered part of the cover system.

- NMED and MMD stated that the proposed cover design may not achieve the Closure/Closeout Plan requirements under the New Mexico Mining Act and Water Quality Act or the remedial action objectives or CERCLA requirements developed in the FS.

- Proposed final reclamation did not satisfy the New Mexico Coal Surface Mining Rule at § 19.8.20.2034 NMAC "Disposal of Excess Spoil" long-term static factor of safety of 1.5 or minimal backfilling and grading requirements for a 1.3 static factor of safety. CMI's analysis of long-term stability in the downslope direction proposes a critical slip surface factor of safety of 1.14. To attain the minimum factor of safety requirements for long-term stability, CMI proposed using a three-dimensional stability analysis instead of the customary two-dimensional stability analysis.

- The plan did not meet the NMED performance criteria for store and release cover systems in New Mexico. The NMED indicated that if a store and release cover system was to be constructed, it must at a minimum have the capacity to store an amount of water equivalent to the average winter precipitation solely within the non-acid generating cover material.

2.12.2 Sugar Shack West Waste Rock Pile Interim Reclamation

In 2007 and 2008, Sugar Shack West Waste Rock Pile was regraded to prevent a loss of restraint in the confining ridge to the north as a result of subsidence from underground mining operations, which could lead to adverse stability impacts.

Six slope inclinometers were installed within and north of the Sugar Shack West Waste Rock Pile in 2008 for monitoring geotechnical performance of the waste rock pile and the area between the pile and the subsidence area following regrading. Vibrating wire piezometers installed in the slope inclinometer boreholes indicated mostly dry conditions, with the water table below the base of the waste rock pile. In the two slope inclinometers located north of the waste rock pile, shear movements (less than 10 feet) were measured in bedrock located 120 and 90 feet beneath ground surface, with a velocity at 0.02 inches per month. The shear movements are likely associated with subsidence related to the underground workings (Norwest 2010).

2.12.3 Roadside Waste Rock Piles Geotechnical Stability Evaluation

A geotechnical stability evaluation was performed on the roadside waste rock piles (Sugar Shack South, Middle, and Sulphur Gulch South) by Norwest in 2004 under the direction and oversight of MMD. A total of 16 boreholes were drilled into the waste rock piles for testing and instrument installation. Eight slope inclinometers were installed to monitor later deformation of the rock piles with depth. Other tests included measuring pore-water pressures within and immediately below the rock piles, running temperature profiles with depth, and running borehole geophysics to look for evidence of clay layers.

Based on these findings, and a Failure Mode Analysis, Norwest recommended enhancement of the toe berm at Sulphur Gulch waste rock pile to adequately contain any small scale shallow flowslides or slumps that may occur. Beginning in 2006, the berm at Sulphur Gulch waste rock pile was raised approximately 20 feet. The raised berms also created additional containment capacity for storm water runoff and eroded soil and waste rock. The berm enhancement reduced the potential for transport of mine site soil containing metals to the Red River.

2.13 National Remedy Review Board Review

EPA's National Remedy Review Board is a peer review group comprised of managers or senior technical or policy experts from EPA offices involved with Superfund remedy selection issues. The National Remedy Review Board has been established by EPA to review proposed CERCLA cleanup decisions where the remedial action is estimated to cost more than $25 million to assure consistency with CERCLA, the NCP, and Superfund policy and guidance.

The National Remedy Review Board reviewed the proposed remedy for the Site in the Fall of 2009. As part of this review, the Board conducted a Site visit with EPA Region 6, NMED, MMD and CMI representatives in September 2009. The National Remedy Review

Board submitted recommendations on the proposed remedy to EPA Region 6 on November 9, 2009. EPA Region 6 responded to the Board’s recommendations on January 8, 2010. There were no significant changes made to the Selected Remedy based on the Board’s review. A copy of the National Remedy Review Board’s comments and EPA Region 6’s responses are included in Appendix B.

3.0 COMMUNITY PARTICIPATION

This section of the ROD describes EPA's community involvement activities. EPA has actively sought a dialogue and collaboration with the affected community and has strived to advocate and strengthen early and meaningful community participation during EPA's remedial activities at the Site. These community participation activities during the remedy selection process meet the public participation requirements in CERCLA § 121 and the NCP at 40 C.F.R. § 300.430(f)(3).

3.1 Community Interviews

In 2002, EPA went door-to-door in the community to provide an opportunity for residents to talk with EPA officials privately about their concerns regarding the Site and how they wanted to be involved. Based on some of these conversations EPA expanded its field investigation to conduct additional environmental sampling in an area south of the tailing facility where residents reported sick livestock grazing in pastures, as well as air monitoring at the northeastern perimeter of the tailing facility. This led to the discovery of soil contamination south of the tailing facility. Also in response to community concerns, EPA collected samples of vegetables, garden soil and irrigation water from three private gardens in close proximity to the tailing facility in August 2003. Results from this study were presented to the community and used in EPA's comprehensive multi-pathway HHRA.

3.2 Community Involvement Plan

A Community Involvement Plan was developed for the Site by EPA in 2002 to specify outreach activities that would be undertaken by EPA to address community concerns and expectations. The Community Involvement Plan was more recently updated in May 2010. The goals of the Community Involvement Plan include the following:

- Provide the public with accurate, timely, and understandable information and/or access to the information needed to understand the RI/FS as it moves forward;
- Provide the public with the opportunity to give informed and meaningful input;
- Ensure adequate time and opportunity for the public to provide input and for that input to be considered;
- Assist the public in understanding EPA's decision-making process during the RI/FS and Site cleanup and the community's role in that process.

The Community Involvement Plan provides a detailed description of the community involvement activities and identifies how they will be used to address community concerns and promote public involvement. The Community Involvement Plan also contains references and a series of appendices designed to serve as resources for both EPA and the community. Specific sections include EPA and project team, local government, and media contacts, and directions on how to obtain additional information. The Community Involvement Plan was placed in the Site information repository.

3.3 Community Meetings

EPA and NMED have conducted numerous community meetings and open house sessions during the course of the RI/FS for the Site and provided public notices of these meetings and sessions to encourage the community's participation. The meetings were held to provide status updates on the RI/FS activities and risk assessments. The meetings and availability sessions held during the RI/FS are as follows:

- November 12, 2002 – Scope of the RI/FS and Initial Field Investigation Update
- August 27, 2003 – RI Field Investigation Update
- June 22, 2004 – RI Field Investigation Update

- December 9, 2004 – RI Field Investigation Update
- June 28, 2005 – RI Field Investigation Update and Introduction to Risk Assessment
- August 23, 2007 – Risk Assessment
- May 13, 2008 – Preliminary Cleanup Options

At each community meeting and open house, EPA presented technical experts to explain aspects of the Site or phase of the RI/FS being presented and discussed. The experts included (1) geologists and hydrologists to explain the ground water and surface water investigations, (2) toxicologist to talk about Site-specific contaminants, their known effects on people or ecological receptors and the overall risk assessment process, and (3) aquatic toxicologist to discuss the investigation of Red River aquatic biota.

Prior to these community meetings/open house sessions, EPA often met individually with other key stakeholders. Meetings were held with the Rio Colorado Reclamation Committee [RCRC; the community group awarded the Technical Assistance Grant (TAG) that is now known as the Red River Remediation Group or R3G], the Village of Questa, Amigos Bravos (an environmental group based out of Taos, New Mexico), the U.S. Forest Service, and Taos County.

In late July/early August 2007, EPA toxicologists met with mine workers to discuss and answer any questions related to polychlorinated bi-phenyls (PCBs) and other Site-related contaminants and the preliminary findings of EPA's risk assessment.

3.4 Questa Community Coalition Meetings

The Questa Community Coalition (QCC) was formed by EPA after concerns were raised by the Village of Questa, Amigos Bravos, and the R3G that their technical representatives were unable to participate in meetings between EPA and Molycorp. To address this issue, the QCC was formed to consist of one or two technical representatives from each stakeholder and representatives from EPA, NMED and CMI. The QCC would meet to discuss the status of the project and technical information collected to date. At the meetings, stakeholder's technical representatives could direct questions to EPA, NMED or CMI. The QCC meetings held during the RI/FS were as follows:

- August 26, 2003 – Update on status of RI field sampling activities;
- June 21, 2004 – Update on status of RI field sampling activities and preliminary sample results;
- September 14, 2005 – Update on preliminary RI sampling results for Site characterization;
- December 9, 2008 – Update on preliminary remedial alternatives.

3.5 Technical Assistance Grant

A TAG in the amount of $50,000 was awarded to the RCRC (currently the R3G) on August 29, 2002, to assist the community in its effort to actively participate in the RI/FS and EPA decision-making process. A second grant was awarded on April 10, 2006, for $100,000 and a third grant was awarded on December 1, 2009, for $225,000. The TAG provided for the R3G to hire a technical advisor, who is an independent expert that could explain technical information collected during the RI/FS and facilitate public participation and involvement. The technical advisor's role included the review and comment on all technical documents related to the RI/FS and EPA's Proposed Plan for Site cleanup and articulating the community's concerns to EPA.

The technical advisor was provided a copy of all draft final RI/FS documents for review, including EPA risk assessment reports and technical memoranda (see Document Review by Community Groups, below). The technical advisor submitted written comments to EPA on RI/FS documents, including the draft final RI Report, draft final Alternatives Evaluation

Report, and draft final Feasibility Study Report for EPA's consideration when finalizing the documents.

Information developed by the R3G technical advisor was shared with the community to aid in the preparation of public comments and encourage participation in the cleanup decision-making process. The R3G distributed a fact sheet in January, 2010, which presented an overview of the R3G comments on the Proposed Plan. The R3G also held two open house events to discuss its viewpoint and answer any questions or take comments from the community. The first open house was held in Taos, New Mexico on March 15, 2010; the second in the Village of Questa on March 16, 2010. Representatives from NMED attended the meetings. EPA did not send representatives to the meetings.

3.6 Document Review by Community Groups

In late 2002, concerns were raised by the community groups and the Village of Questa about the opportunity to review key documents related to the RI/FS. They requested review of all draft documents, including RI/FS work plans, so that they could provide technical input and influence the scope and direction of the work before the plans were considered final by EPA. They expressed to EPA the need to review documents before EPA considered them final if they were to have any real meaningful involvement in the RI/FS process. To address this issue, EPA agreed to provide copies of all draft final documents to the public for review and comment before they were finalized. Draft final documents were provided to the R3G and Amigos Bravos, as well as the Village of Questa and Taos County. Copies of the draft final documents were also placed into the local repository, as well as the repositories at NMED's office in Santa Fe, New Mexico and EPA Region 6's office in Dallas, Texas. In providing these documents, EPA notified the stakeholders that if they wished to provide written comments, they do so within a certain timeframe in order for EPA to finalize the RI/FS documents in accordance with the RI/FS project schedule.

Members of the public provided written comments to EPA on the following draft final RI/FS documents:

- Proposed South of Tailing Facility Additional Sampling Program – RCRC, July 22, 2003;
- Wind Blown Transects Sampling – RCRC, July 22, 2003
- Draft Sampling and Analysis Plan for Investigation of Historic Tailings Spill Deposits – RCRC, November 14, 2003;
- Preliminary Site Characterization Summary – Village of Questa, September 19, 2005;
- Risk Assessment Memorandum No. 3 – Exposure Point Concentrations and Site Conceptual Exposure Models – Miller Geotechnical Consultants on behalf of Village of Questa, April 23, 2007;
- Alternatives Evaluation Report – RCRC, Amigos Bravos, and Village of Questa, January 29 and 31, 2008;
- Draft final RI Report – Village of Questa, March 9, 2009;
- Draft final FS Report – RCRC, Amigos Bravos, Village of Questa, June 29, 2009

3.7 Other Community Involvement

3.7.1 Private Well Sampling

During the RI/FS, EPA offered to sample any private well located within two miles of the mine site or tailing facility or along the tailing pipeline if requested by the owner of the well. At the December 2004 community meeting in Questa, several residents informed EPA of their interest in having their private wells sampled. Over twenty other residents asked to have their private wells sampled, but did not want EPA or the state to perform the sampling. The Village of Questa offered to sample those resident's private wells but later cancelled the sampling.

In July 2005, EPA sampled the private wells of those residents that asked EPA to perform the work. The laboratory analytical results were provided to the property owners in August 2005. The results showed no exceedances of federal drinking water or state water quality standards.

3.7.2 Reported Petroleum Waste Dumps

In a letter dated August 15, 2003, the RCRC technical advisor notified EPA and NMED of an allegation made by former employees of Molycorp that there were buried petroleum waste dumps at the mine site. The EPA, NMED, and Molycorp discussed the allegation with the technical advisor and a Site visit was conducted with the resident making the allegation to identify the area of alleged dumping. A comparison of the dumping area and the RI/FS sampling locations was performed to determine if any additional sampling was necessary. Based on that comparison, EPA determined that no additional sampling was required beyond what had already been performed.

On April 26, 2004, EPA provided the RCRC technical advisor with the preliminary organics data from surface water and ground water samples collected in the vicinity of alleged dumping area, as well as all other known landfills at the mine site. The analytical data showed low levels of petroleum contamination which did not warrant further action.

3.7.3 Tailing Used as Bedding Material for Questa Municipal Water Supply Piping and Residential Tap Sampling

In 2003, residents and the village of Questa expressed concerns with the possibility that tailing was used as bedding material for the municipal water supply pipes that could potentially contaminate the drinking water in their homes if the pipes were damaged (cracked) and allowed tailing to slough into the line. These concerns led EPA to request the NMED's Drinking Water Bureau to sample several residential taps. This sampling was performed in August 2003. The EPA collected split samples for independent analyses at the request of residents.

Tailing was discovered in a trench excavated by Taos County Soil and Conservation District (SCD) adjacent to Hunt's Pond in November 2003. The excavation, which exposed utility lines, was confirmation that tailing had been used as bedding material.

3.7.4 Tailing in Hunt's Pond

In February 2000, the Village of Questa, working with the U.S. Forest Service, was conducting activities to remove water and silt from Hunt's Pond. These activities led to the discovery of tailing mixed with organic material beneath two feet of black organic matter. Molycorp excavated the tailing mixture from the pond and transported it to the tailing facility for disposal. According to Molycorp, the source of the tailing was likely the result of a tailing spill incident in the late 1960s or early 1970s.

In a letter to EPA and other agencies, dated November 25, 2003, Amigos Bravos suggested that tailing may have actually been deposited in Hunt's Pond from a large tailing spill that occurred along the tailing pipeline on March 5, 1966 (news story and photo in the *Taos News* on March 10, 1966). Amigos Bravos' letter was in response to a more recent discovery of tailing in a trench excavated by the Taos County Soil and Conservation District to drain water and sediment from the Hunt's Pond to the Red River on November 17, 2003. Amigos Bravos expressed concern that tailing had drained from the trench to the Red River and that the pond was never adequately cleaned of the tailing material discovered in 2000.

No action was taken by EPA related to this incident.

3.7.5 Oil Sheens on Water within *Acequia*

In 2005, after concerns were expressed by two Questa residents that ditch water quality on their properties had an unusual cloudy appearance and surficial foamy substance, the EPA collected surface water samples from the North (Embargo) and South irrigation ditches. Sampling was also conducted upstream and downstream of these properties in close proximity to the property boundaries and at headgate structures that divert water from the Red River into the irrigation ditches.

Analytical results of samples collected at selected locations from the North and South irrigation ditches indicate that low levels of DROs were detected in several samples. However, higher concentrations of DRO were detected downstream of the headgate indicating that the source of DRO in the South Ditch surface water is most likely not mine site related. DRO was also detected at low levels in Cabresto Creek upstream from where it confluences with the North Ditch. Unlike the South Ditch, Cabresto Creek drains an area undisturbed by mining activities and as such, was used as a reference area to collect samples for the RI/FS. The low level of DRO present in the sample suggests that the source of this compound may be also due to farming activities along or near Cabresto Creek.

No GROs were detected in any samples and most of the metals were either not detected, or were qualified concentrations in all of the samples. The metals that were detected were measured at concentrations well below human health risk-based screening levels assembled during the RI/FS process for the surface water media.

3.7.6 Potential Data Gaps in Ground Water Investigation at Tailing Facility

In 2007, the Village of Questa expressed concerns about potential data gaps with the investigation for determining if ground water contamination was present along the eastern flank of the tailing facility. This led EPA to require the installation of five additional monitoring wells in that area for further ground water testing. Based on the analytical results, no tailing-seepage impacts were detected in ground water samples collected at the five wells.

In 2010, the Village of Questa, in response to EPA's Proposed Plan, expressed concern for elevated uranium concentrations in ground water south of the tailing facility. The Village of Questa noted that uranium levels exceed the federal drinking water standard of 0.03 mg/L for uranium in three monitoring wells (MW-26, MW-29, and MW-9A), three extraction wells (EW-5A, EW-5D, and EW-6), the East Seep, and Seep Barriers 001 and 003 that represent the upper portion of the alluvial aquifer at the tailing facility. The 0.03 mg/L standard is the maximum contaminant level (MCL) established under the federal Safe Drinking Water Act (SDWA) and the ground water quality standard established under the New Mexico Water Quality Act for uranium. In response to the Village of Questa's concern, EPA evaluated all available post-RI sampling data associated with New Mexico Ground Water Discharge Permit DP-933 at the tailing facility. These data were used to construct two isoconcentration contour maps of two time periods: the third quarter of 2008 and the third quarter of 2009 (Figures 3-1 and 3-2). These maps delineate the areal extent of uranium contamination in the shallow alluvial aquifer south of the tailing facility.

The contour maps show that the higher concentrations of uranium receded somewhat in 2009 from the extent delineated in 2008. In 2008, uranium contamination extended south of MW-26 at a concentration that exceeded the MCL. In 2009, the concentration was below the MCL in this area.

In addition to uranium contamination in the alluvial aquifer, there is some indication that the basal bedrock aquifer is also contaminated with uranium (also a concern of the Village of Questa). This conclusion is based on elevated concentrations above the federal and state MCL in MW-1, which is completed in the basal bedrock aquifer.

EPA believes that the Selected Remedy will adequately mitigate uranium contamination, as well as other Contaminants of Concern (COCs) in the alluvial aquifer south of the tailing facility. However, further investigation and monitoring of uranium contamination in ground water at the tailing facility, as well as the mine site, is warranted as part of the CERCLA response action.

3.7.7 Molybdenosis and the Loss of Livestock in Pastures South of Tailing Facility

There has been a long history of claims by local residents of livestock (cattle and sheep) becoming sick and dying after grazing in the pastures south of the tailing facility. Some of these claims include descriptions of such animals' hair turning white and falling out, a possible effect of molybdenosis, a molybdenum-induced form of copper deficiency. The EPA first learned of this issue during the door-to-door community interviews conducted at the start of the RI/FS and Community Involvement effort.

During one of the interviews, a local resident living in close proximity to the tailing facility dams (Dam No. 1) informed EPA officials that in addition to suffering a loss of cattle that grazed in the pasture near the river, his children's hair turned white when they were teenagers. He indicated that his family was exposed to metals contamination in ground water from his private well, which came from the tailing facility. He also informed EPA of spills flowing over the ground from the tailing facility in earlier years of operation which inundated his property as well as a relative's property located across the road. He could not provide EPA with any documentation of the loss of cattle or mining-related contamination on his property or his relative's property, as such information was placed under seal by court order following a civil lawsuit and 1980's settlement with Molycorp.

To date, no documentation (*e.g.*, pathology report) has been obtained by EPA to verify the claims of livestock loss from molybdenosis. However, based on the findings of the RI, shallow soil in the meadow contains concentrations of molybdenum at levels which pose a risk to cattle and sheep, as well as other large herbivorous mammals (deer and elk) for molybdenosis (see Summary of Ecological Risk Assessment, Section 7.2, below).

A local rancher notified EPA in September 2007 of a loss of twelve calves and two cows during the 2006-2007 winter calving season. The herd had grazed previously in the meadow south of the Tailing Facility between Embargo Road and the Red River and was being fed hay harvested from the meadow. CMI had the rancher's hay analyzed and found the average concentration of molybdenum to be below the level considered to be a risk for molybdenosis. Remains of two of the calves were submitted to the Colorado State University College of Veterinary Medicine for pathology and clinical chemistry evaluation. According to the consulting veterinarian, the results were inconclusive with regard to the cause of death. One calf had low liver copper levels just above levels that would be considered deficient. The second calf had normal concentrations of copper. Both calves had normal concentrations of molybdenum, but were deficient in vitamins A and E.

3.7.8 Dust from the Tailing Facility

There is a long history of dust problems associated with the tailing facility. Reports of dust storms originating from the tailing impoundments in the 1970s and 1980s are common. More than once, the dust storms were so severe that the Questa High School, located near the northeast boundary of the tailing facility, was shut down and students sent home with their parents. In 1980, the state championship baseball game at Questa High School had to be canceled because of a dust storm.

Since the start of the RI/FS in 2001, there have been reported observations of dust clouds blowing off the tailing facility by local residents to EPA, but they have been few. Ambient air monitoring of particulates along the inside perimeter of the tailing facility was initiated by Molycorp in 2003, and continues today as a voluntary monitoring program (see Air Quality Monitoring, Section 5.8.12, below).

Various dust suppression techniques have been implemented by CMI at the tailing facility over the years, some apparently more successful than others. Dust suppression measures conducted by CMI are ongoing.

3.7.9 Community Petitions EPA to Examine Other Options for Tailing Facility

A petition signed by over 90 community members and sponsored by the RCRC was submitted to EPA on January 1, 2008. The petitioners called for EPA, NMED, and CMI to evaluate another method of tailing disposal, preferably storing the tailing at the mine site in the form of paste (tailing bricks which are less likely to contaminate the air or water). The petitioners also requested that CMI recycle the water it uses, rather than using precious fresh water and allowing it to become contaminated by tailing and subsequently reaching and contaminating ground water at the tailing facility. The petitioners asked that no remedy be decided upon until such a study has been completed and commented upon by the public.

EPA discussed the petitioners' request with the RCRC and the community at the next community meeting in Questa. EPA also included a discussion of the issue in the community fact sheet, dated June 2009.

3.8 ATSDR Meetings

ATSDR staff spoke with local residents in a public availability session held June 25, 2003, in Questa and after an EPA community meeting held in Questa on August 27, 2003. During the meeting, ATSDR asked the community to share their health concerns related to contaminants at the Site. ATSDR also collected health concerns from community members by e-mail and by telephone.

The ATSDR presented and discussed the findings of its revised public health assessment to the Questa community on September 22 and 23, 2004. Public comments were accepted on the public health assessment from September 5, 2004 to October 22, 2004. The final public health assessment addresses the written comments received, which are included in their entirety with ATSDR responses in Appendix D of ATSDR's Public Health Assessment document.

3.9 Fact Sheets

Numerous fact sheets, some both in English and Spanish, were prepared by EPA during the planning and implementation of the RI/FS. These fact sheets were placed at the Site Repository in Questa and distributed to those persons on the Site mailing list maintained by EPA. The New Mexico Department of Health also prepared a fact sheet on molybdenum health effects. These fact sheets are identified below.

- Update on RI Field Investigation – February 2003
- Molybdenum Health Effects Information Summary (NMDOH) – September 2003
- Results of Fish Tissue Sampling – April 2004
- Questions and Answer Summary from June 22, 2004 Community Meeting – September 2004
- RI/FS Update – December 2004
- Ecological Risk Assessment – June 2005
- Residential Garden Sampling – August 2005
- Human Health Risk Assessment – August 2007
- Summary of Remedial Alternatives – June 2009
- Proposed Plan Fact Sheet – December 2009

3.10 Public Meetings for the Proposed Plan

Two public meetings were held on January 21, 2010, and a third public meeting on February 23, 2010, at the VFW Hall in Questa, New Mexico, to present the Proposed Plan (USEPA 2009) to community members. Representatives from EPA answered questions about EPA's preferred alternative for the Site. Oral and written comments were accepted at the meetings. A court reporter transcribed the discussions held during each meeting. These transcripts are included in the Administrative Record file for the Site, which is maintained at the Information Repository located at the Village of Questa Municipal Offices, NMED's office located in Santa Fe, and EPA's office located in Dallas, Texas.

The RI Report (URS 2009a), FS Report (URS 2009b), Baseline Human Health Risk Assessment (CDM 2009a), Baseline Ecological Risk Assessment (CDM 2009b), and the Proposed Plan (USEPA 2009) for the Site were made available to the public on January 4, 2010. These documents are currently located in the Administrative Record file for the Site. The notice of the availability of these documents, as well as the complete Administrative Record for the Proposed Plan, was published in the Taos News on December 31, 2009, and January 7, 2010.

A public comment period was held from January 6, 2010, to March 31, 2010, a period of 85 days. The comment period was extended three times for periods of 32, 15 and 8 days. The first 32-day extension was provided when the Administrative Record was not received by the Village of Questa Municipal Offices (local Site repository) at the planned start of the comment period on December 31, 2009. The second 15-day extension and third 8-day extension were provided at the request of several stakeholders, including the Village of Questa and the R3G.

3.11 Local Site Repository

EPA has established a local site information repository for documents and other information on the Site and EPA response actions. The purpose of the local site repository is to provide a location near the Site for the community to review and copy background and current information about the Site.

The local Site repository is located at:

Village of Questa Municipal Offices
2500 Old State Road 3
P.O. Box 260
Questa, NM
(505) 586-0694

4.0 SCOPE AND ROLE OF RESPONSE ACTION

This is the first CERCLA response action to be conducted at the Site and it will be conducted as one Site-wide operable unit. However, as with many large mine sites, this Site poses a number of complex problems and technical challenges in dealing with such large volumes of waste material (*i.e.*, waste rock and tailing) and performing remediation at five separate and distinctly different geographical areas of the Site. Additionally, it is complicated by the fact that this Site is an operating facility and currently regulated by New Mexico through mining and ground water discharge permits that include requirements for mine reclamation and closure, as well as ground water protection and abatement. Therefore, from a practical standpoint, EPA is organizing the work into separate phases which take into account these other technical and operational issues.

4.1 Phases of Work

The phases of work shall be conducted as shown below.

<u>Phase I</u>

- Conduct pre-design investigation of ground water contamination before initiating design work for the ground water component of the remedy at the Tailing Facility Area as well as additional characterization of the spatial distribution, concentration and chemical form of molybdenum at the Spring Gulch Waste Rock Pile, the preferred borrow source for cover material at the Mine Site Area.
- Conduct response actions to mitigate soil contamination at the Mill Area, soil contamination and tailing spills at the Red River Riparian and South of Tailing Facility Area, sediment contamination at Eagle Rock Lake, and surface water and ground water contamination at the Mine Site Area and Tailing Facility Area.

- Conduct response actions for treatment of contaminated water collected by the tailing facility remedial systems as well as contaminated water collected from the mine site remedial systems.

- Conduct response actions for source control at the Mine Site Area waste rock piles in a phased approach, with the design of the first rock pile conducted as a pilot study. The pilot study will incorporate treatability studies to identify appropriate cover amendments and designs to provide for water resource protection. The treatability studies will be conducted concurrently with the pilot study and will not impede the start of the design and construction of the second tier of waste rock piles to be remediated. The first waste rock pile to be remediated will likely be the Goathill North Waste Rock Pile. Upon approval of the first design, remedial construction will proceed on the Goathill North Waste Rock Pile at the same time design work is initiated for two subsequent waste rock piles, one of which shall be a roadside waste rock pile. This work shall continue with design and construction of no less than two waste rock piles at a time through completion of this component of the remedy. The phased approach allows for a "toolbox" approach for developing individual mine reclamation designs on a rock pile-by-rock pile basis, while taking into consideration lessons learned after implementation of each design.

<u>Phase II</u>

- Conduct response actions for placement of cover at the Mill Area following permanent cessation of milling operations.

- Conduct response actions for source containment at the Tailing Facility following permanent cessation of tailing disposal operations.

The two phases of work may be conducted sequentially or concurrently, depending on the timing of CMI's mining and/or tailing disposal operations.

Through a combination of technologies such as treatment, removal, engineering controls for containment and, in limited circumstances if needed, institutional controls, these response actions will protect human health and the environment by (1) eliminating or reducing the leaching and migration of contamination caused by acid rock drainage and tailing seepage to ground water, and subsequently to surface water at zones of ground water upwelling, (2) restoring ground water to meet drinking water or water quality standards, risk-based cleanup levels, or background levels, (3) protecting Red River aquatic and aquatic-dependent life from chronic exposure to contaminants by eliminating or reducing mining-impacted discharges to the Red River, (4) reducing or eliminating exposure by human and ecological receptors to tailing in ponded areas, and (5) eliminating or reducing direct exposure and exposure via accumulation in plants by wildlife and livestock to mining-affected soil and tailing spills that contain molybdenum.

In light of other ongoing actions being conducted by CMI pursuant to the New Mexico Mining and Water Quality Acts and associated regulations for Site reclamation and closure, as well as ground water abatement, the CERCLA response action will be consistent with such requirements to the extent practicable.

4.2 Role of CERCLA Response Action as Part of Comprehensive Red River Watershed Restoration

Since the early stages of the CERCLA RI/FS, the EPA Superfund Program has coordinated with other state and federal agencies, as well as other EPA programs, in implementing environmental investigations and response actions under their respective authorities as part of a comprehensive restoration approach for the Red River Watershed. These other regulatory and response programs include the federal and state Natural Resource Damage Assessment and Restoration programs, the Clean Water Act Total Maximum Daily Load (TMDL) program, and the U.S. Forest Service's CERCLA Removal Program.

4.2.1 Natural Resource Damage Assessment and Restoration

In May 2002, a Memorandum of Understanding was executed among EPA, DOI, USDA, and ONRT which defined a framework for coordination of the CERCLA remedial process and the Natural Resource Damage Assessment and Restoration process. The Memorandum of Understanding also established a Site Planning Team for such coordination and sharing of data and work products. The trustee agencies were given the opportunity to review and comment on RI/FS documents and the Proposed Plan. The Site Planning Team was comprised of representatives from EPA, USFWS, BLM, U.S. Forest Service and ONRT.

In light of the anticipated CERCLA response actions, the trustee agencies chose to focus on restoration alternatives that would not conflict with or be put at risk from any planned or proposed CERCLA response actions. Therefore, in conducting the damage assessment and restoration process, the trustee agencies identified additional actions beyond the CERCLA response actions to address injuries to natural resources. The trustee agencies are currently negotiating a settlement with CMI for the restoration of natural resources injured by the release of hazardous substances from mining activities.

4.2.2 Total Maximum Daily Load

Under Section 303(d)(1) of the Clean Water Act, states are required to establish a list of waters within a state that are impaired and establish a TMDL for each pollutant. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive without violating a state's water quality standard. In other words, it is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined at 40 C.F.R. Part 130 as the sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background conditions, and include a margin of safety.

The Red River (from its confluence with the Rio Grande), together with its perennial and ephemeral tributaries, including Bitter Creek, Pioneer Creek and Placer Creek, and its headwaters define the Red River Watershed (Figure 4-1). Based on surface water quality data, impairment determinations of New Mexico water quality standards for metals (chronic and acute aluminum), stream bottom deposits, and turbidity were documented by NMED's Surface Water Quality Bureau for the Red River (Rio Grande to Placer Creek) and the Bitter Creek and Placer Creek tributaries. Information collected as part of the CERCLA RI for the Red River was provided to NMED to assist in development of the TMDL.

For the listed reach of the Red River, the TMDL addresses these impairments for acute aluminum. Chronic aluminum TMDLs were not prepared due to potential changes to the New Mexico surface water standards for chronic aluminum. NMED found that naturally-occurring aluminum levels in the Red River Watershed are typically high and often exceed the chronic aluminum standard of 0.087 mg/L for aquatic life habitat uses. The future development of chronic aluminum TMDLs for the Red River will be dependent on the development of appropriate segment-specific chronic aluminum standards.

The TMDL calculated for acute aluminum is as follows:

> *Waste Load Allocation (3.90 lbs/day) + Load Allocation (578 lbs/day) +*
> *Margin of Safety (194 lbs/day) = 776 lbs/day*

The measured load of aluminum for the Red River (Rio Grande to Placer Creek) in 1999 was 1,170 lbs/day.

The waste load allocations included the four NPDES permitted outfalls at the mine site and tailing facility, as they represented point sources to the Red River. Because Molycorp installed seepage interception systems and ground water withdrawal wells to prevent discharges of process-related ground water at Springs 13 and 39 under its NPDES permit[12], no waste load allocation was assigned to Spring 13, Spring 39, or any other springs or seeps located along Red River.

In developing the TMDL, NMED stated that the exact amount of the measured load for the Red River attributed to point sources, background, and nonpoint sources was yet to be determined and acknowledged that studies[13] were currently attempting to resolve this issue. NMED also acknowledged that the potential sources include tailing and acid mine drainage.

The draft TMDL was made available for public comment on November 16, 2005. A public meeting was held on November 29, 2005. The final approved TMDL was established on March 17, 2006.

The EPA Superfund Program will continue to work with the TMDL program by providing any new Site data collected as part of the CERCLA response actions that may support further TMDL development.

4.2.3 CERCLA Removal Action at Abandoned Mines in Upper Red River Watershed

Beginning in 2006, the U.S. Forest Service conducted a CERCLA Non-Time Critical Removal Action to respond to hazardous substance releases at 25 abandoned mines on lands under the jurisdiction of the Carson National Forest, pursuant to 42 U.S.C. § 9604(a), Executive Order 12580, and 7 C.F.R. § 2.60(a)(39). The 25 abandoned mines are located in Bitter Creek, Pioneer Creek and Placer Creek Watersheds that surround the town of Red River, New Mexico (Figures 4-2, 4-3, and 4-4). These watersheds are smaller tributary watersheds within the larger Red River Watershed. The hazardous substances as defined

[12] Seepage interception systems and ground water withdrawal wells were installed as part of Best Management Practices under NPDES Permit NM0022306 to comply with the prohibition against discharge to the Red River of pollutants traceable to point source mine operations.
[13] The studies referred to by NMED included the CERCLA RI/FS.

by CERCLA are arsenic, lead, and mercury. The primary objectives are to eliminate or reduce direct exposure risk to recreational users and ecological receptors, minimize surface water contamination, and minimize erosion and sedimentation. The removal action consisted of removing approximately 57,000 cubic yards by capping, excavating, and consolidating unconfined waste rock and tailing at the site.

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5.0 SITE CHARACTERISTICS

This section provides an overview of the Site's physiographic setting, geology and hydrology; the sampling strategy chosen for the Site; the Site Conceptual Exposure Model; and the nature and extent of contamination at the Site. Detailed information about the Site's characteristics can be found in the RI Report (URS 2009) and other Site related documents referenced therein.

5.1 Site Conceptual Exposure Model

A site conceptual exposure model is a schematic representation of the potential contaminant sources, contaminant release/transport mechanisms, potential exposure media, potential exposure routes, and potential receptors. Four conceptual exposure models were developed for the Site which consist of human health and ecological conceptual models at both the mine site and tailing facility. They are presented in flow-chart form in Figures 5-1, 5-2, and 5-3. The four models evaluate potential exposure at the mine site and tailing facility as well as all other areas of the Site where contaminants may be transported to exposure media (*e.g.,* Red River or Eagle Rock Lake surface water and sediment). The release/transport mechanisms and migration pathways are illustrated with a series of exposure pathway lines linking contaminants at primary sources via various transport mechanisms to intermediate media (secondary sources) and, finally, exposure media.

Each of the conceptual models depicts potential primary sources and release/transport mechanisms, as well as potential secondary sources and release/transport mechanisms. Of the potential pathways of contaminant migration, only complete pathways were evaluated in risk assessment. The complete pathways selected for quantitative evaluation in risk assessment are depicted with solid circles for receptors. Completed pathways selected for qualitative risk evaluation in risk assessment are depicted with open circles. Incomplete pathways are depicted with straight lines.

At each site (mine site and tailing facility), both the human health and ecological conceptual models share the same potential source categories, migration pathways, and exposure media.

The Site conceptual exposure models presented in this ROD are from the models contained in the EPA HHRA and BERA, which have been simplified to perform risk assessment. For a complete schematic representation of the more complex conceptual site models used to develop sampling plans for the RI, see RI/FS Work Plan (URS 2007a).

An ecological food web model used in the BERA is presented in Figure 5-4.

5.1.1 Mine Site

For the mine site, there are four primary sources: mine site soil, administration and maintenance and engineering shop area soil, mill area soil, and tailing pipeline and emergency sumps (Upper and Lower Dump Sumps). The mine site soil includes waste rock, mine site tailing, open pit soil, subsidence area soil, spilled tailing, historic and current Spring Gulch and Goathill landfills soil, underground debris stockpiles, soil at current gasoline, diesel and non-gasoline underground storage tanks and former tank sites, and miscellaneous sources with and without VOCs.

The primary release/transport mechanisms are (1) infiltration and leaching to ground water, (2) surface runoff, erosion and seasonal flooding to surface water, sediment, and riparian soil, (3) wind erosion and re-suspension to dust, (4) releases from mining operations, (5) tailing spills, and (6) biotic uptake. Once contaminants are released into the environment, they are transported (migrate) within and/or from ground water, surface water, sediment, and surface soil.

Secondary release/transport mechanisms for ground water include discharge to the Red River at zones of ground water upwelling, seepage recharge to seeps and springs, irrigation and pumping for domestic or industrial use. Secondary release/transport mechanisms for Red River surface water include irrigation to homegrown produce and conveyance to Eagle Rock Lake via the water inlet, uptake by fish, ingestion by game or domestic animals, and uptake by riparian plants; such mechanisms are similar for sediment, with the exception of irrigation. Secondary release/transport mechanisms for riparian soil are also ingestion by game or domestic animals and uptake by riparian plants.

5.1.2 Tailing Facility

For the tailing facility, there are three primary sources of contamination: tailing and tailing facility soil, tailing slurry and pipeline water, and the tailing pipeline. The tailing facility soil includes the dry maintenance area, the ion exchange plant, and other surface soil.

The primary release/transport mechanisms include (1) the infiltration and leaching of tailing seepage to ground water, (2) surface runoff, erosion and seasonal flooding to riparian soil and surface water and sediment of the Red River, (3) releases from mining operations, (4) separation to tailing surface water (decant water), (5) wind erosion and re-suspension to dust, (6) spills from the tailing pipeline, and (7) uptake by biota (riparian plants and homegrown produce). Once contaminants are released into the environment, they migrate within and/or from ground water, surface water, sediment and riparian soil.

The secondary release/transport mechanisms for ground water include discharge to the Red River via seeps and springs at zones of ground water upwelling, irrigation for homegrown produce and livestock watering, and pumping for domestic or industrial use. The Red River State Fish Hatchery uses a system of collection pipes and vaults to capture a series of seeps and spring (known as Spring 18) along the northern side of the Red River Gorge between the tailing facility and the hatchery and south of Dam No. 1 at the tailing facility (Spring 17). The water is used for rearing hatchery trout, as well as for drinking water and other domestic uses within the facility structures, including residential dwellings and public facilities. The secondary release/transport mechanisms for surface water include irrigation, uptake by fish, ingestion by game or domestic animals and uptake by riparian plants. The mechanisms for sediment are similar, with the exception of irrigation. Secondary release/transport mechanisms for riparian soil are ingestion by game or domestic animals and uptake by riparian plants.

5.2 Site Overview

The mine site, tailing facility, Red River, Eagle Rock Lake and other key features of the Site are described below.

5.2.1 Mine Site

The mine site covers approximately three square miles of land located three and a half miles east of the village of Questa. It is located in the Taos Range of the Sangre de Cristo Mountains, part of the Southern Rocky Mountains physiographic province. Wheeler Peak (elevation 11,161 ft), which lies 10 miles southeast of the mine, is the highest point in New Mexico. The Red River runs south of the mine and Cabresto Creek drainage roughly parallels the Red River to the north of the mine.

The mine site borders the Carson National Forest. It is within two miles of the Latir Peak Wilderness to the north, and within seven miles of the Wheeler Peak Wilderness to the south.

The mine site is located within an area of high topographic relief on the south-facing slopes of the Red River Valley. Elevations at the mine site range from approximately 7,550 feet adjacent to the Red River below the mine to over 10,750 feet at the divide between the Red River and the adjacent Cabresto Creek drainage basin. Deeply incised, steep-sided valleys dissect the mine site and surrounding area. Due to its location and high elevation, the mine site is located in an area dominated by a mixed conifer forest. The Red River canyon contains riparian vegetation and aquatic habitat.

5.2.2 Tailing Facility

The tailing facility is located on a broad alluvial plain approximately nine miles west of the mine site and one mile west of the village of Questa, within the Rio Grande rift valley. It is bounded on the west by the Guadalupe Mountains. Elevations at the tailing facility range from 7,300 to 7,500 feet. The tailing facility covers an area of approximately 1,000 acres and contains over 100 million tons of tailing material.

The area south of the tailing facility includes a low-lying riparian valley located south of Embargo Road toward the Red River and generally south of Dam No. 1. The distance across this valley from Dam No. 1 to the Red River is approximately half a mile. There are residential properties and irrigated pasture land for agriculture and livestock grazing within the valley.

The riparian valley narrows in its approach to a steep canyon that opens into the Red River Gorge south of Dam No. 4. The distance from Dam No. 4 to the Red River is about 2,000 feet. The rugged landscape of the Red River Gorge and canyon southwest of the riparian valley is within BLM-managed lands and although there is a vehicle access road the gorge is isolated and remote. The remoteness of the area is an attractive and important asset in which Congress recognized and designated this section of the Red River as part of the Rio Grande Wild and Scenic River, under the authority of the Wild and Scenic Rivers Act, 16 U.S.C. 1271, § *et seq.*

5.2.3 Red River

The Red River is a tributary of the Rio Grande that generally flows east to west from its headwaters within the Sangre de Cristo Mountains, through the town of Red River and the Village of Questa, and along the southern boundary of the Site to its confluence with the Rio Grande. At its headwaters, the main stem of the Red River is formed at an elevation of 9,400 feet, approximately 5.5 miles south of the town of Red River. From this point, the

Red River flows predominantly north, adjacent to State Highway 578, and is confined within a narrow canyon for much of its length in this reach. Near the town of Red River, the Red River turns west. Several tributaries, including Placer Creek, Bitter Creek, Mallette Creek, and Pioneer Creek enter the Red River near town. Just downstream of town, several short tributaries that drain natural hydrothermal alteration scars (scars) intermittently flow into the Red River, including Straight Creek, Hottentot Creek, and Hansen Creek. This reach of the Red River also flows through several existing and closed campgrounds. The effluent for the town of Red River's Wastewater Treatment Plant (WWTP) also enters the Red River near the Elephant Rock Campground (URS 2002).

In its middle reaches, the Red River flows past the mine site. The river in this section is still confined within a narrow valley. Two of the tributaries that enter this reach include Columbine Creek from the south and, prior to the mid-1990s, the intermittent flow of Capulin Canyon from the north. Since that time there is no evidence that overland flow from Capulin Canyon reaches the Red River. The Red River exhibits similar physical characteristics down to Eagle Rock Lake near the U.S. Forest Service Questa Ranger Station. Downstream of Eagle Rock Lake, the Red River enters a broad valley upstream of the Village of Questa. The river flows through the valley for several miles, and is joined by Cabresto Creek. The Questa WWTP ponds are near the Red River downstream of Questa. Pope Creek drains the area adjacent to the tailing ponds, and is also an intermittent stream that flows into the Red River as the valley narrows near the downstream end of this reach. Downstream of Pope Creek, the Red River flows through the narrow, steep canyon of the Red River Gorge downstream to its confluence with the Rio Grande. The Red River State Fish Hatchery is located within the Gorge approximately one mile downstream of the tailing facility. The confluence with the Rio Grande is at an elevation of approximately 6,500 feet. As stated above, the Red River and the Rio Grande, in the vicinity of their confluence, were designated a Wild and Scenic River by Congress in 1983.

High flow periods for the Red River typically occur during the months of May through July and are fed by snowmelt. Low-flow periods typically occur during the winter (November through March) (URS 2009a).

The river is also the source of water for small lakes and ponds upstream and downstream of the mine site, including Fawn Lakes and Eagle Rock Lake. Numerous wetlands have been documented by the U.S. Forest Service. See Red River Watershed and Tributaries Map (Figure 4-1).

5.2.4 Irrigation (Acequia) System

Several irrigation ditches (acequia) are located in the Village of Questa that diverts water from the Red River or from Cabresto Creek (Figure 5-5). River water is diverted to the ditches seasonally, typically from May to August. Irrigation ditches that divert water from the Red River include Acequia del Molino, North Ditch (aka Embargo Road Ditch), Middle Ditch, and South Ditch (aka South Side Ditch). The South Ditch diverts river water from upstream of Eagle Rock Lake near the Molycorp tailing pipeline crossing of Red River. The North Ditch diverts river water from Cabresto Creek.

5.2.5 Red River State Fish Hatchery

The Red River State Fish Hatchery was constructed by the New Mexico Department of Game and Fish in 1942. It is the largest fish hatchery in New Mexico, as it stocks approximately 44,000 rainbow trout annually to the Red River and nearby lakes and ponds, including Eagle Rock Lake (R. Jankowitz, New Mexico Department of Game and Fish, e-mail communication, 2010). Stocking of the Red River generally occurs between May and September.

The Red River State Fish Hatchery uses a large amount of ground water from two spring areas south of the tailing facility. The intercepted spring water is transported to the hatchery by two pipelines that run through the Red River Gorge. One spring originates south of the tailing facility between Embargo Road and the Red River. The spring has had various names in the past, including Cold Water Spring and Questa Spring, but is identified as Spring 17 in the RI. According to hatchery personnel, the flow from this spring varies between 900 to 1,500 gpm or 2 to 3.3 cubic feet per second (cfs). The other spring area used by the fish hatchery originates about 0.5 mile upstream of the hatchery within the Red River Gorge. There appear to be several springs that make up this water source along the Gorge. The water is collected utilizing vaults and infiltration galleries and is transported to the hatchery in the pipeline. These springs have collectively been referred to as the Warm Water Spring by hatchery personnel. The collection point for these springs has been identified as Spring 18 in the RI. The reported flow rate is 4,600 to 4,700 gpm or approximately 10 cfs. The location of Spring 17 and Spring 18 are identified on the Tailing Facility Features Map (Figure 5-6).

There are a number of buildings and structures located at the fish hatchery, including residential dwellings used by several permanent workers and their families. The source of the potable and drinking water supplied to these facilities is the same ground water collected from Spring 18, with both Spring 17 and Spring 18 used in the fish hatchery rearing operations. The public also uses the potable or drinking water supplied to these facilities, as the hatchery receives visitors to tour the facilities, most often in the summer months.

5.2.6 Eagle Rock Lake

Eagle Rock Lake is located approximately 1,000 feet downstream of the mine site on public land managed by the U.S. Forest Service. The lake is a former gravel pit that was excavated during the construction of State Highway 38 in the mid-1950s. It is approximately three acres in size and seven feet deep. Diverted water from the Red River flows into Eagle Rock Lake at a gated inlet and back into the Red River through an outlet. The U.S. Forest Service controls the inlet gate. The lake is currently used for fishing and is routinely stocked with rainbow trout from the state fish hatchery. Approximately 5,000 rainbow trout are stocked in the lake annually.

5.2.7 Hunt's Pond

Hunt's Pond is a small man-made pond located adjacent to the Red River about a half mile downstream of the Cabresto Creek confluence. It is also located in close proximity to the tailing pipeline. It is approximately one-third of an acre in size and its depth reaches about five feet. Presently, there are no inlet or outlet structures at the pond. The pond is part of a four-acre parcel of land, which had been donated by a family to the Village of Questa with the understanding that it would eventually be used as a park. In February 2000, the Village of Questa, working with the U.S. Forest Service, initiated clean up the area, including the pond. Activities to de-water and de-silt the pond led to the discovery of tailing mixed with organic material beneath two feet of black organic matter. Molycorp excavated the tailing mixture from the pond, with approximately 25 truckloads of the material transported to the tailing facility for disposal. At the time of the discovery, Molycorp's Environmental Manager indicated to NMED officials that the tailing was likely the result of an incident in the late 1960s or early 1970s. The Village of Questa made improvements to the pond in 2004, which included dredging and stabilization of the north bank with rock gabions.

5.2.8 Hydrothermal Alteration Scars

Within the Red River drainage basin are natural areas of hydrothermally altered, brecciated, and highly erosive rock that are locally referred to as hydrothermal alteration scars (scars). At least 20 scars are present within tributary drainages along the north side of the Red River Valley, extending from near the town of Red River through the mine site and west to the village of Questa. Upstream of the mine site, the scar-impacted drainages include Straight Creek, Hottentot Creek, and Hanson Creek. Scars are typically characterized by yellow-stained, easily eroded materials that support little or no vegetation. Field paste pH values range from less than 2.5 to 3.2. These scars are significant in that they represent source areas for debris flows that pose a substantial geologic hazard and have altered the topographic form of the Red River drainage. During storm events, acidic flow and sediment drain from these scar-impacted tributaries to the Red River.

5.2.9 Debris Fans

Periodic debris flows are generated from scars, and have resulted in the development of large fans of debris that form an alluvial infill in the lower reaches of the Red River Valley. Periodically (storm events) and historically, large debris flows have occurred that reached the Red River resulting in placement of significant volumes of scar and mineralized rock debris directly in the flow channel. Damming of the Red River by these debris flows led to the formation of the flat alluvial terraces at locations such as the town of Red River and Fawn Lakes (Meyer and Leonardson 1991). When the debris flows reach the river, large volumes of sediment are dumped into the river and transported downstream, covering the river bottom with silt and fine grained sand.

5.3 Mine Site Features

The mine site consists primarily of (1) administrative, maintenance and electrical areas, (2) open pit, (3) waste rock piles, (4) old and current underground mine workings, (5) the Moly Tunnel, (6) subsidence area, (7) construction/demolition debris landfills, (8) mill area and (9) hydrothermal alteration scars, and (10) the Goathill debris fan. These features are depicted on Figures 2-4 and 5-7.

5.3.1 Administrative, Maintenance, and Electrical Areas

This area is adjacent to the mine shafts and includes a dry shop, machine shops, warehouse, maintenance, and engineering buildings and a storage yard. The administration building and carpenter shop are nearby and, therefore, included with these facilities.

Other maintenance areas include a tank farm located at the Goathill area that contains five fuel and oil storage tanks. Only one of these tanks is currently in use. There are also four tanks (600 gallons each) for used oil, used antifreeze, and oily water. The tanks are contained with a berm area sufficient to contain any spills. Another 600-gallon lube oil tank is located in the Goathill area, but is not used. A large diesel tank is located near the No. 2 Shaft, within the lower storage yard.

Three permitted underground storage tanks for fueling company vehicles are located near the administration building at the guard station. The tanks have been treated to prevent corrosion and are fitted with cathodic protection. Overflow protection, a sump, and double-walled piping were installed in 1998.

5.3.2 Open Pit

The historic open pit is a result of surface mining from 1965 to 1983. The open pit varies from approximately 3,500 to 4,500 feet in diameter and is approximately 1,500 feet deep. The crest limits of the pit cover an area of approximately 300 acres. As discussed under Storm Water and Surface Water (Seepage) Management, Section 2.3.1.2, the open pit collects storm water, precipitation, and ground water seeps within its hydraulic capture zone. The runoff collects in the bottom of the pit in an intermittent pond where it infiltrates into the old underground mine workings and active underground mine.

CMI has indicated that the open pit may be a potential future access point for ore bodies, including the Truckshop Slice Area, located along the southwestern rim of the pit wall (Figure 5-7), and the F2 ore body, a permitted underground ore zone that could be accessed from the northwest side of the open pit. Additionally, the west wall of the open pit is within the predicted subsidence area and the land surface will deform as the result of subsidence.

5.3.3 Waste Rock Piles

Waste rock is the non-economical material overlying the ore (*i.e.,* overburden material) that was removed during open pit mining from 1965 to 1983. It is a primary source or potential source of contamination at the mine site. Approximately 328 million tons of waste rock was placed in ten large piles within the deeply incised, steep-sided valleys surrounding the open pit. The names of the waste rock piles are: Sulphur Gulch North, Spring Gulch, and Blind Gulch (the pit piles) located in drainages north of the roadside rock piles; Sulphur Gulch South, Middle, and Sugar Shack South (the roadside waste rock piles located along State Highway 38); Sugar Shack West located west of the roadside waste rock piles; Goathill South located in Slick Line Gulch and Goathill North located in Goathill Gulch; and Capulin located in the upper portion of Capulin Canyon. See Figure 1-2.

During open pit mining, the initial overburden material removed would have been dumped in the higher topographic areas near the pit. If that is the case, then Capulin, Goathill North and South, and Sugar Shack West waste rock piles are among the oldest piles constructed and received material extracted near the top of the overburden. The roadside waste rock piles would be younger piles which received overburden material extracted from deeper within the pit. In the early/middle stages of open pit mining, waste rock was typically dumped from the higher points of the piles. As the open pit developed, horizontal benches were wrapped around the front of the existing piles (Smith et al. 2007).

Waste rock was deposited by end-dumping in thick lifts, such that each lift consists of inclined layers corresponding to the angle of repose of the material. The waste rock piles vary in height from 500 feet (Goathill South) to 1,580 feet (Sugar Shack South). The latter are reported to be the highest waste rock piles in the world. The volume of waste rock in each pile varies from under a million cubic yards (yd^3) to 53 million yd^3. The largest waste rock piles are the three roadside rock piles: Sugar Shack South (29.1 million yd^3), Middle (35.4 million yd^3), and Sulphur Gulch South (53 million yd^3). The horizontal benches at most of the piles are at variable vertical spacings, ranging from about 200 feet to 650 feet. Rock pile slopes between the benches (interbench) are typically between 1.1H:1V and 3.7H:1V, with overall rock pile slopes between 1.6H:1V and 3.7H:1V.

5.3.4 Underground Mine Workings

An extensive system of underground mine workings was developed from 1919 to 1965 in the Sulphur Gulch area during the original phase of mining. These workings total about 35 miles in length. Many of these workings were intercepted by the excavation of the open pit, beginning in 1965. Ground water that seeps from the exposed workings in the pit walls is directed by a series of older workings and rises to a 700-foot borehole that extends into the new underground workings below. The borehole discharges the water into a sump in the new underground mine and it is then pumped up to the decline to the sump adjacent to the mill. The water is transferred to the tailing facility during milling and non-milling periods, independent of the milling operations.

5.3.5 Moly Tunnel

The Moly Tunnel is a mile-long old service portal that was built in 1941 as a haulage route for ore and to drain ground water from the underground mine workings by gravity to the Red River. The tunnel is connected to the deepest portion of the underground workings, now referred to as the old underground workings. The average slope grade of the tunnel is one percent. After the new underground workings were developed, the water (30 gpm) was, and continues to be, drained to the present underground mine workings. The Moly Tunnel was sealed in 1992 by constructing a concrete bulkhead near the northern end. A discharge pipe piercing the bulkhead is used for draining. The bulkhead is equipped with a pressure gauge to measure the static water head behind the bulkhead. The Moly Tunnel fills with water and has to be drained periodically to relieve the pressure on the bulkhead.

5.3.6 Subsidence Area

Block-caving mining operations have caused subsidence of the land surface in the Goathill Gulch drainage basin, which resulted in the formation of a topographic depression in the stream course of the upper and middle portions of Goathill Gulch. This surface depression, known as the subsidence area or Goathill Glory Hole, covers approximately 50 acres. It has subsided approximately 180 to 200 feet compared to pre-mine surface conditions. The subsidence area consequently funnels the stream flow of upper Goathill Gulch into the new underground mine workings; including acidic, metals-laden seepage from the toe of Goathill North Waste Rock Pile. Additionally, drainage of the seepage from the toe of Capulin Waste Rock Pile within Capulin Canyon is directed to the Goathill Gulch drainage basin through a near horizontal borehole and enters the underground mine workings through the subsidence area. The rubblized nature of the subsidence area allows surface water and shallow ground water to drain into the underground workings 400 to 500 feet below, where it mixes with the underground bedrock water and pumped to the sump adjacent to the mill. The water is then transferred to the tailing facility during milling and non-milling periods, independent of the milling operations.

The subsidence area currently extends east and northeast over the active underground workings. The subsidence area will continue to expand with the expansion of the underground workings and will ultimately encompass an area of approximately 1,066 acres, including approximately three quarters of the western portion of the open pit.

5.3.7 Construction/Demolition Debris Landfills

Four construction and demolition debris landfills were identified at the mine site. They are the current Spring Gulch Landfill, the historic Spring Gulch Landfill, the underground debris stockpile, and former Goathill Landfill. In addition, there are five explosive storage areas identified on the mine site. One is currently in use and the other four are former storage areas. The current explosive storage area is in Goathill Gulch. There is a former explosive storage area located just north of the administrative area, a former explosive storage area in the Mill Area, a historic ammonium nitrate/fuel oil storage area to the north in Sulphur Gulch, and a former explosives bunker adjacent to Blind Gulch rock pile (Figure 5-7).

5.3.8 Mill Area

The Mill Area is an area of the mine site located near the eastern mine property boundary bordering State Highway 38. The Mill Area includes the crusher, mill, and concentrator buildings, assay lab, reagent tanks and stores, thickeners, warehouse, decline shop, and portal. The floatation mill has a current capacity to process 18,000 tons of ore per day.

When operating, the mill requires a supply of fresh water to separate and remove the tailing material. The mill is supplied fresh water from the Red River and five water supply wells located at the Mill Area and Columbine/Cottonwood Park area (Mill Well Nos. 1 and 1A, Columbine Well Nos. 1 and 2, and the re-drilled Columbine Well No. 1). Diversion of Red River water is the largest single source of water used at the mill, which totaled approximately 1,619 acre-feet. This was followed by the mill wells (1,325 acre-feet) and Columbine wells (1,075 acre-feet).

Potable water is supplied to the administration buildings, the mine dry, and the mill from the Lab Well at the mill and the Columbine domestic well near the confluence of Columbine Creek and the Red River. Water from those wells is not used in the milling operations.

5.3.9 Hydrothermal Scars

Hydrothermal scars are described under Geology, Section 5.6, below. A portion of the mine site is underlain by hydrothermal scar material. Prior to mine operations, there were hydrothermal scars present in the drainages where Sulphur Gulch North/Blind Gulch and Sugar Shack South waste rock piles are now located. Hydrothermal scar material excavated during open pit mining was dumped onto the waste rock piles along with other overburden rock. A portion of the Goathill North and Goathill South waste rock piles overlie the Goathill scar. A portion of the Sulphur Gulch scar still remains above the northwest wall of the open pit, but the majority of that scar was excavated during open pit mining. Hydrothermal scars are located beneath the Sulphur Gulch South and Sugar Shack South waste rock piles. The locations of the hydrothermal scars are depicted on Figure 2-4.

5.3.10 Goathill Debris Fan

One of several large debris fans within the Red River Valley is the Goathill debris fan, located at the mouths of the Goathill Gulch and Slick Line drainages. The Goathill debris fan has altered (historically) the path of the Red River by deflecting it to the far side of the steeply incised valley. It also impacts the hydrogeology of the Red River alluvial aquifer. A further description of debris fans within the Red River Valley is provided under Geology, Section 5.6, below.

5.4 Tailing Facility and Pipeline Features

The tailing facility consists of two large unlined impoundments. They were built within two natural southwest draining arroyos (drainages) by construction of earthen-filled dams. The largest of these dams are Dam No. 1 and Dam No. 4 located at the southern end of the impoundments. There are drainage diversion channels along the west and east perimeter of the tailing impoundments, a Change House, and a former ion exchange water treatment plant located near Dam No. 4. Ponds atop the facility are maintained by decant water from the tailing slurry. The tailing ponds support vegetation and wildlife, including waterfowl. Land access to the facility is restricted by a fence in most places. The Red River State Fish Hatchery is located about a mile downriver of the tailing facility. See Tailing Facility Features Map (Figure 5-6).

A nine-mile long tailing pipeline runs from the milling facility at the mine site to the tailing facility. A segment of the tailing pipeline is located adjacent to State Highway 38 and runs parallel to the Red River and within its floodplain over much of the route. The other segment traverses the valley southeast of the tailing facility. For most of its length, the pipeline rests on the ground. It is buried where it crosses highways and roads. It is elevated where it crosses the Red River. The Upper Dump Sump and Lower Dump Sump (discussed above) are emergency basins located along the pipeline corridor used for tailing management during pipeline maintenance.

5.5 Climate

Climate is an important factor to be considered at mine sites as it can influence the drainage produced by weathering mineral deposits. Important controls on rock weathering and related environmental processes are temperature, humidity, and the amount of precipitation (rain and snow) relative to evapotranspiration. Mineral deposits commonly generate less drainage in arid and semi-arid climates than in wet climates. For sites with acid rock drainage, those drainage waters that do occur in arid and semi-arid climates tend to be more acidic and metalliferous than those in wetter climates due to the effects of increased evaporation and the decreased potential to be diluted by non-mineralized ground and surface waters (Plumlee et al. 1999).

There are two types of climates that affect the Site: a high-altitude wetter climate for the mine site, located within the Taos Range, and a semiarid climate on the broad plateau to the west where the tailing facility is located. The climate at the mine site is somewhat modified by the semiarid plateau to the west. For the town of Red River, the annual precipitation varies from a low of 16 inches to a high of 29 inches, with a 20-year average of 23 inches. The climate statistics collected from weather stations established at the mine site show an annual precipitation ranging between approximately 10 inches to 18 inches per year from 2000 to 2004 (Golder 2005). However, there was a severe drought in 2001 and 2002, which explains why these rainfall levels are somewhat less than the average.

The Taos Range, due to its higher elevation and orographic precipitation effects, has higher precipitation and lower evapotranspiration that the adjacent valley in the wet seasons. Precipitation at the tailing facility, which is located on the semiarid plateau, is less than the mine. Using long-term climate records collected at the community of Cerro, located 3.5

miles north of Dam No. 1, the annual precipitation is estimated at 13.6 inches (Robertson GeoConsultants [RGC] 2000a).

Temperatures vary greatly both annually and diurnally. The average daily maximum temperatures range from 37º to 77º Fahrenheit (F), with average daily minimum temperatures ranging from 4º to 41ºF.

Summer is characterized by hot days and cool nights. The rainy season is mostly during July and August. Heavy, but localized, rains can cause flash floods and debris flows, which occasionally block the highway. Winters are mild. The heaviest snowfall is limited to the higher parts of the mountains. There are many sunny days during the winter and the ground is often bare in areas exposed to the sun. Snowfall ranges from 106 inches per year to 259 inches per year, with only two months, July and August, having no snowfall. Spring arrives in late May with warm, windy weather. Dust storms are common.

5.6 Geology

The Questa area is characterized by a complex geologic history that includes volcanism and crustal extension associated with the Rio Grande rifting, followed by periods of intense mineralization and formation of sulfide ore bodies. Geological characteristics of mineral deposits at the mine site and throughout the Red River Valley control the composition of natural- and mine-drainage waters, such as the content of acid generating pyrite and other iron sulfides. The geochemical interaction of water with these highly mineralized rocks produces the composition of the surface and ground waters. The concentrations of individual elements in these waters partly reflect the elements' abundances in the mineral deposits drained by the waters (Plumlee et al. 1999). Hence, understanding the geology is an important aspect to understanding the quality of ground water and surface water at the Site, as well as the affect that mining has had on those waters.

A brief summary of the complex geologic history is presented herein. A more detailed description is provided in the RI Report (URS 2009a).

5.6.1 Mid-Tertiary Volcanism and Questa Caldera Formation

The Questa area has been subject to intense structural deformation related to mid-Tertiary volcanism and the formation of the Questa caldera.[14] The volcanism was associated with the extension of crustal rocks and incipient Rio Grande rift structures. The upper crustal extension over the Questa magma chamber may have triggered the volcanic eruptions and subsequent collapse of the chamber. The volcanic flows that resulted were deposited over older Precambrian basement rocks (quartzite, basalt, and granitic plutons) and late Eocene conglomerates. The volcanic flows included andesites, mudflows, and sheets of welded ash flows (rhyolitic composition). The rhyolitic flows are referred to as the Amalia tuff. Together, these rocks comprise the Latir volcanic field.

The formation of caldera collapse features accompanied these eruptive events. These collapse features are defined by fractures formed at the southern margin of the caldera, and they deeply penetrate the earth's crust in the vicinity of the Red River east of the town of Red River. Moderately- to steeply-dipping ring dikes trend parallel to the Red River valley and fill the collapse-related fractures. Many of these dikes are located in the Goathill Gulch and Cabin Spring areas at the mine site, the Log Cabin area south of the Red River at Spring 13, and north of the mill area (see Geology Map, Figure 5-8). The numerous fracture networks, faults, and joints sets that pervasively penetrate this area control the movement of bedrock ground water. High to extreme joint intensity and multiple zones of faulting, including high-angle open faults, have been documented by the USGS (Caine, 2007).

[14] A caldera is a cauldron-like volcanic feature usually formed by the collapse of land following a volcanic eruption from a magma chamber. A collapse is triggered by the emptying of the magma chamber beneath the volcano and results in a large, basin-shaped volcanic depression. With the collapse, roughly circular fractures referred to as "ring faults" develop around the edge of the chamber. These fractures serve as feeders for fault intrusions which are known as ring dykes. If the magma is rich in silica, the caldera is often filled in with pyroclast, tuff, rhyolite and other igneous rocks. Since silica-rich magma is highly viscous, it does not flow easily and can result in trapped gases which trigger explosive destruction of the magma and spreading of volcanic ash. The rock record indicates that the Questa caldera formed from the eruption of silica-rich magma.

The mine site lies entirely within the Questa caldera. The Questa caldera is oval shaped; exhibiting an approximate 7.5-mile width (north/south) and 9.3-mile length (east/west), where preserved. The central portion of the caldera is down-dropped relative to the older rocks (Precambrian) outside of the caldera. Continued crustal extension truncated the Questa caldera at the eastward margin of the Rio Grande rift.

5.6.2 Character of Mineralizing Fluids

Later mineralizing intrusions (porphyritic stocks, sills and dykes) having a silica-rich granitic composition were emplaced into the volcanic pile along the fracture zones (*i.e.,* along the Red River) at the southern margin of the caldera some 22-25 million years ago. The mineralized hydrothermal fluids associated with the emplacement of the intrusions circulated within these brecciated and fractured zones, resulting in several pulses or episodes of intense mineralization and hydrothermal alteration (referred to as “hot water” alteration). The hydrothermal fluids evolved from magmas rich in metals such as silicon, iron, aluminum, beryllium, molybdenum, tungsten, tin, copper, bismuth, silver, rubidium, thallium, manganese, light rare earths, and uranium, as well as non-metals such as sulfur, fluoride, chlorine, oxygen, and carbon dioxide. The resulting deposit was a high-silica, rhyolite porphyry molybdenite deposit, with abundant fluorite, and containing fluorine-rich mineral assemblages such as muscovite, biotite and apatite. These types of deposits are referred to as Climax-type deposits (Plumlee et al., 1999).

5.6.3 Questa Molybdenite Deposits

Molybdenum in the ore bodies at the mine site occur as a sulfide, molybdenite (MoS_2). Molybdenite is the principal ore mineral of molybdenum. Most typically, molybdenite is associated with quartz veins that are proximal to the tops of granitic intrusions, as it precipitated from very hot waters evolved from the crystallizing granitic magma.

Economic molybdenum mineralization occurs in two distinct ore zones, the Southwest Zone and the Northeast Zone. These relatively narrow zones are elongated east-northeast and trend sub-parallel to each other (Figure 5-9). The mineralization contained in each zone consists of discontinuous pods of high grade (greater than 0.2% by weight) molybdenite enclosed within envelopes of lower grade mineralization (0.06% MoS_2).

Several episodes of thermal alteration and mineralization in and around the ore zone resulted in pervasive alteration patterns and halos of mineral veins. The principal alteration zones include highly altered quartz-sericite-pyrite zones, less altered clay (dominantly kaolinite) zones, and mildly altered prophyllitc zones (containing calcite mineralization). The quartz-sericite-pyrite alteration, as the name implies, produces a mixture of quartz, pyrite (up to 10 percent), and fine-grained mica (sericite) or illite. Chlorite, epidote, albite, and calcite typically are present in the propylitic assemblages. Ore deposits contain molybdenite, quartz, pyrite, fluorite, calcite, manganiferous calcite, dolomite, and rhodochrosite. Lesser amounts of galena, sphalerite, chalcopyrite, magnetite, and hematite also are present toward the fringes of the deposits.

The alteration minerals show consistent zoned sequences related to each mineralization episode. These sequences have a direct bearing on the mineralogy within the waste rock removed during open pit mining, as well as the mineralogy of the bedrock exposed at the surface within the tributary drainages. The mineralogy of the waste rock depends on where the rock was originally located within the open pit and, hence, its proximity to the core of the mineralization. Abundant minerals in the waste rock include pyrite, chlorite, gypsum, illite, illite-smectite, jarosite, kaolinite, and muscovite.

The mineralogy of the rock exposed within the tributary drainages depends on the location of the drainage and the degree to which it has incised downward into these different alteration zones. Drainages have incised into the rock to varying degrees and, therefore, are at different positions within the alteration zones and distance to the core of the mineralization. Thus, the type and percent of the minerals vary significantly from drainage to drainage and within the drainage, resulting in significant heterogeneities in chemical composition. This variable mineralogy also results in significant differences in the geochemistry of the waters within the drainage through water/rock interactions.

5.6.4 Vein Alteration Minerals

Vein alteration minerals show a consistent zoning pattern (halo) around each mineralization episode. In each single alteration/mineralization event, five vein-type halos within the alteration zones have been distinguished. From the outside toward the mineralization, these are:

- Pyrite
- Calcite + fluorite
- Magnetite ± quartz or hematite
- Molybdenite
- Quartz

5.6.5 Pyritic Veins

Pyrite is the most critical mineral for potential acid generation at the mine site. Pyrite occurs as finely disseminated crystals in the rock matrix and as stockwork veins up to 6-inches thick. The veined pyrite halo surrounding the ore body has a content ranging from 1-5 percent by volume and averaging about 2 percent by volume. Beneath this halo, pyrite content decrease rapidly to trace amounts. All of the exposed volcanic rocks in the Questa area are, to some extent, pyritic. Goathill Gulch is incised into the pyrite halo, and the rocks exposed on the cliffs contain at least 2 percent by volume. This higher percentage of pyrite at Goathill Gulch is associated with hydrothermal scar formation. Oxidation of the pyrite has resulted in strong jarositic (yellow) staining, and chemical weathering of the host rock. Where pyrite content averages less than 1 percent by volume, chemical weathering is not as severe.

5.6.6 Mixed Volcanics

There are four primary lithological units in which open pit mining was conducted. These are the andesitic porphyry, the aplite porphyry, andesite latite to quartz latite porphyry flow, and the rhyolite tuff (Amalia tuff). Due to weathering, classification of these units in the field is sometimes difficult and the term "mixed volcanics" has been used as a classification for the waste rock piles.

5.6.7 Hydrothermal Alteration Scars

As discussed previously, many of the drainages on the north side of the Red River Valley contain areas of weathered, hydrothermally-altered, brecciated, and highly erosive rock that are locally referred to as hydrothermal scars. These scars are located both on and off the mine site. The high rates of erosion exhibited by hydrothermal scars occur as a combination of the erosive susceptibility of the weathered mineralized rocks in which they form, the steep slopes, and sparse vegetation.

Alteration minerals within these hydrothermal scar areas consist mainly of pyrite, with some quartz, sericite, clay, and carbonate. Weathering may also produce secondary minerals including sericite, clay, jarosite, goethite, gypsum, malachite, and manganese oxide.

Hydrothermal scars represent source areas for mudflows and debris flows that have altered the topographic form of the Red River drainage.

5.6.8 Debris Fans

Periodic debris flows are generated in scar-impacted tributary drainages within the Red River valley and have resulted in the development of large debris fans (largely unsorted sediments of clayey, silty and sandy, boulder-rich gravels). These debris fans form an infill of material in the lower reaches of the tributary drainages and have a characteristic lobate geometry that protrudes into the Red River valley. Periodically and historically, large debris flows have occurred which reached the Red River and have caused damming of the Red River to form fine alluvial terraces and meadow at locations such as Fawn Lakes and the town of Red River. The larger debris fans inter-finger with alluvial sediments within the Red River valley and have resulted in significant heterogeneities within the Red River alluvial aquifer because the fan deposits have several orders of magnitude lower permeability than the alluvial deposits. The largest debris fan in the Red River valley is the Goathill Gulch debris fan, which is depicted on the Mine Site Features Map (Figure 2-4).

From a textural and lithological standpoint, there is little difference between colluvium within the drainages (see below) and the debris flow material near the mouth of the drainages, except that the debris flow material may be more layered and inter-fingered with Red River alluvium near the distal ends of the fans. Therefore, the two names are sometimes used interchangeably. Like the colluvium, debris flow material typically contains pyrite and is acid generating. Layers of limonite-cemented gravels are present within some of the debris flow deposits.

5.6.9 Colluvium Deposits

Colluvium deposits are present within the steeply incised tributary drainages at the mine site, as well as throughout the Red River Valley. Colluvium consists of poorly sorted rock fragments ranging from pebbles to boulders in a matrix containing varying amounts of clay, silt and sand. Colluvium can also contain rootlets, sticks, and other organic debris. Colluvium may also be referred to as slope wash. Individual clasts tend to be angular to sub-round due to the relatively short distance of transport from the valley slopes to the drainages. Because of the steep topography, there is less colluvium present in the upper reaches of the drainages, with a tendency to increase in thickness downslope. At the downslope end, colluvium inter-fingers with debris flow alluvium sediments at the mouths of the drainages. Waste rock placed in many of the drainages has covered the colluvium.

Because of this and the similarity of rock types within the colluvium and waste rock, it is sometimes difficult to distinguish the two.

The composition of the colluvium reflects the rock type present within the drainage. At the mine site, colluvium typically will contain pyrite and is acid generating. Within the scar-impacted drainages, the colluvium will also contain erodible scar material.

5.6.10 Alluvium Deposits

The Red River flows on a highly permeable Quaternary alluvial valley fill of at least 140-foot depth in the vicinity of the mine site. The alluvium sediments consist of well washed, rounded sands, gravels and cobbles.

5.6.11 Tailing Facility Area

The tailing facility is located within the Taos Plateau Volcanic Field, a series of late Tertiary flows that were deposited within the Rio Grande Rift Valley. The Taos Plateau Volcanic Field inter-fingers with alluvial sediments of the Santa Fe Group and more recent deposits which were sourced from highlands of the Sangre de Cristo Mountains to the east. The highlands were associated with a mountain building event which coincided with crustal extension at the eastward margin of the Rio Grande rift.

5.6.11.1 Santa Fe Group Alluvium

A thick section (15,000 feet) of alluvial sediments of the Santa Fe Group underlies the region around the tailing facility and adjacent Guadalupe Mountains. The sediments consist primarily of alluvial silts, sands, gravels, and conglomerate which were deposited in the subsiding Taos Graben segment of the Rio Grande Rift. Fine-grained lacustrine deposits (silts and clays) are also present in the section. Geologic borehole data collected as part of the RI document lacustrine deposits of varying thicknesses up to 136 feet beneath the tailing impoundments (URS 2009a).

5.6.11.2 Taos Plateau Volcanics

Basalt flows of the Servilletta Formation unconformably overlie the Santa Fe Group sediment in the vicinity of the Village of Questa and define the base of the Taos plateau volcanic field sequence. The Taos plateau volcanic field (1.8 to 6 million years old) consists of the basalt flows and volcanic centers (shield volcanoes, intrusive domes, cinder cones, etc.). Rock compositions in the volcanic centers include basalt, andesite, dacite, quartz latite, and rhyolite. The volcanoes form small mountains above the basalt plain, such as the Guadalupe Mountains.

Dacite flows were erupted primarily from the vents on the Guadalupe Mountains. The bulk of the Guadalupe Mountains consist of dacite flows and associated minor pryoclastic material. Individual flows take the form of elongate tubes that extend around the mountain to distances up to four miles from their vent. The form of the flow lobe is a flattened tube 50 to 100 feet in diameter, although massive flows up to 0.5 miles wide and 200 feet in thickness are also present. Congealed blocks of lava fell off the advancing flow front, producing a coarse rubble base beneath the flow. Rubble zones up to 20 feet in thickness are present beneath dacite flows above Big Arsenic Springs, located at the Rio Grande Gorge three miles west of the tailing facility. Large springs at Big Arsenic Springs and below the Red River State Fish Hatchery can be seen to emanate from the base of dacite flows (Vail 1987).

5.6.11.3 Late Tertiary to Recent Alluvium

After the inception of the Guadalupe volcanism, late Tertiary fan sediments (sand and gravel) were deposited on the Taos plateau. These sediments are late rift-fill sequences that are inter-bedded with the regional basalt flows at their base and volcanic ash (tuff) near the top of the sequence. They built up against the eastern flank of the Guadalupe Mountains and the ancestral Red River was subsequently diverted southward to its present day location). Sedimentary interbeds were deposited between volcanic flows. The interbeds, which range from 0 to 100 feet in thickness, are dominantly silty sand, with aeolian and possibly tuffaceous material, and contain larger clasts originating locally from volcanic flows. Quaternary sediments overlie the fan deposits. They consist of pediment gravel, fluvial terrace sands and gravels, and alluvial fan silts, sands and gravels.

5.6.11.4 Structural Geology

The structural geology of the area is controlled by normal, extension faulting associated with the Rio Grande rift basin. The nearest boundary fault of the Rio Grande rift is located three miles to the east. The rift faults were active throughout deposition of the Santa Fe Formation, producing a total displacement of about 15,000 feet. There are several inferred northeast-trending normal faults which have been mapped beneath the tailing facility. The faults laterally juxtapose the basalt, andesite, and dacite into contact with the alluvial/lacustrine sediments. Along the eastern edge of the Guadalupe Mountains and extending beneath the western edge of the tailing facility, ash flow tuffs of the Guadalupe volcanics also appear to be in fault contact with the Servilleta Basalt.

Northwest trending faults, conjugate to the main rift fault, are common regionally and define a fault zone over a width of about two miles where it cuts across the Red River Gorge near the Red River State Fish Hatchery. Combined movement of the faults is in excess of 200 feet and is possibly much greater. The fault zone created a barrier to westward flow of lavas from the Guadalupe Mountains. A geologic map of the Tailing Facility Area is depicted on Figure 5-10.

5.7 Hydrogeology

5.7.1 Mine Site

In the vicinity of the mine site, ground water occurs in the bedrock and sediments, similar to ground water found throughout the Red River Watershed. For the RI, ground water has been divided into the following three distinct aquifers or water-bearing zones for physical characterization:

- Red River Alluvial Aquifer
- Colluvium and Debris Flow Ground Water
- Bedrock Ground Water

Springs and shallow alluvial ground water discharge into the Red River, rendering it a gaining stream over much of its length within the Red River Valley. Between the town of Red River and the USGS Questa gauging station, there are many ephemeral seeps and springs along the banks of the Red River and also intermittent seeps and springs in tributary drainages on the north side of the river (South Pass Resources, Inc. [SPRI] 1995; Steffen, Robertson and Kirsten [SRK] 1995a; RGC 2001).

5.7.1.1 Red River Alluvial Aquifer

The Red River alluvial aquifer occurs within the valley basin deposits and follows the Red River floodplain, extending continuously from above the town of Red River to below the tailing facility. Downstream of the tailing facility, the alluvium is less developed as the river cuts through the volcanic rocks within the Red River Gorge on the southern flank of the Guadalupe Mountains to the Rio Grande. At the mine site, the width of the alluvium varies from a few hundred feet to over 900 feet, while the known thickness, based on well data, ranges from about 50 to 150 feet. The widest and thickest portions of the aquifer are at the mill (800 feet wide, 120 feet deep) and at Columbine Park (900 feet wide, 150 feet deep). The alluvial aquifer consists of sediments with a wide range of grain sizes, from clay and silt to sand, gravel, cobbles and occasional boulders. The aquifer is unconfined.

5.7.1.1.1 Ferricrete and Manganocrete Deposits

The alluvium is unconsolidated, except for localized areas of cementation. Ferricrete and manganocrete cementation of the alluvial sediments have been found along several areas of the mine site. They are indicators of acid rock drainage. Ferricrete, a chemically precipitated iron oxide, was discovered in the mill area (monitoring well MMW-43A), at the lower extent of the Goathill Gulch debris fan (MMW-42A), and upstream from the Spring 13 area (MMW-50A). The thickness of the ferricrete deposit decreases from 25 feet at MMW-42A to 5 feet at MMW-50A, and is consistent with a downstream tapering (or runout) of the acid water from Goathill Gulch and Slick Line Gulch drainages. Manganocrete cementation of alluvial sediments has also been observed in the river bottom near Portal Springs and at Cabin Springs. Manganocrete is black and very dense and hard, as compared to the reddish ferricrete. The occurrence of ferricrete and manganocrete deposits can locally affect ground water flow by decreasing the permeability of the alluvium.

5.7.1.1.2 Ground Water Recharge and Discharge

Areas of aquifer recharge and losing conditions are created in the Red River where the aquifer water table elevation is lower than the river level. Where the water table elevation is greater than the river level represents areas of ground water discharge. Generally, the natural water level in the alluvial aquifer is predominantly below the river level along most of the reach between the town of Red River and the Questa Ranger Station. Aquifer pumping affects these conditions in the mill area and Columbine Park.

The alluvial aquifer receives recharge from the Red River during periods of high flow. During high flows, the river bottom is scoured, leaving only sand, gravel, and cobbles. This condition increases the seepage and recharge rate through the channel bottom. Additionally, the high stage of the river creates a greater downward hydraulic gradient from the river into the underlying alluvial sediments. After the high flows subside, silts and clays are re-deposited on the channel bottom resulting in a decreased vertical seepage rate. Recharge of the alluvial aquifer also occurs from alluvial, colluvial, and debris fan ground water in the tributary drainages, infiltration of precipitation, and from bedrock water where the gradient is from bedrock to alluvium. However, the magnitude of recharge from these sources is relatively small compared to recharge during high river flow.

During periods of normal and low flow in the Red River, alluvial ground water discharges into the Red River in most reaches bordering the mine site (see Ground Water-to-Surface Water Interaction, Section 5.7.1.1.6, below).

The main tributary drainages at the mine site are Capulin Canyon, Goathill Gulch, Slick Line Gulch, and Sulphur Gulch North. Other smaller tributary drainages are the Sugar Shack South, Middle, and Sulphur Gulch South drainages. The tributary drainages are shown on Figure 2-4.

Ground water flowing in the shallow alluvial aquifer passes alternately through Red River alluvium and debris fans and may emerge into the river when a relatively low permeability fan is encountered. Both the Red River alluvium and the debris fans act as a complex aquifer unit (Smith et al. 2007)

5.7.1.1.3 Ground Water Flow

The alluvial aquifer ground water flows parallel to the Red River generally from east to west between the town of Red River and the Questa Ranger Station.

Based on water levels at several nested pairs of monitoring wells in the alluvial aquifer and underlying bedrock aquifer along the mine site reach, vertical gradients between the two aquifers are known to be both upward and downward, but none of the gradients are considered to be particularly strong. At the mill, the gradient is moderately downward and is likely affected by pumping at the mill wells. Along the base of the roadside waste rock piles, the gradient is slightly upward. Pumping of the ground water withdrawal wells in the alluvium may induce an upward component of flow from bedrock to alluvium. At Columbine Park, high rates of pumping at the production supply well, Columbine No. 2 creates a downward hydraulic gradient. A downward hydraulic gradient was measured at well pairs MMW-45A/B located at the downstream mine boundary.

The alluvial aquifer is highly transmissive with continuous pumping rates of over 2,000 gpm demonstrated at the mill and Columbine Park for short periods of time. A hydraulic conductivity of 220 feet/day and transmissivity of 26,400 feet^2/day were estimated at Columbine Park based on a constant rate aquifer pumping test in Columbine Park No. 2. Hydraulic conductivity values between 700 and 860 feet/day and a transmissivity value of 90,300 feet^2/day have been estimated from aquifer tests at the mill area.

Aquifer testing was also performed in areas where the alluvium is inter-fingered with some amount of colluvium (debris flows) from the side drainages. The estimated hydraulic conductivity values were somewhat lower for the inter-fingered sediments, with a geometric mean of 86 feet/day. The lower hydraulic conductivity, as compared to the wells completed entirely within the alluvium, is due to the lower permeability colluvium material.

5.7.1.1.4 Controls on Flow

The flow of ground water through the Red River alluvial aquifer is influenced and controlled primarily by naturally occurring geomorphologic and bedrock features and by operational pumping of alluvial ground water for milling water supply, pipeline maintenance, and environmental response actions under NPDES Best Management Practices.

Geomorphologic controls on flow include the debris fans that extend from the tributary drainages into the Red River valley. The large Goathill Gulch debris fan is the most significant of these features. The width of the alluvial aquifer decreases at this location. The permeability of the debris flow materials is significantly lower than the alluvium; thus, the debris fan has effectively constricted the alluvial floodplain and underlying alluvial aquifer. The width of the alluvial aquifer upstream of the debris fan is 600 to 800 feet as compared to only 100 to 200 feet at the debris fan. Due to the reduced cross-sectional area of the alluvial aquifer, ground water discharges into the river upstream of the debris fan, at Spring 39, resulting in significant gains in stream flow of 3 to 5 cfs. Other examples of where debris fans may constrict the alluvial aquifer, but at a much smaller scale than the Goathill Gulch debris fan, include Sulphur Gulch North and Sugar Shack South drainages.

The alluvial ground water flow is also strongly influenced by the subsurface topography of the bedrock underlying the alluvium. Bedrock constricts the cross-sectional area of flow of the alluvium at several locations along the river valley. Because the bedrock has a permeability that is typically 2 to 4 orders of magnitude lower than the alluvial aquifer, the rate of ground water flow is limited where the lateral extent of the alluvium is limited by the bedrock. One significant bedrock constriction is at the downstream mine boundary near monitoring wells MMW-45A/B, where the bedrock has "pinched" the alluvial aquifer to a width of 100 to 200 feet and a depth of approximately 50 feet. This reduction in the cross-sectional area through which alluvial ground water can flow results in ground water discharging to the Red River, as evident by the Spring 13 and Spring 14 areas.[15]

It should also be noted that alluvial ground water flow can be influenced by low-permeability manganocrete and ferricrete deposits which cement the alluvial cements and restrict flow. An example of this is Cabin Springs, where ground water is forced upward when it encounters manganocrete.

5.7.1.1.5 <u>Effects of Operational Pumping</u>

The mine uses alluvial ground water for operations such as milling and transport of tailing via pipeline to the tailing facility. The mine pumps alluvial ground water from Columbine Nos. 1 and 2 wells in Columbine Park and from Mill 1 and 1A wells at the mill. Although

[15] It is possible that the alluvium may be incised deeper into the bedrock along this reach of the river, maintaining a similar cross-sectional area to that upstream. However, limited available borehole information suggests otherwise.

the wells can pump at high rates, the alluvial aquifer cannot sustain the high rates for long periods of time. Consequently, the mine has had to adjust the pumping rates. The average daily pumping rates for the Columbine wells are typically between 1,000 and 1,500 gpm during milling and lower when the mine is not milling. Alluvial water levels are drawn down by up to 15 feet in nearby wells during milling.

The average daily pumping rates for the mill wells range from 1,000 to 2,000 gpm in each well or collectively 4,000 gpm during milling. Pumping rates are decreased to below a combined flow of 500 gpm when the mill is not operating. During milling, alluvial water levels are drawn down as much as 30 feet in nearby wells, with drawdown evident in wells as far as one mile downstream of the mill.

5.7.1.1.6 Ground Water-to-Surface Water Interaction

The interaction between ground water and Red River surface water is an important hydrologic condition that occurs along the mine site, as it represents a primary transport mechanism for contaminant loading to the Red River.

Based on several surface water investigation conducted at the Site, including the RI and tracer studies by the USGS, the interaction between ground water and surface water has been characterized for the mine reach of the river as follows:[16]

- **Mill to Columbine Creek** – This reach experiences little interaction.
- **Columbine Creek to Goathill Gulch** – This reach is a large ground water discharge area that spans approximately 5,000 feet of river length. Beginning downstream of Columbine Creek, ground water discharge is first observed in the Cabin Spring area. The largest ground water discharge area begins farther downstream near where the tailing pipeline crosses the Red River at Spring 39

[16] It is noted that ground water/surface water interaction is transient and affected by changes in operational pumping and river diversion at the mill, seasonal differences between low- and high-flow conditions, and climatic conditions such as periods of drought.

(Thunder Bridge) and extends to Goathill Gulch. Gains in surface water flow between 3 and 8 cfs have been measured.

- **Goathill Gulch to Downstream Boundary** – This reach of the river is losing from Goathill Gulch to Spring 13 based on a comparison between ground water levels to the estimated river level. At Spring 13 gaining stream conditions occur, but the magnitude is significantly less than in the Columbine Park reach upstream.

A graph of the gain/loss of Red River flow along the mine site reach from the USGS tracer study depicts these ground water discharge zones (Figure 5-11).

5.7.1.1.7 Seeps and Springs

A number of alluvial seeps and springs have been identified along the Red River representing point sources of ground water discharge. They are primarily on the north side of the river. The seeps and springs observed to flow at the mine site during the RI are Sulphur Gulch Seep, Portal Springs, Cabin Springs, Spring 39, Spring 13, Lower Spring 13, Spring 14M and 14MA, and Spring 15M. The locations of these seeps and springs are shown on Figure 2-4. Several of them were observed to seldom flow, which could be caused by operational pumping at the mine site. Flows measures at these seeps and springs typically range from 0 (dry) to about 5 gpm. Cabin Spring flow was measured at 10 gpm in July 2003.

If operational pumping occurs near a seep/spring, it may lower the water table enough to decrease the flow rate. The pumping of Columbine Nos. 1 and 2 influences the flow at Cabin Springs and it seldom flows. When pumping ceases, as it did from 1992 to 1996 when mining was suspended, flow from Cabin Springs appears to increase.

5.7.1.1.8 Ground Water Collection Systems

As discussed above, CMI operates two seepage interception systems and a ground water withdrawal system at locations along the southern boundary of mine site as part of Best Management Practices under NPDES Permit (No. NM0022306).

5.7.1.2 Colluvium and Debris Fan Ground Water

Colluvium occurs within each of the tributary drainages at the mine site. Water occurs within colluvium in exposed drainages and in drainages covered by waste rock. The origin of the water is primarily from precipitation and runoff, with contributions from the underlying bedrock. The saturated thicknesses range from zero to a few feet in the upper portion of the drainages to tens of feet near the mouth of the drainages along the Red River.

The inter-fingering of colluvium, debris flows and alluvial sediments at the mouths of the tributary drainages results in a mixing zone of their respective ground waters (*e.g.,* Goathill Gulch debris fan). The source of the water in the debris fans is infiltration of ephemeral surface water, recharge from the side canyons, and infiltration of precipitation through the debris fan. Water within the colluvium is controlled by the low permeability bedrock below the colluvium and along the sides of drainages. Water flows in the direction of the drainage, which is generally south toward the Red River. The horizontal gradients are high and approximate the slope of the pre-mining topographic surface. Some colluvium monitoring wells are dry, suggesting that saturated conditions may not be continuous. However, it is difficult to verify the presence of ground water in the drainages filled with waste rock. The wells have to be accurately located within the narrow drainage axis and must penetrate the entire colluvial section. Where colluvial water is present at the upper reaches of drainages (*e.g.,* Capulin Canyon), it is assumed that saturation is continuous down the drainages to where the water commingles with alluvial water. The thickness of saturated colluvium is assumed to be greatest near the mouth of the drainages.

Based on slug or pump tests, the hydraulic conductivity values of the colluvium and debris flow material ranges from 0.04 to 61 feet/day. The large range is due to the inherent heterogeneity and nature in which the sediments were deposits. The geometric mean hydraulic conductivity value is 0.9 feet/day, which is almost three orders of magnitude less than the mean value (607 feet/day) for the Red River alluvium.

The following sections discuss the occurrence of colluvial water specific to mine site drainages. Table 5-1 shows the thickness of saturated colluvium/debris fans for individual drainages.

5.7.1.2.1 Spring and Blind Gulches

Spring and Blind gulches are two former small tributaries to Sulphur Gulch in the northeast portion of the mine site that contains colluvium. Waste rock has been placed over the colluvium in both drainages. Two monitoring wells were installed through the Spring Gulch Waste Rock Pile into the underlying colluvium near the former drainage channel of Spring Gulch. Mine monitoring well MMW-40A encountered water within waste rock and underlying colluvium. The total saturated thickness is approximately 32 feet, of which 17 feet is within colluvium and 15 feet within the waste rock overlying the colluvium. MMW-34A encountered thirty feet of unsaturated colluvium before penetrating bedrock. Based on these wells, saturation in the colluvium may not be continuous along the length of the drainage.

The Blind Gulch drainage is west of Spring Gulch and filled with waste rock. A total of four boreholes were drilled through the Blind Gulch Waste Rock Pile and sited to intersect the former drainage channel. Only two of these boreholes penetrated the entire colluvium section and were converted into monitoring wells. However, no water was encountered in any of the boreholes. The colluvium thickness ranged from one foot at the upper drainage to 25 feet at the lower drainage. The unsaturated conditions within the colluvium of the Blind Gulch drainage are likely the result of two mining activities. First, some storm water runoff is diverted from the waste rock pile to the open pit allowing less water to infiltrate through the pile. Second, the open pit functions as a large sink drawing water to the pit and dewatering the surrounding bedrock in portions of Blind Gulch and upper Sulphur Gulch.

5.7.1.2.2 Sulphur Gulch

The former Sulphur Gulch drains the eastern one-third of the mine site. Colluvium within the drainage is comprised of eroded material from the slopes of the drainage and alteration material from the hydrothermal scar at the headwaters of the drainage. Development of the open pit consumed almost the upper one-half of the drainage. The lower portion of the drainage is filled with waste rock that comprises Sulphur Gulch Waste Rock Pile. Monitoring well MMW-39A penetrated about 66 feet of colluvium in lower Sulphur Gulch; the lowermost nine feet were saturated. Other wells have been installed near the mouth of the drainage that encountered saturated colluvium. The hydraulic conductivity estimated from pump testing at MMW-39 averaged 61 feet/day.

Colluvial water in lower Sulphur Gulch flows south in line with the former drainage and commingles with Red River alluvial water. The gradient of the colluvial water is less than the gradient of the former drainage and may indicate another flow path for some water. There is the potential for water to drain through bedrock fractures into the Decline which passes underneath Sulphur Gulch near MMW-39A. However, there has been no direct evidence that this occurs.

The unnamed drainage is located west of Sulphur Gulch drainage that is filled with the Sulphur Gulch South Waste Rock Pile. The drainage contains a hydrothermal scar that comprises nearly 50 percent of the drainage area. Several boreholes have been drilled that targeted the drainage channel. Colluvium is present in the lower and middle drainage channel, with thicknesses up to 15 feet (SI-51) at the mouth of the drainage. A thirty-foot wet zone within the colluvium section was reported by the driller. However, a vibrating wire-line piezometer installed near the bottom of this interval is dry. This suggests that the wet conditions may have been an infiltration front passing through the colluvium.

5.7.1.2.3 Unnamed Drainage Beneath Middle Waste Rock Pile

An unnamed drainage underlies the Middle Waste Rock Pile that contains colluvium. It is the only drainage beneath the roadside waste rock piles that has no hydrothermal scar. A cross section of the drainage is depicted on Figure 5-12.

Borehole drilling has penetrated through colluvium ranging in thickness from 16 feet in the upper drainage to approximately 120 feet at the mouth of the drainage, some of which could be fill material used to construct the berm at the toe of the waste rock pile. Water is present in the colluvium beginning about two-thirds up the drainage and continuing to the mouth of the drainage. Relatively large fluctuations in water levels indicate that the colluvial water is hydraulically connected to the Red River alluvial aquifer.

Colluvial water is presumed to flow southeast in line with the former drainage to commingle with Red River alluvial water. The hydraulic gradient is estimated to be 0.4, which is a very steep gradient and similar to the slope of the original drainage. The hydraulic gradient was estimated at 16.6 feet/day from slug tests conducted at MMW-38A. The estimated flow from the colluvium to Red River alluvium at the mouth of the drainage is about 30 gpm.

Although the colluvial water is believed to flow southeast toward the river, there is other physical evidence that suggests that some water may be flowing northwest. A colloidal borescope investigation of MMW-38A was performed by using a down-hole camera that videos colloids suspended in the water column. The investigation showed flow directions from two separate zones within the 11-foot saturated section to the northwest and west-northwest. The flow directions suggest that some colluvial water may move toward the hydraulic capture zone created by dewatering of the underground mine northwest of the well or the Moly Tunnel that passes beneath the unnamed drainage. These results are highly suspect, considering that the colluvial water occurs in a steeply sloping drainage and should flow down slope consistent with the conceptual model.

5.7.1.2.4 Unnamed Drainage Beneath Sugar Shack South Waste Rock Pile

An unnamed drainage underlies the present day Sugar Shack South Waste Rock Pile that contains colluvium. The former drainage contains a hydrothermal scar and the eroded scar material likely comprises much of the colluvial material in the drainage. The scar covers about a third of the drainage area. Several boreholes have been drilled through the waste rock pile targeting the colluvium within the drainage channel. Boreholes encountered colluvium that ranged in thickness from 3 feet in the upper drainage to approximately 160 feet at the mouth of the drainage. Water is present in the colluvium. Relatively large fluctuations in water levels indicate that the colluvial water is hydraulically connected to the Red River alluvial aquifer. A cross section of the drainage is depicted on Figure 5-13.

The flow direction within the colluvium is to the southeast in line with the former drainage and toward the river. The hydraulic gradient is 0.4, similar to the gradient of the slope beneath the waste rock pile. The hydraulic conductivity was estimated to be 1.1 feet/day. The estimated flow from the colluvium to the Red River alluvium at the mouth of the drainage is about 2 gpm.

5.7.1.2.5 Slick Line Gulch

Colluvium occurs within Slick Line Gulch that passes through the present-day M&E facility and joins the debris fan of Goathill Gulch near the Red River. There are two segments at the upper drainage, the segment to the west is partially covered with the Goathill South Waste Rock Pile and passes over the D-Ore Body and the underground workings, and the segment to the east is covered with the Sugar Shack West Waste Rock Pile. The two segments join about 1,500 feet north of the M&E facility.

Little is known about the colluvium in the upper segment that drains the Goathill South Waste Rock Pile. No wells have been installed in the drainage. The borehole drilled for monitoring well MMW-36A at the toe of Sugar Shack West Rock Pile encountered about 50 feet of colluvium. MMW-36A has had no water since 2002. MMW-36B had recorded water until mid-2006. The current absence of water is likely to be related to the hydraulic capture zone created by the underground workings as both of these upper segments overlie or are near the underground workings. Dewatering of the underground has created a hydraulic gradient toward the underground that drains the overlying bedrock. Therefore, it may be reasonable to expect minimal, if any, saturation in the upper segment that drains the Goathill South Waste Rock Pile, although exploratory borehole drilling would be needed to verify.

Several boreholes have been drilled for monitoring well installation in the lower segment of Slick Line Gulch. Water is present in the colluvium (and alluvium) within the lower drainage, with saturated thicknesses ranging from 20 feet at MMW-22 to approximately 140 feet at MMW-48A.

Colluvial water in the lower reach of Slick Line Gulch (*i.e.* the eastern half of the Goathill Gulch debris fan) flows is to the south-southwest in line with the former drainage and eventually commingles with the Red River alluvial water. The hydraulic gradient is 0.2, which is similar to the slope of drainage. The hydraulic conductivity estimated from pumping and slug tests ranged from 6.7 to 8.9 feet/day, with a geometric mean of 8.3 feet/day. The estimated flow from the colluvium to Red River alluvium at the base of Slick Line Gulch drainage is about 200 gpm.

5.7.1.2.6 <u>Goathill Gulch</u>

Colluvium occurs along the entire length of the Goathill Gulch drainage. The Goathill North Waste Rock Pile is located at the head of the drainage. Hydrothermal scars make up about 20 percent of the total drainage area. Water and seepage from the waste rock pile originating in the upper drainage, together with diverted water and seepage from the Capulin Canyon seepage collection system, flows in the unlined drainage until reaching the subsidence area, where it temporarily collects and infiltrates through the fractured rock overlying the underground mine workings. Some of this water flows through the colluvium that is present in the drainage channel.

The thickness of the colluvial sediments upstream of the subsidence area is somewhat unknown as there are no monitoring wells. Two mining exploratory boreholes just upstream of the subsidence area encountered colluvium water at a depth of 14- to 16-feet below the flowing surface water in the drainage. The thickness of the colluvium at that location is approximately 65 feet. Ground water flow through the colluvium upstream of the subsidence area is estimated to range from 7 to 20 gpm.

Downstream of the subsidence area, Goathill Gulch drains onto the large debris fan. The occurrence of colluvium is comprised largely of debris flow material. Based on borehole drilling, up to 265 feet of colluvium has been encountered. At the western edge of the debris fan, a 20-foot deposit of ferricrete and possibly some Red River alluvium were encountered.

The water within the central portion of the debris fan is typically found at a depth of 100 feet. Saturated colluvium ranges in thickness from 40 to 70 feet on both the east and west sides of the fan to about 150 feet in the center of the fan that overlies the bedrock depression. The water level within the eastern section of the debris fan is near the river level, suggesting a relatively flat hydraulic gradient toward the river. At the distal end of the debris fan, a change from a southerly flow direction to a westerly flow direction occurs as mixing begins with more permeable Red River alluvium, and the gradient decreases to less than 0.1 in the direction of wells toward the river. It is also noted that the water level is similar to the level of the river from the center of the fan upstream along the river to the east. This shows the effect of the debris fan “damming” the valley and forcing ground water to discharge into the river. Downstream of the center of the debris fan, water levels are below the level of the river.

The hydraulic gradient estimated from slug testing at MMW-48A and MMW-44A ranges from 2.3 to 8.9 feet/day, with a geometric mean of 6.2 feet/day. The estimated flow from colluvium to Red River alluvium at the mouth of the Goathill Gulch drainage is approximately 300 gpm.

5.7.1.2.7 Capulin Canyon

Colluvium lines the narrow drainage of Capulin Canyon from near its headwaters to the mouth of the drainage. The Capulin Waste Rock Pile covers the upper drainage. A relatively small hydrothermal scar is located on the west facing slope of the lower drainage and covers approximately three percent of the total drainage area. Based on borehole drilling, the colluvium thickness ranges from 6 feet in the upper drainage to 58 feet at the mouth of the drainage.

Water is present in the colluvium within Capulin Canyon. Over the year, water levels may fluctuate up to 8 feet in the upper drainage, with saturated thicknesses ranging from 10 to 18 feet. Near the mouth of the drainage, water levels only fluctuate up to two feet per year and saturated thicknesses in the colluvium are about 26 feet. Water within the colluvium flows to the southwest in line with the drainage and eventually commingles with the Red River alluvial water.

The hydraulic gradient in the upper drainage is approximated by the slope of the land surface to be 0.16. The gradient for the lower drainage is estimated to be 0.11. Hydraulic conductivity estimates in Capulin Canyon colluvium are low. Based on slug tests at MMW-3A, hydraulic conductivities were estimated to range from 0.1 to 2.8 feet/day, with a geometric mean of 0.7 feet/day. At the mouth of the drainage, hydraulic conductivity calculated from pumping test at MMW-2 averaged 0.08 feet/day. Using these values, ground water flow from colluvium to Red River alluvium is calculated to be less than 1 gpm.

Yield analysis estimated considerably more recharge or ground water flow available from Capulin Canyon. It is possible that the very low hydraulic conductivity values calculated for MMW-2 are not representative of the entire colluvium/debris fan and that there is a higher flow rate of ground water from the canyon. Another possibility is that flow within the colluvium drains to the underlying bedrock and exits the canyon through the bedrock aquifer.

5.7.1.3 Bedrock Aquifer

The Tertiary volcanic rocks form the primary bedrock aquifer in the mine area. The volcanic rocks are fractures and faulted throughout the mine area north of the Red River (SPRI 1995) as they represent the southern margin of the Questa caldera. Caine (2007) also identified intense joint sets and multiple fault zones with high-angle open faults throughout this area as part of the USGS Baseline Study. Water within the bedrock occurs within secondary porosity features such as these faults, fractures, and joints. Water is also present in large void spaces associated with underground mining such as workings, tunnels, shafts, rises and winzes. These features typically function as drains that collect water. Water is present within the primary porosity of the bedrock, but the amount of water is likely to be limited as compared to the amount in secondary structures.

Bedrock water is present beneath the mine site and beneath the adjoining Red River floodplain to the south. Bedrock water interior to the mine site originates as precipitation within the mine watersheds and enters the bedrock by infiltration through colluvial soils, waste rock, the open pit, the subsidence area, and other areas of exposed bedrock. In contrast, bedrock beneath the Red River alluvial floodplain is likely to contain some amount of water sourced by the alluvial aquifer. The upper few tens of feet of the bedrock beneath the Red River alluvium are known to be highly fractured and in hydraulic communication with the overlying alluvial ground water and, therefore, have similar water chemistries. Bedrock waters at depths beyond the upper tens of feet have dissimilar chemistries than the alluvial ground water.

Within tributary drainages, bedrock water is generally present at relatively shallow depths and is unaffected by underground dewatering. Bedrock ground water may be confined at lower elevations of some drainages. Examples are SI-50 at the first bench of the Sugar Shack South Waste Rock Pile and SI-45 at the second bench of the Middle Waste Rock

Pile. At both of these locations water movement may be upward from bedrock into the overlying colluvium (and possibly waste rock) because upward gradients between bedrock and colluvium have been measured (see Figure 5-12).

Within the interior of the mine, bedrock water is found only at much greater depths as a result of underground dewatering. A generalized cross section through the east end of the underground workings illustrates the relative position of the bedrock water level surface through the mine (Figure 5-14). The location of the cross section is depicted on Figure 2-4. The cross section begins at the Red River and runs northwest through the Middle Waste Rock Pile and the eastern end of the underground mine. Bedrock water beneath the Middle Waste Rock Pile is near the top of the bedrock surface. Near the top of the waste rock pile, the upper portion of bedrock is dry suggesting that dewatering of the underground mine and the open pit have lowered the bedrock water table in the upper portion of the Middle drainage. The lowering of the bedrock water level has created a bedrock hydraulic divide. The Moly Tunnel is also depicted on the cross section where it passes about 400 feet below the Middle Waste Rock Pile. The bedrock hydraulic divide is likely not influenced by bedrock drainage to the tunnel, which functions as a localized drain. As the cross section passes through the eastern end of the underground mine, the bedrock is dewatered to the 7,120-foot haulage level. The haulage level is about 800 feet below the elevation of the Red River. The cross section illustrates the relative elevation of the open pit, which is projected onto the line of the section, and its interconnection with the old and new underground workings. The dewatering of the mine has resulted in up to 2,000 feet of unsaturated bedrock. The cross section continues to the northwest and passes through a wet, moist area of the underground mine referred to as the “rain forest”. The source of wet conditions is either from the proximal old underground workings that receive water from the open pit, or infiltrating water from the upper reach of Slick Line Gulch.

Potentiometric surface mapping of the bedrock aquifer shows steep gradients beneath the roadside waste rock piles westward to the Slick Line Gulch and Goathill Gulch areas, where there is flattening due to the subsidence area and underground dewatering. The flow direction is toward the river. West of Goathill Gulch to Capulin Canyon, the flow direction is also generally southward toward the river. Bedrock water within the hydraulic capture zone is directed toward the dewatered underground workings. The estimated extent of capture of bedrock water within the interior of the mine is depicted on Figure 5-15.

Bedrock water level fluctuation is dependent on the timing and amount of recharge reaching the bedrock. However, the proximity of bedrock water to the Red River alluvial aquifer and the hydraulic connections between the two waters is the dominant factor that causes water level changes. Bedrock water-level fluctuations range from 20 to 25 at the mill, 10 to 15 feet at the roadside waste rock piles and Columbine Park, and less than one foot at the downstream mine boundary. The higher fluctuations are associated with ground water pumping within the alluvium. Fluctuations in bedrock water levels begin to decrease farther away from the river, demonstrating that the river and alluvial aquifer have no influence on bedrock water interior to the mine.

The saturated thickness of the bedrock is unknown. Water is known to extend hundreds of feet into the deeper portions of the bedrock based on borehole data. However, bedrock water may extend thousands of feet.

The hydraulic gradient of the bedrock aquifer is highly variable and dependent on the orientation, spacing, and openness of the fractures, faults, and joint systems below the water table. Generally, competent to slightly fractured rock has an average hydraulic gradient about one order of magnitude less than colluvium, and three to four orders of magnitude less than alluvium. Highly fractured rock can have hydraulic conductivities similar to values for colluvium.

5.7.1.3.1 Red River Floodplain

Shallow bedrock water beneath the Red River floodplain is similar to the overlying Red River alluvial ground water in terms of depth to water, water level responses, and chemistry. The upper few tens of feet of bedrock within the floodplain tend to be weathered and fractured, allowing the bedrock water to be hydraulically connected with

Red River alluvial water. Depth to bedrock water within the floodplain ranges from 60 to 100 feet in the mill area (the large variation due to pumping) to 8 to 10 feet at the downstream end of the mine site. Fluctuations in the bedrock water levels range from 15 to 20 feet over the year, similar to the magnitude of water level fluctuation in the Red River alluvial aquifer.

Although water levels in the upper bedrock are similar to levels in the alluvium, there is some evidence of vertical movement. Downward gradients from alluvium to bedrock are apparent in the mill area, Columbine Park and at the downstream boundary of the mine site. Upward gradients from bedrock into the overlying alluvium are evident at the base of the Middle and Sugar Shack South waste rock piles.

5.7.2 Tailing Facility

Ground water occurs within piedmont alluvial sediments beneath the tailing facility within the Santa Fe Group to the east. It also occurs within volcanic flows of the Guadalupe Mountains and Servilleta flood basalts beneath the western flank of the tailing facility and to the west. Ground water in the alluvial sediments is unconfined and occurs in the interstitial porosity between clay to cobble size material. The permeability of the alluvial sediments varies depending on the amount of fine- and coarse-grained material. In contrast, ground water in the volcanics occurs in the secondary porosity associated with faults, fractures and vugs. Ground water in the volcanics has a much higher permeability than the alluvial sediments and, as such, it has a lower horizontal gradient.

The western flank of the Sangre de Cristo Mountains is the primary area of recharge to the Questa valley. Recharge to ground water occurs from ephemeral and perennial streams draining the Sangre de Cristo Mountains. Other sources of recharge include infiltration of irrigation water, precipitation, and water management practices at the tailing facility. Recharge to the volcanics is primarily through leakage from the overlying alluvial sediments (Vail 1987).

The local hydrogeology at the tailing facility is comprised of two primary aquifers: an alluvial aquifer and a basal bedrock (volcanic) aquifer.[17]

Geologic cross sections A-A' through D-D' were developed through the tailing facility and surrounding areas to illustrate the occurrence of the different alluvial and volcanic strata in relationship to the tailing impoundments (Figures 5-16 through 5-19). The cross sections also show the general occurrence of the alluvial and basal bedrock aquifers and tailing water within the impoundments. Figure 5-20 is a map of the tailing facility showing the locations of the cross sections.

5.7.2.1 Tailing Impoundment Water

Discharge of tailing water and ensuing seepage has resulted in saturated tailing material within the two pre-existing arroyos now referred to as the tailing impoundments. The tailing pore water has created an area of high water table that covers much of the two impoundments. At the eastern impoundment behind Dam No. 1, the water table is approximately 120 feet below the surface of the tailing. In the western impoundment behind Dam No. 4, the water table is 40 to 50 feet below the surface.

Tailing deposits are over 200 feet thick within the eastern impoundment. The water level in the eastern impoundment has been decreasing since the late 1980s, with the cessation of tailing deposition. Between 1996 and 2004, the water table had decreased approximately 30 to 40 feet. This decrease is due to dewatering of the impoundments though leakage of the earthen dams and the bottom and flanks of the arroyo on which the tailing has been placed. Water within the tailing occurs as alternating wet and dry sequences overlying a

[17] The stratigraphy at the tailing facility is complex, with correlation of sand and clay units and water zones between wells being very difficult, especially in areas of known or suspected faulting. CMI has separated the alluvial aquifer into upper and basal alluvial aquifers in the RI Report (URS 2009a). However, the lack of a continuous confining layer (clay) between these two alluvial aquifers indicates that they are in hydraulic communication with one another. As stated in the RI and FS reports, CMI recognizes such interpretation may be an unnecessary simplification which may require further investigation as part of any ground water response action. EPA has elected to consider the alluvial aquifer as one aquifer for the Selected Remedy.

continuous zone of saturation. Currently, there is about 100 feet of saturated tailing on the bottom of the impoundment behind Dam No. 1.

Tailing deposits reach a current thickness of about 150 feet in the western impoundment behind Dam No. 4, where active tailing deposition occurs today. Similar to the eastern impoundments, there are alternating wet and dry sequences overlying about 75 feet of saturated tailing.

Based on the findings of the RI and other investigations, tailing liquids have seeped, and continue to seep, through the impoundments into the underlying alluvial and volcanic aquifers.

5.7.2.2 Alluvial Aquifer

Directly beneath the tailing impoundments is the alluvial aquifer. It is the producing aquifer for a number of domestic wells and the two municipal supply wells used by the Village of Questa. The municipal supply wells are located about one mile northeast and upgradient of the tailing facility and reach total depths of 300 and 325 feet.

The alluvial aquifer is a mixture of alluvial sediments generally comprised of sandy, silty gravels. Up to 300 feet of alluvial sediments have been encountered via borehole drilling at the tailing facility. The total thickness is estimated to reach up to 500 feet beneath the eastern flank of the facility.

Under the western impoundments are thick beds of low-permeability clay and silt that inter-finger with the high permeability alluvial sediments. Approximately 140 feet of reddish clay and 40 feet of silt were encountered in the borehole for MW-23. These beds appear to be laterally continuous for over one and a half miles to the north, where they were encountered in the boring for MW-18. The extent of the clay is shown in cross-sectional view (Figures 5-16 and 5-17) and in plan view (Figure 5-21).[18] The fine grained sediments are lacustrine (lake) deposits which likely formed when volcanic flows from the Guadalupe Mountains dammed the ancestral Red River or other surface water flows in the valley. These clay beds likely impede downward flow under portions of the western impoundments. The water within the impounded tailing is locally perched in the vicinity of MW-23, as the alluvium and clay beds are dry. The lacustrine clay is not present under the eastern impoundments.

The clay and silt beds at MW-23 do not extend as far south as Dam No. 4, but terminate somewhere between the well and the dam. Seepage of tailing water downward through the alluvial sediments and into the volcanic aquifer likely occurs in the area where the low-permeability clay is absent. This is illustrated as vertical flow arrows on Cross Section B-B' (Figure 5-17). Another area where seepage of tailing water occurs is behind Dam 5A. Here the impounded tailing water is in contact with the base of the Guadalupe Mountains and water infiltrates through the thin alluvial deposits downward into the volcanic rocks.

The eastern impoundments are underlain by variations of sand, silt, and gravel. Minimal clay is present in contrast to the large clay beds underneath the western impoundments (see Cross Section C-C', Figure 5-18). With the absence of continuous clay beds, there is no hydrostratigraphic distinction between the upper and basal portions of the alluvium in this area. Water levels and water chemistry are similar. However, there are some differences in the major anion and cation chemistry of the deeper ground water that tends to be richer in sodium and alkalinity and has lower concentrations of sulfate than the upper portion of the aquifer. These differences are likely related to tailing-seepage impacts. The thickness of the alluvial aquifer on this eastern portion of the impoundments is unknown and could be thousands of feet thick.

The alluvial aquifer continues to the east of the tailing impoundments and through Questa. The water table is shallow (5 to 10 feet below ground surface) in the vicinity of Cabresto

[18] Figure 5-21 represents an isopach map of total clay thickness calculated from multiple and overlapping clay and clayey gravel beds in the tailing facility area. The map does not necessarily indicate that these overlapping clay beds are continuous over the entire area mapped.

Creek. Infiltration from the creek, irrigation ditches, and flood-irrigation practices saturate the ground.

South of the impoundments, a significant portion of the alluvial aquifer is comprised of clay and clayey gravel beds which inter-finger with alluvium. The amount of clay increases westward toward the volcanic rocks of the Guadalupe Mountains (see Cross Section D-D', Figure 5-19). The clay is similar to the lacustrine clay under the western impoundment, suggesting a similar origin. To the east toward Questa, there is less clay and increasing amounts of sandy, silty gravels.

Ground water flow in the alluvium is generally in a south-southwest direction beneath the eastern impoundment, parallel to the orientation of the original arroyo. A potentiometric surface contour map for the alluvial aquifer is depicted on Figure 5-22. As the alluvial aquifer pinches out to the west onto the slope of the Guadalupe Mountain volcanics, some of the shallow ground water may infiltrate downward into the volcanic aquifer. Hydraulic conductivity values calculated for the alluvial aquifer are variable, ranging from 0.3 feet/day (silty sand) to 312 feet/day (gravelly sand), with a geometric mean for coarse grained sediments of 16 feet/day.

5.7.2.3 Basal Bedrock (Volcanic) Aquifer

Ground water in the basal bedrock aquifer occurs in the volcanic flows originating from the Guadalupe Mountains. The rocks are primarily vesicular basalts and andesites. Ground water is also known to occur in the Servilleta flood basalts which underlie the volcanic flows, but at a greater depth than has been reached by borehole drilling. No bedrock has been encountered on the eastern portion of the impoundment.

The volcanic aquifer is regional. It underlies the Guadalupe Mountains, a portion of the tailing facility, and presumably Questa, although no wells have been drilled deep enough to reach the volcanic bedrock in Questa. It extends to the north to Cerro and to the south, under the Red River. The surface of the volcanics under the tailing facility is sloped to the east from the Guadalupe Mountains and reaches a depth of over 500 feet along the eastern flank of the tailing facility[19] (see Cross Section D-D', Figure 5-19). Water has been encountered in the volcanic rocks under the western impoundments and west and south of the impoundments. The volcanic aquifer is unconfined beneath the Guadalupe Mountains.

The ground water flow direction is southwest at a low gradient. Monitoring well data show a nearly flat hydraulic gradient in the volcanic aquifer. Ground water in the volcanic occurs in secondary porosity associated with faults, fractures, and vugs. Hydraulic conductivity values calculated for the volcanic aquifer (at MW-11) are large, ranging from 916 to 4,612 feet/day, with a geometric mean of 1,990 feet/day. The mean hydraulic conductivity of the volcanic aquifer is two to three orders of magnitude greater than mean values for the alluvial aquifer.

5.7.2.4 Ground Water Discharge

Discharge of ground water occurs as seeps and springs south and southwest of the tailing dams and near the Red River. Many of these seeps and springs contain elevated concentrations of sulfate and molybdenum, which are associated with tailing seepage, and indicate a hydraulic connection to the tailing impoundments. Several seeps and springs occur at or south of Dam No. 1. Seeps occur at the dam face (East and West seeps) and along the east flank of the Dam No. 4 impoundment (003 East, West, and Central seeps). Springs 7, 8, and Embargo Road Seep are the result of the shallow water table intersecting the ground surface. Springs 9 and 10 are located at the contact between alluvial aquifer sediments and the volcanic rocks, where the alluvial aquifer pinches out. Spring 17, known as the Cold Water Spring, provides the Red River State Fish Hatchery with 3 cfs of continuous water supply.

The primary discharge of volcanic water is at springs along the Red River and Rio Grande. Within the upper portion of the Red River Gorge leading to the fish hatchery, several

[19] This depth is defined by one of the Village of Questa's municipal wells that did not encounter volcanic rocks to a depth of 500 feet.

springs issue from the volcanics, including the Warm Water Spring (Spring 18) which provides process water and potable water for the hatchery. Other discrete springs between the tailing facility and the hatchery are Springs 12, 12a, 14T and 15T. The total flow of Spring 18 has been estimated to be as high as 10 cfs. There is some uncertainty as to whether Spring 18 is one or several springs along the gorge, including those listed above. The New Mexico Department of Game and Fish, in working with hatchery personnel and NMED, are currently investigating the origin of this spring by assessing the conveyance system the hatchery uses to collect the spring water.

5.7.2.5 Effects of Faulting on Ground Water Flow

Faults have been inferred that trend southwest to northeast through the tailing facility. A high-angle fault was mapped by Vail (1987) along the western portion of the pre-existing arroyo which is now covered by tailing behind Dam No. 4. Another fault has been inferred to run through the pre-existing arroyo now covered by tailing behind Dam No. 1 (SPRI 1993). The effects of these potential faults on ground water flow are not believed to be significant because the movement of ground water is nearly parallel to the orientation of the faults. However, the fault in the volcanics beneath Dam No. 4 may serve as a preferred ground water pathway, as its projected alignment to the Red River coincides with the location of Spring 12.

5.8 RI Sampling Strategy

The RI sampling strategy was comprehensive in scope and covered all potential sources of Site-related contamination, as well as all areas and all media where Site-related contamination could come to be located for potential exposure by human and ecological receptors.[20]

[20] It is noted that during scoping and development of the RI/FS Work Plan, include the Field Sampling Plan, it was determined that a significant number of investigations and studies had already been conducted or were ongoing at the Site under the direction of other state or federal regulatory authorities, or independently by CMI, especially for mining waste (*i.e.,* waste rock and tailing). To avoid redundancy, EPA decided to incorporate some of the data collected by those investigations and studies if they met EPA's quality assurance

The RI sampling strategy was to define the nature and extent of contamination and support the human health and ecological risk assessments. Therefore, the general rationale for sampling design was media-specific, particularly for nature and extent of contamination. However, to understand exposure and effects for risk assessment requires an understanding of the interrelationships of exposure pathways through physical and/or biological media to human and ecological receptors. Hence, to the extent practicable, terrestrial and aquatic biota sampling for risk assessment was co-located with the physical media sampling (soil, surface water, and sediment) conducted to define nature and extent of contamination. The co-location strategy allows the correlation (or lack thereof) between biotic and abiotic sample results and reduces uncertainty in determining the correlation between chemical concentrations in the various media and receptors. Results were interpreted on the basis of established benchmarks and/or in comparison to data collected on exposure to media from reference background areas.

The conceptual approach for collecting data for risk assessment is line-of-evidence, thus requiring multiple measures to quantify risk. Assessment Endpoints and Measurement Endpoints were identified in the Problem Formulation section of the Baseline Ecological Risk Assessment (BERA). These endpoints and the testable hypotheses relating to them formed the basis of data needs for the ecological risk assessment.

The Site was initially divided into individual investigation areas for the RI. Sample locations were then selected to characterize each investigation area.

After preliminary Site characterization, the RI sampling strategy was expanded several times for collection of additional data deemed necessary by EPA to further define the nature and extent of contamination for development of remedial alternatives and future EPA decision-making.

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and quality control requirements and were considered of sufficient quality for use in a CERCLA investigation. The RI Report (Appendices 2.10-2 and 2.10-3 of Section 2, RI Report (URS 2009a) contains a summary of the documents reviewed and the data incorporated into the RI.

5.8.1 Surface Soil Sampling

Surface soil samples were collected for analysis from the mine site, tailing facility, and the riparian area along the Red River, including south of the tailing facility, as well as reference background areas that have not been affected by mining operations. At most sample sites, two separate soil samples were collected at depths of 0 to 6 inches and 0 to 24 inches. The 0 to 6 inch samples were collected to evaluate risk to humans via incidental ingestion, dermal contact or inhalation. The 0 to 24 inch samples were collected to evaluate risk to ecological receptors. All soil samples were analyzed for metals and inorganic chemicals, as they are common contaminants at mining sites. At select locations near independent sources, soil samples were also analyzed for VOCs and semi-volatile organic compounds (SVOCs), pesticides and PCBs, and dioxins/furans. Synthetic Precipitation Leaching Procedure (SPLP) was also performed on a subset of soil samples.

Systematic random sampling was used in areas with non-point sources to obtain the required sample population from each soil investigation area. The required number of random samples was determined statistically as the number necessary for evaluation of risk and comparison to reference background samples. The required minimum sample size for each investigation area was calculated to be 10. Soil samples were also collected in biased locations in order to characterize a specific potential release from independent sources on the mine site and within areas such as campgrounds and cabin areas as part of the riparian soil evaluation, or a few non-random locations for further characterization of nature and extent.

Vegetation samples and animal samples were co-located with subsets of the soil samples in soil investigation areas. The soil data co-located with the vegetation and animal data were used to evaluate uptake and bioaccumulation in plants and animals.

5.8.1.1 Mine Site

The soil samples collected at the mine site were from the administrative and M&E areas, mill area, waste rock piles, open pit, scars, and mine site independent sources (landfills, underground debris stockpiles, explosive storage areas, former truck shop area, transformers, historic fueling areas, core shop and former carpenter shop). Soil samples were not collected from the subsidence area due to safety concerns for field sampling teams.

The independent source areas are physically located within other soil investigation areas where random sampling was performed. Because these areas represented locations of potential sources, only biased sampling was performed. Samples were collected outside doorways and garages, near existing or former storage tanks and transformers, and from drainage channels from these areas. Samples were also collected from visible staining. All samples collected in areas where transformers used to be located were also analyzed for PCBs.

5.8.1.2 Tailing Facility

The soil samples collected at the tailing facility were from the tailing impoundments, dry maintenance area, ion exchange plant, Pope Lake, south of the tailing facility, and areas potentially affected by wind blown tailing particulates. All soil samples were collected from fall 2002 through May 2004.

Soil samples collected at the tailing impoundments consisted of variable amounts of soil, interim soil cover, and tailing, dependent on what was present in a given depth interval. Samples of tailing were also collected at the same locations. Reference background soil samples were collected from Cater Ranch, located six miles north of the tailing facility.

To determine if soil downwind of the tailing facility had been impacted by windblown tailing particulates, soil samples were collected along transects away from the tailing impoundments to the north, northeast, east, southeast, and south. These transects were based on a wind rose from Alamosa, the nearest wind monitoring station. The dominant wind directions are to the north and northeast. Additional transects were added based on secondary wind directions.

Two soil samples were collected at each transect sampling site from depths of 0-2 and 2-6 inches. The purpose of the 2-6 inch samples was to serve as reference background for the 0-2 inch sample. A concentration representing the 0-6 inch depth sample for human health evaluation was calculated as a weighted average of the 0-2 and 2-6 intervals. Biota sampling was deferred until a windblown area was defined based on the first round of soil sampling.

Soil samples were collected south of the tailing facility to evaluate ephemeral drainages from the tailings dam, irrigation ditches (*acequia*), and irrigation laterals. Soil samples were also collected as part of the drive point sampling effort near the 002 Outfall. Samples were only collected from the 0-6 inch interval.

5.8.1.3 Red River and Riparian Areas

Soil samples were collected in riparian areas along the Red River in the vicinity of the mine site and tailing facility. Reference background soil samples were collected from three areas: (1) along the Red River above the mine site, (2) along upper Cabresto Creek north of the mine site, and (3) along lower Cabresto Creek. These areas were selected because they are similar to riparian areas at the Site.

5.8.1.4 Riparian Areas at Campgrounds and Recreational Areas

Riparian soil samples were collected at the Goathill Campground along the mine and the Eagle Rock Lake recreational area in the vicinity of the mine site. Two campgrounds (June

Bug Campground and Fawn Lake [currently Elephant Rock] Campground) located adjacent to the Red River and upstream of the mine site were sampled as reference background areas.

5.8.2 Surface Water and Sediment Sampling

Surface water samples were collected for analysis from streams, lakes, ponds, unique habitats (beaver ponds), storm water catchments, irrigation ditches, irrigation return flow ditches, tailing impoundments and select reference background areas that had not be affected by mining operations.

The analytical parameters selected for analysis of surface water and sediment samples generally included metals, inorganic chemicals, biological oxygen demand and chemical oxygen demand, hexevalent chromium, particle size distribution, acid volatile sulfide/simultaneously extracted metal (AVS/SEM), VOCs/SVOCs, PCBs, explosives, and dioxins/furans.

5.8.2.1 Seasonal Surface Water and Sediment Sampling Events

Surface water and sediment samples were collected from multiple sites on the Red River and Cabresto Creek during four seasonal sampling events. The Red River sampling sites were located from its headwaters, past the mine site and tailing facility to the Red River State Fish Hatchery, a distance of over 11 river miles. The sampling sites were selected utilizing a biased sampling design in order to supplement historic data and to target points above and below inflows to the river, such as seeps, springs, drainages, and major tributaries. A subset of the surface water sampling sites was co-located with sediment sampling sites and aquatic biota sampling sites. The sediment samples included both riffle and depositional sediment samples. Reference background sampling locations are those stations located on the Red River above the mine site and on Cabresto Creek.

Seasonal surface water and sediment sampling events were conducted to evaluate various hydrological conditions at the Site during low flow, low flow pre-snowmelt, and low flow post-snowmelt. The following sampling events were conducted:

- <u>Fall 2002 Low Flow (September 26 – October 9):</u> Severe drought conditions existed in much of the semi-arid west in the spring and summer of 2002. The flow in the Red River was at its lowest level in many years during the month prior to sampling. Flow recorded at the USGS gage near the Questa Ranger Station for August was below 5 cubic feet per second (cfs), where average daily flows are typically about 40 cfs (based on 72 years of record for the USGS gage). Several rain events in early September brought the base flow in the Red River to above 10 cfs. A rainstorm which occurred a week before sampling resulted in a debris flow within the Hottentot Creek drainage that produced enough sediment to reach and temporarily dam the Red River. When the river cut through the dam, sediment was washed downstream for 3-4 miles, such that most cobbles and boulders in the streambed were embedded with silt and very fine sand.
- <u>Spring 2003 Low Flow Pre-Snowmelt (March 20-23):</u> Stream flow at the USGS gage ranged from 11 to 14 cfs.
- <u>Summer 2003 Low Flow Post-Snowmelt (July 8-16):</u> Stream flow at the USGS gage ranged from 18 to 26 cfs.
- <u>Fall 2003 Low Flow (September 21- 27):</u> Stream flow at the USGS gage ranged from 18 to 21 cfs.

5.8.2.2 Snowmelt Runoff and Rainstorm Events

Surface water samples were collected during snowmelt runoff and rainstorm events at five sites on the Red River using automatic Instrumentation Specialties Company (Isco) samplers. One sampler was positioned upstream of the mine site, two along the mine site, and one downstream of the mine site. The last sampler was located about one mile downstream of the tailing facility. The sampler positioed upstream of the mine site was in an area with scar-impacted drainages.

Sampling during rainstorm events was conducted to evaluate water quality changes as Red River flows past the mine site and tailing facility under high-flow events. Each Isco sampler was equipped with a sensor to trigger sampling when the river stage increased by 0.2 feet. Once the sampler was activated, surface water samples were automatically collected every 30 minutes for four sampling events over a period of two hours. Additional samples were collected at each event for acute toxicity testing.

Four storm events were sampled from July through September 2003. A substantial rainstorm event occurred a few days after storm sampling had been completed for the RI. It was a larger event than the previous four storm events that had been sampled. Although the samplers had not been reset with new bottles, Molycorp was able to collect a sample from the site upstream of the mine, as well as from the mouths of Hanson Creek and Hottentot Creek (scar-impacted drainages) about 12 hours after the event to assess the potential lingering affects to water quality.

5.8.2.3 Additional Quarterly Sampling

At several sites located on the Red River, mine site catchments, and the tailing impoundments, additional surface water samples were collected quarterly during the RI period to satisfy compliance monitoring requirements of NMED discharge permits DP-1055 and DP-933.

5.8.2.4 Red River Sampling Near Springs 13 and 39 Collection Systems

Additional Red River sampling was performed near the Spring 13 and Spring 39 collection systems from February 2003 through September 2004 to evaluate the effectiveness of the systems in removing metals loading of the river.

5.8.2.5 Red River Sampling for Stable Isotope Analysis

In February and April 2004, six of the Red River surface water sampling sites and one additional site on Columbine Creek located at the confluence with the Red River were sampled for analysis of stable isotopes of hydrogen (^{2}H or deuterium) and oxygen (^{18}O). The sampling was performed in conjunction with ground water sampling for isotope analysis. These isotopes were evaluated to help determine origin of the water and nature of contamination.

5.8.2.6 Irrigation Ditch Sampling

Several irrigation ditches divert water from the Red River or Cabresto Creek. These ditches were sampled for surface water and sediment during the four seasonal sampling events if they were flowing at that time. Ditches diverting water from the Red River that were sampled are the North Ditch (also known as Embargo Road Ditch), Central Ditch (also known as Middle Ditch), and South Ditch (also known as South Side Ditch). The Cabresto Ditch No. 4, which diverts water from Cabresto Creek, was also sampled. Surface water and sediment samples were collected from the ditches just downstream from the point of diversion (head gate).

Additional sampling of the South Ditch, North Ditch and lower Cabresto Creek was conducted by EPA in August 2005 in response to concerns of a village of Questa resident regarding the quality of his irrigation ditch water. The resident reported sheens on the ditch water. The property was located in the area south of Dam No. 1. Surface water and sediment samples were collected from eight locations. Sample analyses included DRO and GRO compounds.

The area south of the tailing facility is used for flood irrigation. This area is also the terminus for the North Ditch where non-diverted irrigation water flows onto pastures bordering the Red River. A high-water table condition in this low-lying area results in the irrigation return water entering into the Red River via small ditches and overland flow.

Two of the irrigation return-flow ditches were sampled: one located approximately 400 feet upstream of CMI's Outfall 002 pipe; the other 100 feet downstream of the pipe.

5.8.2.7 Lakes, Ponds, and Unique Habitats

Surface water and sediment samples were collected from Eagle Rock Lake, upper Fawn Lake, Hunt's Pond, and several beaver ponds on the Red River. Upper Fawn Lake is located upstream of the mine site and, like Eagle Rock Lake, receives its water from the Red River. It was sampled to provide a reference for Eagle Rock Lake. Each lake was sampled at three locations: at littoral areas near the inlets and outlets, and in the middle of the lakes. Samples were collected during the four seasonal sampling events.

Hunt's Pond is located along the Red River in the southeastern portion of the village of Questa. It is also located in close proximity to the tailing pipeline. Past breaks in the pipeline resulted in tailing spills in and near Hunt's Pond. Surface water was sampled as part of the historical tailing spill investigation required by the NMED Ground Water Discharge Permit DP-933 (see Other Related Studies, Section 5.8.13, below).

Beaver dams have formed ponds or "unique habitats" within the Red River channel. Two general areas of ponded surface water and sediment were sampled, one along the mine site near Spring 39 and the other along the tailing facility at two locations: the first about 500 feet downstream of Hunt's Pond, the second approximately 100 west of the Outfall 002 pipe. The samples were collected in March and/or September 2003.

5.8.2.8 Mine Site Storm Water Catchments

The mine site storm water catchments temporarily collect seepage and storm water runoff from waste rock piles, other storm water runoff, and water from snowmelt. Catchment water was sampled from seven sites when water or seepage was found to flow or pond for more than 24 hours. Most of the catchments were sampled in September 2003, and fewer catchment sites were sampled during the other sampling events.

The catchments at the mine site that were sampled include:

- Upper Capulin Catchment;
- Capulin Catchment Discharge at Goathill Gulch;
- Mill area;
- Sugar Shack West;
- Goathill Gulch Catchment;
- Lower Goathill Gulch;
- Lower Capulin Canyon.

5.8.2.9 Tailing Impoundments

The tailings impoundments are operational ponds that impound decant water and tailing. Four operational ponds were sampled for surface water and sediment at multiple locations in fall 2002 and February 2003. Several addition surface water and sediment samples were collected near the tailing discharge pipe to satisfy requirements specified in DP-933.

5.8.3 Ground Water Sampling

The initial ground water sampling strategy was to collect water quality and hydrogeology data from all water bearing zones at both the mine site and tailing facility to determine nature and extent of ground water contamination.

Ground water data were collected from monitoring wells, water supply wells, extraction wells, piezometers, private wells, the underground mine workings, seeps and springs, and spring collection systems. Ground water was also collected from reference background areas not affected by CMI mining operations.

A significant number of monitoring wells had been constructed at both the mine site and tailing facility prior to the start of the RI. Most of the existing monitoring wells were utilized for collection of RI ground water data (some were dry), while several new monitoring wells and piezometers were installed to address data gaps. During the RI, ten new monitoring wells were installed at the mine site; 16 new monitoring wells, 11 piezometers and one borehole were installed at the tailing facility, including five monitoring wells along the eastern boundary to address data gaps after concerns were raised by the Village of Questa for potential seepage migration to the east of the tailing facility.

Ground water sampling was performed for the RI from fall 2002 through June 2006. Quarterly sampling at all locations was performed, which totaled (typically) 150 wells and springs at the mine site and tailing facility. Monthly sampling of a reduced number of locations was also performed. Quarterly sampling at all locations continued after June 2006 for compliance monitoring under New Mexico discharge permits DP-1055 and DP-933. For select areas at the Site, water chemistry data from the compliance monitoring program through 2008 have been included in the RI Report (URS 2009a) as upward trends in contaminant levels at the tailing facility increased significantly from 2006 to 2008.

The objectives of ground water sampling were to:

- Define the ground water chemistry and temporal variations for all aquifers and water-bearing units;
- Provide ground water quality information for areas downgradient of suspected sources, such as waste rock and tailing;
- Determine the horizontal and vertical extent of migration of ground water contamination;
- Distinguish mining-related sources of ground water contamination from natural sources such as scars, if possible, based on analysis of water chemistry, isotopes, rare earth elements, and colloidal borescope data;

- Provide information to evaluate the effectiveness of corrective measures, such as the seepage collection systems at the mine site and extraction well system at the tailing facility;
- Provide analytical data suitable for use in assessing risk to human health and the environment from exposure to ground water;
- Define ground water chemistry in reference background areas.

Ground water sample analyses included primarily metals and inorganic chemicals. However, for those areas at the mine site with independent sources that could potentially contaminate ground water (truck shop, a former explosives storage area, former and current landfills), ground water samples were also analyzed for VOCs, SVOCs, and explosives. Radionuclides were not initially included with the ground water sample analyses.[21] However, after concerns were expressed by the community and the Village of Questa, EPA and NMED agreed to include analysis for uranium in water samples collected from residential taps, private wells, monitoring wells, and the NPDES-permitted Outfall 002 at the tailing facility.

5.8.3.1 Mine Site

The strategy for ground water sampling at the mine site focused on characterizing bedrock, colluvium, and Red River alluvium water quality and distinguishing between mining-related and naturally-occurring sources of ground water contamination. It was recognized early in the investigation that the most significant potential sources of ground water contamination were likely the massive waste rock piles located within the steeply incised side drainages and the naturally-occurring scar material (some of which was present beneath certain waste rock piles). An emphasis was placed on collecting ground water samples from wells in the Red River alluvial aquifer upgradient and downgradient of the mouths of the side drainages, as well as in the colluvial and bedrock water-bearing units

[21] Climax-type porphyry molybdenum deposits such as the Questa molybdenum ore deposit can contain elements such as uranium and thorium (Plumlee et al. 1999).

within the side drainages, including beneath and at the toes of waste rock piles and within the massive Goathill Debris Fan located downgradient from the Goathill Scar. Alluvial/bedrock and colluvial/bedrock well pairs were used to understand the hydraulic relationship of the Red River alluvial aquifer or colluvial water-bearing unit to the underlying bedrock water-bearing unit (as measured by potentiometric head).

5.8.3.1.1 Monitoring and Ground Water Withdrawal Wells

All mine site monitoring wells with sufficient water within the wellbores were sampled. The ground water withdrawal wells installed near the roadside waste rock piles as part of the NPDES Best Management Practices were also sampled. Eighteen USGS wells installed in colluvium and Red River alluvium at Straight Creek, LaBobita, Hansen, and Hottentot drainages located upriver from the mine site, and in colluvium and bedrock at Capulin Canyon were sampled as reference background wells.

5.8.3.1.2 Seeps and Springs

Ground water sampling included all seeps and springs at the mine site and a spring upstream of the mine site for reference background water quality. The springs represent ground water at places of upwelling. Ground water at the Spring 13 and Spring 39 collection system pumps were also sampled, as well as the four shallow piezometers installed at Spring 13 as part of the design of the Spring 13 collection system. Water samples were collected from the following seeps and springs:

- Capulin Spring
- Goathill Spring
- Goathill Gulch Seep
- Spring 13
- Lower Spring 13
- Spring 14-M
- Spring 14-MA
- Spring 15-M
- Spring 39
- Upper Spring 39

- Cabin Spring
- Portal Spring
- Shaft Spring
- Waldo Spring, located two miles upstream of the mill

5.8.3.1.3 Underground Mine Workings

Ground water sampling was performed in the underground mine workings.

5.8.3.1.4 Supply Wells at Campground Sites

Supply wells were sampled at Fawn Lake, June Bug, Elephant Rock, Columbine, and Eagle Rock Lake campgrounds.

5.8.3.1.5 Private Wells

Private wells located at cabins along the Red River in the Columbine Park area were sampled. The private cabins were eventually bought by CMI and demolished.

5.8.3.1.6 Questa Ranger Station

The alluvial well at the Questa Ranger Station was sampled. The Questa Ranger Station is located downstream from the mine site.

5.8.3.1.7 Town of Red River

Tap water samples were collected at three condominiums in the town of Red River (Ponderosa, Swiss Mountain 5, and Flag Mountain 9). Water samples were also collected at two monitoring wells located at the town of Red River Waste Water Treatment Plant.

5.8.3.1.8 Isotopes, Lanthanides, Tritium, and Helium Analyses

In early 2004, select wells were sampled and analyzed for lead and sulphur isotopes and lanthanides to lend insight into potential source areas at the mine site. At the same time, select wells, seeps and underground locations were sampled and analyzed for stable isotopes of oxygen (^{18}O) and hydrogen (^{2}H or Deuterium) to evaluate the similarities or dissimilarities in physical processes of water recharging at these locations. Samples were also collected from several wells and springs for analyses of tritium and helium to estimate the age of the water.

5.8.3.1.9 Hydraulic Testing

Hydraulic testing consisting of slug and pumping tests were conducted at wells located in Sulphur Gulch, the Middle waste rock pile, and the Goathill Debris Fan within Lower Sulphur Gulch.

5.8.3.1.10 Colloidal Borescope

A colloidal borescope investigation was performed at three monitoring wells located at the mine site in May 2004. The borescope was used to estimate the direction of ground water flow within the wells. The wells selected for the investigation were located at the M&E area, toe of the Sugar Shack West Waste Rock Pile, and the Middle Waste Rock Pile.

5.8.3.2 Tailing Facility

Ground water sampling was performed at monitoring wells, extraction wells, drain collection systems, springs, and the permitted 002 Outfall to characterize the alluvial and the volcanic bedrock aquifers at the tailing facility.

5.8.3.2.1 Monitoring Wells

All existing and new monitoring wells located around the perimeter of the tailing facility as well as within the impoundments were sampled. The wells located upgradient and to the north of the facility were used for collecting reference background water quality data.

5.8.3.2.2 Piezometers South of Tailing Facility

Several temporary piezometers (some in pairs of varying depths) were installed south of the tailing facility to help define the potentiometric surface and ground water flow direction, horizontal and vertical hydraulic gradients, and to assess the potential impact of inferred faults on the horizontal and vertical flow of ground water in the vicinity of the tailing facility. Some of these piezometers were sampled as a one-time event in 2003. Sampling of temporary piezometers was not part of the monthly or quarterly sampling programs.

5.8.3.2.3 Seeps and Springs

Water samples and flow rates were collected from the following seeps and springs during the RI:

- Two historical seeps located on the western and eastern abutments of Dam No. 1A (West Seep and East Seep)
- Seeps upstream of the 003 Outfall seepage barriers (003 East Seep and 003 West Seep) and at their confluence within the 003 Outfall pipeline (Confluence 003East/003West)
- Springs 7 and 8, located near the 002 Outfall
- Springs 9 and 9(A)

- Spring 10
- Springs 12 and 12(A)
- Spring 17 – Located south of Dam No. 1 in the low-lying pastureland near the Red River
- Spring 18 – Located at the Red River State Fish Hatchery
- Embargo Road Seep – Located along the drainage leading from the seepage interception system, on the south side of Embargo Road

5.8.3.2.4 Drive Point Sampling South of Tailing Facility

After conducting door-to-door interviews with local residents in the fall 2002, EPA became concerned with potential soil, vegetation, and ground water contamination in the area south of the tailing facility due to alleged historic spills/runoff from the tailing facility and tailing seepage to ground water. Additional sampling was performed in November 2003 and May 2004 to characterize the area south of the tailing facility. Because the water table is only 0.5 to 1.0 foot below ground surface, shallow drive points were installed for sampling ground water in the low-lying pastureland near the Outfall 002 pipe. Soil and vegetation samples were co-located with each drive point sample.

5.8.3.2.5 Outfall 002

Water at Outfall 002 is comprised of ground water from the seepage collection systems (extraction wells and drains) located south of Dam No. 1 and east of Dam No. 4. Sampling of Outfall 002 included the discharge point and at the Outfall 002 well, which is at the collection cistern (manhole).

5.8.3.2.6 002 Outfall Pumpback System

In April 2004, the newly installed Outfall 002 Pumpback System was sampled. The system pumps a portion of the seepage collected by the extraction wells and seepage barrier systems back to the tailing facility behind Dam 5A to allow CMI to meet NPDES permitted discharge limits for manganese at the Outfall 002 pipe. Water samples were collected within the system near the Outfall 002 manhole and at the end of the pipeline near Dam 5A.

5.8.3.2.7 Residential Taps and Private Wells

In September 2003, the NMED Drinking Water Bureau conducted sampling of residential taps at several homes connected to the Village of Questa municipal water supply. EPA split samples with NMED for an independent analysis at the request of residents. The Village of Questa also collected tap samples at several commercial properties and residences. The residents requested sampling at the tap due to concerns about tailing being used as bedding for municipal water supply pipes and the potential for sloughing of tailing into cracked water lines. The analytical results of the residential tap water samples are contained in the public health assessment for the Site (ATSDR 2005).

EPA sampled seven private wells in July 2005 at the request of the Village of Questa residents. These requests were the result of an offer by EPA to sample any private well located within two miles of the tailing facility (and the mine site) to address concerns of exposure to ground water contamination raised by the community.[22]

[22] It is noted that more than twenty other residents informed EPA that they wanted their private wells sampled, but did not want EPA to conduct the sampling. The Village of Questa offered to conduct the sampling. However, EPA is not aware that such sampling was ever conducted.

5.8.4 Vegetation Sampling

Two vegetation studies were conducted: the RI vegetation sampling described here and the Wildlife Impact Study described in Section 5.8.13.1, below. The Wildlife Impact Study was a study of plant uptake of metals at the tailing facility performed under the direction and oversight of MMD. It was designed to address toxicity and bioaccumulation potential for molybdenum and other metals. Both the RI and Wildlife Impact Study include tissue and soil sampling, but they are specifically different from one another. The Wildlife Impact Study methods were not included in the RI Work Plan as it was already being conducted, but the data are incorporated into and support the RI.

The RI vegetation sampling was conducted at mine site soils and scars, tailing facility, and riparian areas near both the mine site and tailing facility. EPA also sought to collect vegetation samples from mine site waste rock piles for evaluation of metals uptake. However, this was not done due to an apparent lack of vegetation growing on the waste rock piles, as verified by the field reconnaissance team. The lack of plant tissue data from vegetation growing on rock piles for assessment of metals uptake is recognized as a data gap by EPA.[23]

The purpose of the vegetation sampling was to evaluate the potential effects of mine soil on plants and vegetation communities and the potential effects to humans or animals that may consume the vegetation. Vegetation sampling was conducted for chemical analysis of upland and riparian plant communities, measurement of plant community structure and composition in the field, rye grass bioassay studies, and chemical analysis of edible riparian plants and garden produce.

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[23] After the RI data collection effort was completed, CMI's consultant, Buchanan, indicated to EPA and the state regulatory agencies that trees are successfully growing in acidic waste rock at the mine site. Subsequently, under the direction of MMD, Buchanan conducted a Root Zone Evaluation on trees growing on the waste rock piles (see Section 2.4.5.6). At the time the Root Zone Evaluation was performed, MMD also discussed with CMI about the need to collect tissue samples of trees rooting in waste rock for metals analysis. However, MMD has yet to require CMI to perform such analysis.

5.8.4.1 Upland and Riparian Plant Sampling

Vegetation samples at upland and riparian areas were collected for chemical analysis and compared to reference background data to determine if plant tissue had elevated concentrations due to mine-site related activities, as well as to estimate Site-specific uptake factors. Data were also used to predict risk due to the dietary ingestion pathway.

Vegetation sampling was focused on areas of the Site that were likely to have completed exposure pathways for populations of terrestrial receptors (*i.e.*, areas of terrestrial habitat). Therefore, no soil samples were collected for the rye grass bioassay for the mill area, administrative and M&E area, waste rock piles, open pit, and other independent source areas because these areas were affected by mining-related activities, had little or no flora populations, and could not support terrestrial habitat. Additionally, no plant tissue samples were collected in those areas to assess metals uptake due to lack of vegetation.

Vegetation samples were co-located with surface soil samples and small mammal sampling sites. All sampling sites were pre-located using a randomization process described in the Field Sampling Plan (FSP; URS 2007b). For vegetation sampling and plant community characterization, the samples sites were 300 feet by 300 feet in dimension. Samples were collected of one shrub, one forb, and one grass species at each sampling site. Because plants bioaccumulate metals and sequester them differently between roots and above-ground plant parts, each plant was divided into two tissue samples: aboveground (leaves, fruit, seeds, and small stem/branches) and below ground (roots). All samples consisted of unwashed vegetation, except for the area south of the tailing facility. In that area, vegetation samples included both unwashed and washed.

Mine site and riparian data were collected in the fall 2002. Tailing facility data were collected in spring 2003 and south of the tailing facility area data in spring 2004. Terrestrial vegetation samples were analyzed for target analyte list (TAL) metals, plus boron and molybdenum, and percent solids.

5.8.4.2 Plant Community Structure Measurements

Plant community characterization was performed at the same time as random plant sampling. Plant community characterization used point-intercept transects to evaluate plant cover and ground surface cover and wandering surveys to locate additional species in the sampling site, but not recorded on the transects.

5.8.4.3 Rye Grass Soil Bioassay (14-day)

Metals or other chemicals in soil can influence the survival and growth of rye grass (*Lolium perenne*), thus making a soil bioassay a direct measure of toxic effects due to exposure. Rye grass can be considered as representative for other plants that occur in the Site vicinity. A 14-day germination and growth assay of site soils and reference soils was conducted using perennial rye grass in the fall 2002 and spring 2003. It is noted that the soil sampling sites do not include any from the mine site waste rock piles. Such sampling was not performed because it was anticipated that the rye grass study would show plant toxicity in soil with a pH below 5.0. Most of the surface soil on the waste rock piles is known to exhibit pHs below 5.0. It is also noted that, in accordance with the standard rye grass bioassay method, the soil pH was adjusted if below 6.0. Therefore, this standard test design was not adequate for assessing mine-related pH toxicity on plants. Because it is recognized that there is the potential for mine-related pH toxicity, in addition to metals toxicity, to be associated with acid-generating or potentially acid-generating waste rock and tailing, the results from the rye grass bioassays must be interpreted with caution.

5.8.4.4 Edible Riparian Plant Sampling

Two species of edible plants were selected for sampling based on field reconnaissance: wintercress (*Barbarea vulgaris*), an edible leafy green, and chokecherry (*Prunus virginiana*), an edible berry used in jam, jelly, and similar products. These species were sufficiently common and widely distributed to be sampled at the riparian areas, and they were good quality and common edibles likely to be used regularly. They were sampled in

June and August 2003. The edible riparian plant samples were analyzed for the TAL metals, plus boron and molybdenum, and percent solids.

5.8.4.5 Garden Produce Sampling

Garden produce samples were collected to evaluate the potential uptake of metals in vegetables from soil or irrigation water used in residential gardens near the tailing facility. Three gardens located in close proximity to the tailing facility were chosen for sampling: one each to the north, east, and south of the facility. Two reference gardens that would not be affected by mining-related activities were also sampled.

The garden produce was sampled in August 2003. Green beans, lettuce, and zucchini were selected for sampling because they were common to more than one garden and were sampled in each garden where available. The vegetable samples were analyzed for TAL metals, plus boron and molybdenum, and percent solids. Composite soil samples were collected in the gardens to the depth of the roots (about 8 inches). A sample of the irrigation water that constituted the primary water source at each garden was also collected for analysis. The source of water for the three Site gardens was irrigation water diverted from the Red River or Cabresto Creek. Both the reference gardens were irrigation with ground water. With one exception, the water samples were collected at the same time as the vegetable and soil samples.

The owners of the gardens were also interview regarding their gardening techniques, the application of pesticides and fertilizers, and the consumption of home grown produce through the year.

5.8.5 Animal Sampling

Small mammals and invertebrates were sampled for analysis of tissue metals to evaluate the potential effects to higher trophic-level species that may consume them. Sample collection included small mammals, soil for earthworm bioassay, and soil for fauna community structure analyses. Metals or other chemicals in soil can influence the survival of earthworms, thus making a bioassay a direct measure of toxic effects due to exposure. Earthworms were considered a representative for other soil invertebrates that occur in the Site vicinity.

Similar to the vegetation sampling strategy, effort to characterize terrestrial animals were focused on areas considered likely to be terrestrial habitat. Therefore, no soil samples were collected for the earthworm bioassay (toxicity testing) at the mill, administration area, waste rock piles, open pit, and other mine site independent source areas.

Small mammal and terrestrial invertebrate sampling was performed in fall 2002 and spring 2003.

5.8.5.1 Mine Site Animal Sampling

Small mammal trapping sites and terrestrial invertebrate sampling sites were established at 10 random locations within soil investigation areas for upland and riparian habitats, and co-located with soil and vegetation sampling. At the toe of the waste rock piles, a focused bioaccumulation study was performed on five small mammal samples for uptake of metals. Two reference background areas were selected for the upland areas of the mine site: above the mine site and within the upper Cabresto Creek area. The reference background areas for the mine site riparian were along the Red River above the mine site and along upper Cabresto Creek.

5.8.5.2 Tailing Facility Animal Sampling

Ten randomly located small mammal trapping sites and terrestrial invertebrate sample sites were established at the tailing facility. Additionally, 10 randomly located sample sites were located along the Red River within the riparian zone near the tailing facility. The reference background area for the tailing facility upland area was north of the village of

Questa, at Cater Ranch (a property owned by CMI). The reference background riparian area selected was along lower Cabresto Creek.

5.8.5.3 Earthworm Bioassay (28-day)

Soil samples were collected for earthworm bioassay at those areas considered likely to be habitat for terrestrial receptors. Those areas affected by mining-related activities that no longer supported terrestrial habitat were considered not to have completed exposure pathways for populations of terrestrial receptors. Additionally, it was assumed that soil samples from the waste rock piles would show toxicity to earthworms in soil samples with a pH below 4.0. Much of the surface soil on the waste rock piles is known to exhibit pHs below 4.0.

Earthworm bioassays were conducted for a period of 28 days to assess potential mine-related metals toxicity in Site soils. Measurement endpoints for the assay were survival, growth and reproduction. It is noted that, similar to the rye grass bioassays, pH adjustments were made to soil samples for earthworm bioassays if the soil pH fell outside the allowable range for the standard method. Therefore, this test design was not adequate for assessing mine-related pH toxicity. Because it is recognized that there is the potential for mine-related pH toxicity, in addition to metals toxicity, to be associated with acid generating or potentially acid generating waste rock and tailing at the Site, the results from the earthworm and ryegrass bioassays must be interpreted with caution.

5.8.5.4 Soil Fauna Community Structure

Bulk soils were collected for soil fauna community structure analyses from locations adjacent to the locations sampled for earthworm bioassays. Soil samples were collected at a depth of 0 to 2 centimeters (cm) from a 2,500 square centimeter (cm^2) area.

5.8.5.5 Waterfowl Sampling

The sampling of waterfowl was planned to evaluate potential risk to humans and animal predators that might consume waterfowl. It was determined that fledglings would have the longest Site-related exposure duration and greatest likelihood of significant bioaccumulation of metals from the tailing ponds. Adults would likely be migratory and tissue metals concentrations less likely to spatially correlate with tailing ponds.

To obtain fledgling waterfowl, nest surveys were conducted from spring to late summer 2003 to determine where and when fledging waterfowl would be present.

5.8.6 Aquatic Biota Sampling

Aquatic receptors for the Site are, for the most part, associated with the Red River. However, aquatic receptors also occur in and around Cabresto Creek, Eagle Rock Lake, upper Fawn Lake, Hunt's Pond, and the tailing ponds.

Sampling of various aquatic biota components was conducted for the RI to evaluate potential impacts to aquatic life in these surface water bodies. The approach used for aquatic biota sampling was line-of-evidence, thus multiple measures were required to quantify risk. Aquatic biological sampling of fish, benthic macroinvertebrates, macrophytes, and periphyton were conducted at numerous locations, including the Red River, Red River State Fish Hatchery (fish only), Eagle Rock Lake, upper Fawn Lake, tailing ponds, and beaver ponds.

Biota samples included population community samples and tissue samples for analysis of metals concentrations. Results were used to assess exposure and risk to the aquatic biota themselves and to assess the aquatic biota tissue as exposure media to higher-order predators. Sampling locations were chosen using a biased sampling design to evaluate areas upstream, adjacent to, and downstream of potential mine-related sources. Sampling locations also incorporated existing sampling stations used by Molycorp to study benthic invertebrate populations in the Red River and Cabresto Creek near the mine site.

All aquatic sampling stations (with the exception of the Hatchery) included surface water and sediment sampling so that the results of the aquatic analyses could be correlated with the results of the abiotic sample analyses.

5.8.6.1 Population Analyses

Community/population analyses were conducted to assess the potential effects on the community structure in the water body.

5.8.6.1.1 Fish Populations

The fish community in the vicinity of the Site is not diverse. The most abundant resident species is the non-native brown trout (*Salmo trutta*). Second most abundant is the stocked, hatchery-raised rainbow trout (*Oncorhynchus mykiss*). Relatively few white suckers (*Catostomus commersoni*) are also found within the Site, primarily in upper Fawn and Eagle Rock Lakes. A few brook trout (*Salvelinus fontinalis*) have been found in Cabresto Creek and within the upper reaches of the Red River. Some Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*) have been identified upstream of the town of Red River. Cutthroat/rainbow hybrid trout have also been identified near the headwaters, upstream of the town of Red River, and are abundant in Cabresto Creek.

Fish population data were collected from all stream sites in fall 2002 and fall 2003. The section of stream sampled at each site was chosen to be representative of the habitat present in that reach of stream, in terms of habitat features, such as pool/riffle ratio, shading, and bank stability. Sites were of sufficient length to obtain a representative section of the available habitat features, and ranged from 250 to 500 feet in length.

Fish populations were sampled in Eagle Rock Lake and upper Fawn Lake in fall of 2002 and 2003. Attempts were made to collect fish in the east tailing pond site in fall 2002. No fish could be collected in the pond, thus no attempt was made to collect fish in 2003.

All fish sampled were identified, counted, measured for length, weighed, and released. This sampling strategy provided for species lists, estimates of density (number of fish per mile, number of fish per acre), biomass (lbs/acre), condition factors, and the size structure of the fish community.

5.8.6.1.2 Benthic Invertebrate Populations

Prior to the start of the RI, benthic invertebrate population sampling was conducted at several Red River and Cabresto Creek sampling stations by Molycorp, starting in 1997. The sampling stations established for the RI in 2001 included those historical sampling sites, plus additional sites. Benthic invertebrate sampling for the RI was conducted every fall and spring, beginning in fall 2002 and continuing through fall 2005.

Benthic macroinvertebrate populations were sampled at all stream sites. These samples were used to determine community structure using a specific set of abundance and diversity metrics. Benthic macroinvertebrate populations were sampled in all the lakes, tailing ponds, and unique habitats (beaver ponds) in fall 2002 and in spring and fall 2003.

The population analysis provided species lists, estimates of density (numbers per square meter), and the total number of taxa present.

In mountain streams, such as those near the mine site, the presence of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa (collectively referred to as the EPT taxa) can be used as an indicator of water quality. These insect groups are considered to be sensitive to a wide range of contaminants. Stress to aquatic systems can be evaluated by comparing the number of EPT taxa and the percent of EPT taxa between unimpacted and potentially impacted sites. Impacted sites would be expected to have fewer EPT taxa and a lower percent of EPT taxa compared to unimpacted sites.

Since stoneflies are relatively rare in lakes, the number of EPT taxa was changed to the number of ETO taxa, with stoneflies replaced by dragonflies and damselflies (Odonata), which are also sensitive to acid and metals stress. Percent ETO taxa effectively replaced the percent EPT taxa parameter in lake analyses. Additionally, the percent of total density as mayflies was not used in lakes. Rather, the number of Crustacea and Mollusca taxa and the percent of total density as Crustacea and Mollusca were used as indicators of acid and metals stress.

5.8.6.2 Tissue Analyses

Tissue analyses were performed to assess the bioaccumulation of metals and bioaccumulative organic compounds from sediment and water and the subsequent ingestion of aquatic organisms by predators. Tissue analyses were also used to assess toxicity to the aquatic biota that corresponds to tissue levels of chemicals.

5.8.6.2.1 Fish Tissue

Attempts were made to collect fish for tissue analysis of metals concentrations from all stream and lake sites in fall 2002 and fall 2003. Target samples for each stream and lake site were adult brown trout and adult rainbow trout, juvenile brown trout, and young of the year (YOY) brown trout. Juvenile and adult white suckers were included for tissue analysis in lakes because brown trout were rare or absent in lakes. Attempts were made to collect fish in the east tailing pond in fall 2002 for fish tissue analysis of metals concentrations. No fish were collected, so attempts were not made to collect fish in the tailing pond in 2003. Not all sample targets could be met at each stream and lake site.

5.8.6.2.2 Benthic Invertebrate Tissue

Benthic invertebrate tissue samples were collected from all stream and lake sampling sites. Macroinvertebrate samples were collected from the tailing pond and unique habitat (beaver pond) sites. All samples were collected in fall 2002 and spring and fall 2003. Composite macroinvertebrate samples were analyzed for metals.

5.8.6.3 Habitat Evaluation

Fish habitat measurements for the RI were taken from all stream sites concurrently with the fish and macroinvertebrate population sampling in the fall 2002 and 2003. Habitat continued to be evaluated in the spring and fall of 2004. Some habitat measurements conducted in 1999 by Molycorp were also incorporated into the RI.

Evaluation of habitat was made using a set of parameters developed and agreed upon by EPA, USFWS, NMED and Molycorp during Site reconnaissance in August 2002. Individual habitat units were identified using the classification developed by the U.S. Forest Service.

Measurement within each habitat unit included length, wetted width, maximum depth, residual pool depth, average depth, habitat quality rating, percent fines by area (visual estimation) and percent fines by grid, and embeddedness. The habitat quality rating is a subjective score ranging from 1 (very poor) to 5 (very good). It was based on an overall assessment of the habitat unit to support fish and benthic invertebrates using the parameters discussed above, as well as suitable trout cover, bank stability and other factors.

5.8.6.4 Periphyton Populations

Periphyton was collected for population analysis at all stream sites in fall 2002 and fall 2003. This analysis provided species lists and relative abundance of the various periphyton taxa.

5.8.6.5 Bryophyte, Macrophyte, and Periphyton Tissue

Originally, aquatic macrophytes were intended to be used for plant tissue analysis. However, due to the rarity of rooted macrophytes in the Red River watershed, aquatic byrophytes (mosses, hornworts, and liverworts) were collected from most sites.

Byrophytes were collected for metals analysis at all stream sites. Periphyton (algae) tissue samples were collected from all lake, tailing pond, and unique habitat sites. Tissue samples were collected in fall 2002 and fall 2003 and analyzed for metals.

5.8.6.6 Surface Water and Sediment Bioassays

Bioassays were performed to test the toxicity of water and sediment on standard test fresh water aquatic organisms. Surface water bioassays were conducted using laboratory toxicity tests with Site surface water and commonly used test organisms. Surface water samples were collected during base flow, snowmelt runoff, and storm water runoff events to test the chronic or acute toxicity to *Ceriodaphnia dubia* (*C. dubia*) or fathead minnows (*Pimephales promelas*).

The measurement endpoint for acute *C. dubia* 48-hour toxicity tests was morality; for full dilution series chronic *C. dubia* 7-day toxicity tests, the endpoints were mortality and reproduction. Measurement endpoints for the chronic Fat Minnow 7-day tests included mortality, terata, and unhatched eggs.

Ten-day chronic sediment toxicity tests using *Hyalella azteca* and *Chironomus tentans* were conducted on samples collected from all aquatic sampling sites in streams and at sites in the lakes and tailing pond in fall 2002. Chronic sediment toxicity endpoints included mortality and growth.

5.8.7 Tailing Characterization

Tailing material was collected at the same 10 random sample locations in the tailing impoundment where surface soil was collected and analyzed for RI soil chemical parameters. Also, sediment samples were collected in the tailing ponds at the 10 random locations where surface water was sampled and analyzed for RI sediment chemical parameters. These sediment samples, which are discussed in Surface Water and Sediment Sampling, Section 5.8.2, are representative of tailing material.

The chemistry of the tailing solids was characterized in previous studies and additional samples were collected for further chemical characterization during the RI. The previous studies include SRK 1996, SRK 1997, and RGC 1998. They are summarized in the RI Report (URS 2009a) and RI/FS Work Plan (URS 2007a).

Analytical testing on surface and subsurface tailing samples included chemical analysis using ICP-mass spectrometry, petrographic analysis, acid-base accounting, toxicity characteristic leaching procedure (USEPA Method 1312 with liquid to solid ration of 1:1), SPLP, 20-week humidity cell tests, and enhanced oxidation tests to determine acid-generating capacity.

5.8.7.1 Tailing Solid – Currently Produced from Mill

Under the New Mexico Ground Water Discharge Permit DP-933, when the mill is operating, a sample of tailing solid is collected quarterly and tested for total metals concentrations, paste parameters and acid-base accounting. Samples of the tailing solid are collected before entering the tailing pipeline at the mill. These data were used in the characterization of the Site.

5.8.7.2 Tailing Pond Water

Under DP-933, tailing pond water is sampled and analyzed quarterly. These data were used in the characterization of the Site.

5.8.8 Waste Rock Pile Characterization

In April 2005, after performance of the initial RI sampling effort and summarization of the preliminary Site characterization, EPA directed CMI to conduct additional characterization of the waste rock piles as sources or potential sources of ground water contamination at the mine site.

5.8.8.1 Roadside Waste Rock Piles

The geotechnical stability evaluation performed by CMI's contractor, Norwest Corporation, in 2004/2005 on the roadside waste rock piles presented an opportunity to perform analytical testing on borehole drill cuttings collected from all three waste rock piles, as well as the underlying colluvium, bedrock, debris fan and hydrothermal scar material. EPA directed CMI to study the mineralogy and leachability of the drill cuttings and cores to provide some understanding of the water-rock interactions, the potential impact to ground water, and the source(s) of the ground water contamination beneath the roadside waste rock piles.

Characterization of the lower Goathill Gulch debris fan was included as part of this investigation. Samples were collected along the bank of the Goathill Gulch drainage near the administration building.

The objectives of the study were as follows:

- Characterize the geochemistry and mineralogy of the roadside waste rock piles and the surrounding lithologies (mine rock, scar, debris fan, colluvium, and bedrock);
- Determine the acid generating potential of these materials;
- Determine through analysis whether the roadside waste rock piles are contributing sources or potential sources of the metals and acidic contamination present in the ground water and surface water at the mine site;
- Evaluate whether the roadside waste rock piles are similar or different compared to all the other waste rock piles at the mine site, which themselves are sources or potential sources of ground water and surface water contamination.

Drill cutting samples were collected for analyses in July 2005. The samples selected were from various depths within the waste rock pile, including depths associated with the highest temperatures measured in the slope inclinometer boreholes by Norwest. Sample analyses included chemical analyses (paste pH, metals, and fluoride), acid-based accounting, leach tests, and mineralogy/petrography. Mineralogical characterization was conducted using x-ray diffraction, heavy mineral analysis, petrographic analysis, and polished thin sections. Paste pH and acid-base accounting investigations compliment the mineralogical characterization. Paste pH analysis gives an indication of the present balance and acidity and alkalinity of a soil or waste rock sample. It is used as a quick indication of whether a sample is presently forming acid. Acid-base accounting is a method of predicting whether the sample has the potential to generate acid in the future.

5.8.8.1.1 <u>Acid-Base Accounting – Static Testing</u>

Acid-base accounting measures both the acid generating potential, based on sulfur species, and the acid neutralization potential, based on titration with hydrochloric acid (HCL) and sodium hydroxide. The acid-base accounting test is called a “static” test because it measures the total amount of acid generating material and acid neutralizing material and assumes that both react to completion. It gives no indication of relative reaction rates.

Both acid-generating potential and acid-neutralizing potential are expressed in units of tons of calcium carbonate ($CaCO_3$) equivalent per kiloton of rock, typically abbreviated as t $CaCO_3$/kt or simply t/kt.

Two criteria are typically used as limits beyond which a rock is considered an acid generator based on acid-base accounting analysis, specifically the acid-neutralizing potential and acid-generating potential. The first criterion is the acid-neutralizing potential/acid-generating potential ratio. If the ratio is less than one, then the rock is considered potentially acid generating. If the ratio is three or greater, the rock is considered non-acid generating. If the ratio is greater than or equal to one and less than or equal to three, then the status of the rock is undetermined.

The second criterion is the net neutralization potential, which equals the acid-neutralizing potential minus the acid-generating potential. If the net neutralizing potential is less than -20 t/kt, then the rock is considered potentially acid generating; if it is greater than +20 t/kt, it is considered non-acid generating.

In order to provide a conservative estimate of the acid generating capacity of the rock, a combination of the above-described criteria were used as follows:

- if either the acid-neutralizing potential/acid-generating potential ratio is less than 1 **OR** the net neutralizing potential is less than -20 t/kt, then the rock is classified as potentially acid generating;
- if the rock is not potentially acid generating **AND** either the acid-neutralizing potential/acid-generating potential ratio is greater than or equal to 1 and less than or equal to 3 **OR** the net neutralizing potential is greater than or equal to -20 t/kt and less than or equal to +20 t/kt, then the rock acid generating potential is classified as Unknown;

- if both the acid-neutralizing potential/acid-generating potential ratio is greater than 3 **AND** the net neutralizing potential is greater than +20 t/kt, then the rock is classified as non-acid generating.

5.8.8.1.2 Leach Extraction

A variety of geochemical extraction or leach tests were conducted on the waste rock piles by the USGS and CMI consultants in an attempt to mimic leachability under ambient conditions. In order to evaluate the comparability of leachate data from these different tests as well as to verify the results, leachability testing was conducted on waste rock, colluvium, debris fan and hydrothermal scar material as part of the roadside waste rock pile characterization in 2004. The following six different leaching tests were conducted:

- **Shake Flask 3:1** – Shake flask tests previously conducted by Molycorp's contractor, SRK Consulting (1995b), labeled "shake flask 3:1"

- **SPLP 2:1 and SPLP 3:1** – Leaching methods previously used by Molycorp's contractor, Robertson GeoConsultants (RGC), based on the EPA 1312 leach method with Nevada Meteoric Water Mobility Test reagent, but with lower liquids/solids ratio. They are labeled "SPLP 2:1" and "SPLP 3:1" depending on the liquid/solid ratio used.

- **USGS FLT and USGS 18 Hour** – Leaching tests previously used by the USGS (Smith et al, 2007). The USGS tests include a field leach test using 20:1 deionized water/solid. After an aliquot of this sample is taken for analysis, the remaining sample/solution is tumbled for 18 hours and re-sampled. These tests are labeled "USGS FLT" and "USGS 18 Hour".

- **SPLP** – The standard SPLP EPA Method 1312, which uses a liquid/solid ratio of 20:1.

To achieve the objective for determining the similarities or differences between the roadside and other waste rock piles, a comparison was made between the roadside waste rock piles leachate extraction data and the seepage and ground water data collected from the Capulin Waste Rock Pile.

5.8.8.2 Other Waste Rock Characterization Studies

A series of investigations were conducted at the mine site beginning in 1995 to characterize the geochemical and physical properties of the mine, including the waste rock piles (RGC 1999, 2000b, 2003). They included reconnaissance surveys, test pits, trenches, borehole drilling investigations, infiltration test plots, and laboratory testing and analysis. Boreholes were placed to intercept the channels of pre-mining drainages beneath the rock piles. Surface and subsurface materials from the test pits and trenches were subject to geotechnical and geochemical analyses. Surface and subsurface waste rock materials from the boreholes were analyzed for geochemical properties, including acid-base accounting. Several boreholes were instrumented to characterize temperature and pore gas. Since static acid-base accounting tests give no indication of relative reaction rates, kinetic testing was also performed using humidity cell tests. The humidity cell tests were run on several borehole samples to simulate weathering. The tests were conducted from 24 to 44 weeks, depending on the sample. Two objectives for the humidity cell tests were to provide data necessary for calculating a sulfide oxidation rate, and to determine if certain geochemical units classified as uncertain with respect to acid-generating potential based on acid-base accounting tests could be re-classified based on kinetic tests.

The 2004 geotechnical stability evaluation by Molycorp on the roadside waste rock piles is mentioned above. This evaluation included the installation of slope inclinometers and wireline piezometers.

Finally, various investigations have been performed for specific waste rock piles by others, including USGS as part of its Baseline Study (Briggs et al. 2003, Smith et al. 2007, Nordstrom 2008). These investigations are summarized in the RI Report (URS 2009a).

5.8.9 Geophysical Investigation

Non-intrusive geophysical investigations were conducted in the fall 2002 as part of the RI. The geophysical investigation was used for characterization of bedrock, thickness of overburden or overlying lithologic units, location of fault or significant fracture zones, and other preferred pathways for ground water flow. Geophysical methods used at the Site were magnetics, seismic reflection, seismic refraction, and downhole geophysical methods.

Geophysics at the mine site was used within the Goathill Gulch/Slick Line Gulch drainages to characterize further the bedrock surface and colluvium thickness, identify preferred ground water pathways and faulting, and help optimize placement of monitoring wells.

Geophysics at the tailing facility was conducted primarily to identify locations of suspected faults in the area, which could affect ground water flow.

5.8.10 Ground Water-to-Surface Water Interaction Study

An *in situ* assessment of the ground water-to-surface water interaction (GSI) zones in the Red River was conducted by EPA and members of EPA's Environmental Response Team, with assistance from Molycorp, in 2003 and 2004. The overall objective of the study was to generate Site specific ecological and contaminant data to assess the toxicity of discharging ground water and sediment in the Red River. The study was necessary to evaluate the ground water-to-surface water exposure pathway to aquatic receptors identified as potentially complete in the Problem Formulation for the BERA. Contaminated ground water discharging into the Red River at separate locations of upwelling was hypothesized to be source of several Contaminants of Potential Concern (COPCs) in Red River surface water and sediment.

The sampling was designed to evaluate exposure point concentrations in ground water discharge zones (*i.e.,* upwelling zones) within the Red River. Optimal conditions for testing were considered to be low flow conditions within gaining portions of the river. Streambed piezometers were used to measure vertical hydraulic gradients and collect samples of sediment pore water. Exposure chambers were also used for *in situ* bioassays to evaluate acute toxicity. Toxicity was evaluated through the exposures of laboratory-reared *Hyallela azteca* (amphipod), a common freshwater test species, and indigenous mayflies (*Drunella doddsii* and *Drunella grandis*; henceforth *Drunella* spp.) that were isolated at or within three environmental compartments of the Red River: (1) water column, (2) sediment/water interface, and (3) surficial sediments (top 2-4 cm).

Three separate GSI studies were conducted in the Red River, with 10 separate sampling sites used in at least one of the studies. At each location, a triad of mini-piezometer pairs was installed in the streambed, with each piezometer pair installed at depths of 20 and 30 cm. Sets of exposure chambers were situated in the center of the piezometer triad at each location.

The first GSI study was performed at six locations over four days in October 2003. The locations were at the headwaters (control location), upstream of the mine in an area of scar-impacted drainages (scar reference location), downstream of Spring 13, and three locations in the vicinity of the tailing facility. At each location, surface water, sediment, sediment pore water, and exposure chamber water were sampled for metals analyses. Two sets of exposure chambers filled with *Drunella* spp. and *Hyalella azteca* were placed within the piezometer triads: one against the sediment and one suspended in the water column. Measurement endpoints were survival and mortality at each test location. The Red River was at low flow conditions (20 cfs) during the study.

The second GSI study was designed to include more specific evaluation at Spring 13 and Spring 39, the two most significant upwelling areas along the mine site reach. The study was conducted over three days in March 2004 at the following locations: the headwaters (control location), upstream of mine (scar reference location), multiple locations near Spring 39 and Spring 13, downstream of Spring 13, and the three locations near the tailing facility. Piezometers and surface water were sampled, but exposure chambers were not used and sediment was not sampled. Samples were analyzed primarily for metals. The Red River was at low flow conditions (22-27 cfs) during the study.

The third and last GSI study was also designed to focus specifically on the Spring 13 and Spring 39 areas of ground water upwelling. It was conducted as part of the additional data collection discussed below. The study was conducted over four days from September 27 to October 1, 2004 at the following six locations: headwaters (control location), upstream of mine (scar reference location), two locations near Spring 39 and two locations near Spring 13. One set of exposure chambers was placed in the center of the piezometer triad within the streambed. The chambers were filled with indigenous mayflies (*Drunella* spp.) collected at the headwaters. Piezometer water, chamber water, surface water, and sediment were sampled at each site primarily for analysis of metals. The Red River was at low flow conditions at the start of the study. However, on September 28 an afternoon rainstorm occurred that increased the flow from 20 to 40 cfs (USGS Gage). Initial upwelling conditions changed to downwelling conditions, as measured in the shallow piezometers. Measurement endpoints were survival and mortality at each test location.

5.8.11 Additional Data Collection to Determine Environmental Impacts of Ground Water Discharge to Red River

After reviewing data collected and evaluated as part of the initial RI Site investigation, EPA determined that the biotic and abiotic data collected along the mine site reach of the Red River (from Columbine Park to downstream of Capulin Canyon) lacked the resolution to define the extent of discrete environmental impact zones in the Spring 13 and Spring 39 areas. Based on preliminary data, adverse impacts to aquatic receptors were apparent from the scar-impacted areas upstream of the mine site to downstream of the mine site, as far as the tailing facility. However, because little to no recovery in populations of fish and benthic invertebrates were observed from station to station along the mine site reach of the river, the severity of the impacts that the sources in the Spring 13 and Spring 39 areas were having on the stressed aquatic ecosystem was not apparent. There was also concern that the distance between sampling stations was too great to document small zones of recovery that may be occurring between the impacted zones.

Therefore, a focused sampling and analysis program was implemented to target the Spring 13 and Spring 39 reaches of the Red River for evaluating multiple lines of evidence. The specific objectives were as follows:

- Identify selected impacted areas;
- Determine the spatial extent of impact and recovery zones for isolated impact areas;
- Evaluate metals loadings to surface water;
- Evaluate a range of acute and chronic toxicity effects to selected aquatic receptors exposed to discharging ground water.

The data required to meet the aforementioned objectives are described below. The exposure and toxicity information will be used to characterize and quantify risk and the severity of risk to aquatic receptors as part of the EPA's BERA.

5.8.11.1 Benthic Macroinvertebrate and Physical Habitat Assessment

A ground water-to-surface water pathway for contaminant transport is identified in the Site conceptual exposure model as potentially complete. Discharge of metals-laden, low pH ground water to surface water is a suspected source of impairment to the Red River as evidenced by reduced macroinvertebrate abundance and diversity related to reference background locations. The specific objective of this study was to identify impacted areas of the Red River from just upstream of Columbine Creek to downstream of Capulin drainage using (1) screening level techniques to determine macroinvertebrate density and taxa richness trends and (2) closely spaced sampling stations to resolve discrete zones of impact and recovery.

In addition, the synoptic evaluation of physical habitat was necessary to determine if the diversity or abundance of benthic macroinvertebrates is significantly influenced by physical habitat conditions rather than degraded surface water or sediment quality.

The focused benthic macroinvertebrate and physical habitat assessment was conducted in September 2004. Macroinvertebrate abundance and diversity were measured along transects perpendicular to stream flow and spaced approximately 1,000 feet apart. A total of 20 transect locations were sampled. A quantitative assessment (scoring) of the physical habitat was also assessed along with the macroinvertebrate sampling using a modified Rapid Bioassessment Protocol for wadeable streams. Surface water and sediment samples were collected along each transect for analysis of metals and other inorganic chemicals. Sediment samples were also analyzed for grain size. Riffle habitat was targeted for sampling.

The collected data were used to provide definition or trend analysis of macroinvertebrate abundance and diversity immediately upstream, within, and downstream of suspected areas of the river where metals-laden, low pH ground water discharges to surface water (*i.e.,* hot spot areas). The data were also used to determine the quality of the aquatic habitat to benthic macroinvertebrates within the lower mine site reach of the Red River.

5.8.11.2 *In Situ* Toxicity Testing/Water Quality Analysis

The *in situ* toxicity testing represents the third GSI study conducted in the Red River. It is discussed above.

5.8.11.3 Ground Water Discharge Estimated by ^{222}Radon Tracer

A ^{222}radon tracer study was conducted by the USGS to evaluate ground water inflow to the Red River near Spring 13 and Spring 39 in October 2004. The study involved using a mass balance approach to quantitatively estimate ground water inflow to the river based on stream flow measurements and ^{222}radon concentrations in surface water and ground water within a defined stream reach. The ^{222}radon tracer was used to delineate and quantify the volume of ground water discharging to the river along a 2,000-foot reach encompassing Spring 13 and a 3,500-foot reach encompassing Spring 39.

5.8.11.4 Acute and Subchronic Toxicity (Serial Dilution) Tests

The objective of the subchronic toxicity (serial dilution) test was to determine mortality and sublethal endpoints of sensitive life stages of salmonid fish from metals-laden, low pH ground water discharging to the Red River. Serial dilution testing in this case differs from *in situ* toxicity testing in that exposure to contaminants is of sufficiently long duration to allow observation of one or more sublethal effects (*e.g.,* growth) and the use of early life stage salmonid fish as the test organism.

Two paired serial dilution tests were performed in a laboratory and consisted of a modified standard chronic toxicity test with salmonid fish using Spring 13 and Spring 39 collection system water. The dilutions included 100%, 50%, 20%, 10%, 5%, and 0% spring water. The paired tests were conducted using both reconstituted laboratory water and Red River water (collected just upstream of each spring) as dilution water. The methodology was based on static renewal and 7-day exposure duration. The salmonid fish used as test organisms were young early life stage rainbow trout (*Oncorhynchus mykiss*). Acute toxicity was measured during the first 96 hours of the test to allow calculation of acute endpoints (*e.g.,* lethal concentration of 50 percent of the population [LC_{50}]). The test was continued though the 7-day exposure to measure growth by dry weight. Reported endpoints included LC_{50}, acute survival no adverse effects level (NOAEL), subchronic survival no observed effects concentrations (NOEC), subchronic growth NOEC, and an inhibition concentration associated with 25 percent reduction in growth compared to controls (IC_{25}).

5.8.12 Air Quality Monitoring

Air quality monitoring was necessary to evaluate the air exposure pathway to human receptors identified as potentially complete in the Site Conceptual Exposure Model at the tailing facility. Additionally, in reviewing records and interviewing residents, EPA learned that there was a long history of air quality problems associated with dust blowing off the tailing facility. Children had been taken out of nearby schools by their parents and the schools closed because of dust in the air. See Dust from the Tailing Facility, Section 3.7.8, above.

An air monitoring network was installed and operated by CMI at the tailing facility since February 2003. Three monitoring stations were originally installed at the north, northeast, and south perimeter of the tailing facility. The locations of the monitoring stations were chosen based on prevailing wind direction and proximity to either on-site operations or off-site residents. Three additional air monitoring stations have been installed since the RI field sampling activities were completed. CMI continues to maintain and operate the air monitoring network.

5.8.12.1 PM_{10} Monitoring

The main purpose of the air monitoring network was to provide information about potential off-site wind-born dust originating from the tailing operations. The monitoring instrumentation was set up to continuously (24 hours/day) monitor PM^{10} (particulate matter less than 10 microns in size). The PM_{10} data are compared against National Ambient Air Quality Standards (NAAQS) for PM_{10}, the 24-hour average of 150 µg/m^3, and the annual average of 50 µg/m^3. The PM_{10} monitoring program is reviewed on a quarterly basis.

5.8.12.2 Metals Monitoring

Air samples collected at the air monitoring network in May 2003 were analyzed for metals concentrations in the dust captured by the monitoring stations. Fifteen samples were collected over a period of approximately one month. The samples were collected for 24 hours.

5.8.13 Other Related Studies

As stated previously, EPA decided during scoping of the RI/FS not to conduct sampling at the Site which was performed in related studies under the direction and oversight of other regulatory authorities to avoid redundancy, if the sampling data were relevant and of sufficient quality to be incorporated into, and supplement, the CERCLA RI data. This section describes the sampling strategy of those other related studies.

5.8.13.1 Wildlife Impact Study

As discussed in Sections 2.4.5.4 and 2.8.4, above, the Wildlife Impact Study was conducted to evaluate plant uptake of metals at the tailing facility, as required by New Mexico Mining Permit TA001RE 96-1 and Ground water Discharge Permit DP-933. The objective of the study was to investigate the toxicity and bioaccumulation potential of molybdenum and other metals to plants and animals that may come into contact with tailing or consume vegetation growing on covered tailing. This was to be accomplished by analyzing metal concentrations in vegetation and root zone soils at the tailing facility and a nearby reference background area (Cater Ranch). The Wildlife Impact Study was performed from 2002 to 2004. The data from the study was included in the Preliminary Site Characterization Report (PSCR; URS 2005)

Sampling consisted of nine plant species (shrubs, forbs, and grasses), including both cool season and warm season plants. Replicates were collected at three different sites on the tailing facility and reference background areas. All vegetation samples were split into washed and unwashed fraction prior to chemical analysis. Vegetation samples were analyzed for metals, percent solids and nitrogen. Soil samples were analyzed for metals, inorganic chemicals and percent solids. All sampling sites had cover material over the tailing.

Plant community characterization was also performed as part of the Wildlife Impact Study. Vegetation community data were collected using 100 meter point-intercept transects. Data were collected at one-meter intervals along each transect, and included ground cover, plant species (if any), and height interval.

There were several differences between the Wildlife Impact Study and the RI vegetation and soil sampling. The main differences were:

- The Wildlife Impact Study sampled the same nine species at the tailing facility and reference background areas, with three replicates of each species in each area. The RI did not necessarily use the same species in both areas, but used whatever shrub, forb, and grass species were available at pre-determined sample sites.

- The Wildlife Impact Study sampling sites were selected in the field based on the availability of the target species. The RI sampling was done at pre-determined random sites that were co-located with soil and wildlife sampling.

- All Wildlife Impact Study samples were split into a washed and unwashed fraction prior to chemical analysis. Most of the RI vegetation samples were unwashed.

- In the Wildlife Impact Study, soil samples were collected from the root zone of the individual plants that were sampled, and samples varied in depth depending on the depth of the roots. In the RI, soil samples were collected from fixed-depth intervals (0-6 inches and 0-24 inches) at the center point of the sample site.

5.8.13.2 Historic Tailing Spills Investigation

The Historic Tailing Spills Investigation was conducted by Molycorp as required under Ground Water Discharge Permit DP-933. In fall 2003, EPA requested that the investigation be incorporated into the RI.

The objective of the Historic Tailing Spills Investigation was two-fold. First, the investigation was to determine whether the tailing spills were geochemically and statistically different from reference background soils and soil adjacent to the spill area. The second objective was to determine if leaching from the tailing spills had impacted the underlying ground water. The investigation included a review of documentation relating to the tailing spills, field reconnaissance to locate and map the spills, and sampling and analysis of the spill material. All sampling was performed in May 2004.

5.8.13.2.1 Field Reconnaissance

Two field reconnaissance surveys were conducted to visit locations of known tailing spills and to identify previously unknown tailing material on soil along the pipeline route or within the Red River. The first survey was conducted by Molycorp in May 2002 and extended from the mill site to the Red River State Fish Hatchery. The second survey was conducted by EPA and Molycorp in September 2003 and covered the same area, but also extended below the fish hatchery to the confluence of the Red River with the Rio Grande.

5.8.13.2.2 Tailing Pipeline Spills

Samples were collected from tailing spills containing greater than 10 yd^3 of tailing. At each of these sites, a sample was collected of the tailing, the soil underlying the tailing, and the soil located adjacent to and upgradient from the tailing spill as a reference background soil sample. Ground water was sampled at the six wells located at the Upper and Lower Dump Sumps.

5.8.13.2.3 Hunt's Pond

Soil, sediment and pond surface water were collected at Hunt's Pond. The soil samples were collected at a depth of 3-4 feet. One surface water sample was collected from the northwest shore of the pond near the trench dug by the village of Questa across Old River Road. Tailing was discovered in the trench, which was dug to drain the pond in 2003. A second surface water sample was taken from the center of the pond. An attempt was made to collect sediment samples from the bottom of the pond. However, construction at the pond in 2000 and 2003 had removed all the sediment from the pond bottom. Sediment samples were collected from the sides of the pond.

In addition, a temporary ground water monitoring well was installed downgradient of the pond to determine the quality of the water flowing from the pond toward the Red River.

5.8.13.2.4 Private Residences

Soil samples were collected at three private residences located west of the Lower Dump Sump. Samples were collected from a depth of 0-6 inches. At nine of the sites, after the soil sample was collected, a bobcat auger was used to drill to a depth of four feet to determine if tailing was deposited at depth. The residences were in close proximity to the tailing pipeline and had been reportedly impacted from tailing spills. A reconnaissance was also performed for tailing around trees in the areas where residents reported tailing deposits.

Ground water wells at each of the three private residences were sampled though the kitchen faucets.

5.8.13.2.5 Irrigation Ditches

Sediment samples were collected from irrigation ditches for analysis of metals. Sediment samples were collected in the Gallegos Ditch upstream and downstream of the Lower

Dump Sump and near the Gallegos property. After collection of the sediment samples, a bobcat auger was used to drill down four feet into the bottom of the ditch to determine if there were tailing at depth. Sediment samples were also collected from the South (or High) Ditch near the Ranger Station and south of the Village of Questa, and from the unnamed ditch (Central Ditch) where the tailing pipeline crosses the Red River near the Lower Dump Sump. All the ditches contained water when sampled.

5.9 USGS Questa Baseline and Pre-Mining Ground Water Quality Investigation

The USGS, in collaboration with NMED, conducted the Questa Baseline and Pre-Mining Ground Water Quality Investigation (USGS Baseline Investigation) to estimate pre-mining ground water quality at the mine site, as required by New Mexico Ground Water Discharge Permit DP-1055. The objective of the USGS Baseline Investigation was to infer the pre-mining ground water quality by the examination of the geologic, hydrologic, and geochemical controls on ground water quality in a nearby, or proximal, analog site in the Straight Creek drainage. Straight Creek was chosen as the analog because the lithology, mineralogy, elevation, and hydrology were found to be similar to most of those at the mine site. The Straight Creek watershed consists of acid surface drainage derived from the weathering of quartz-sericite-pyrite (QSP)-altered rocks and hydrothermal scar development at the headwaters.

The USGS Baseline Investigation included the following studies:

- Environmental geology of the Red River Valley;
- Mapping and surface mineralogy by Airborne Visible Infrared Imaging Spectrometry;
- Geomorphology and its effects on ground water flow;
- Geophysical studies on depth to ground water and bedrock;

- Bedrock fractures and their potential influence on ground water flow;
- Leaching studies of scars and waste rock piles;
- Mineralogy and mineral chemistry and their effect on ground water quality;
- Ground water geochemistry of selected wells undisturbed by mining in the Red River Valley;
- Synoptic/tracer studies with mass loading and temporal water-quality trends of the Red River;
- Hydrology and water balance for the Red River Valley;
- Reaction-transport modeling of the Red River;
- Lake-sediment geochemical record from 1960 to 2002, Eagle Rock and Fawn Lakes.

Twenty-seven reports detail the studies listed above. A summary of the USGS Baseline Investigation is contained in Nordstrom (2008).

The data collected from Straight Creek, as well as additional information collected from Hottentot Creek, Hansen Creek, La Bobita Campground, and Capulin Canyon were used to derive pre-mining ground water chemistry at the mine site. Pre-mining concentrations of chemical constituents were inferred for ground water in colluvium and bedrock within the following mine site drainages: Capulin, Goathill, Sulphur Gulch, and the three unnamed drainages beneath the roadside waste rock piles. Sulphur Gulch was divided into the three subdrainages: upper Sulphur Gulch, Spring Gulch, and Blind Gulch and chemistries approximating ground waters in the three smaller subdrainages were mixed to resulting in concentrations for lower Sulphur Gulch.

The USGS Baseline Investigation did not infer concentrations for the three smaller subdrainages (Blind, Spring, and upper Sulphur gulches) nor the Red River alluvial aquifer and bedrock ground water beneath the alluvial aquifer.

The pre-mining concentrations are based on the hydrogeochemical processes found to control the concentrations at the Straight Creek analog site modified by the differences observed between Straight Creek and mine site lithology, mineralogy, and hydrology. These differences are primarily related to the position of the weathering surface with respect to the sequence of hydrothermal alteration zones that vary with distance from the core of the mineralization. Different ranges of constituent concentrations had to be estimated for each different watershed on the mine site because the geology changed markedly from drainage to drainage (Nordstrom 2008).

The USGS inferred ranges of colluvium and bedrock concentrations for 15 constituents considered to be COPCs[24] for the purpose of characterizing pre-mining ground water quality. The constituents are the following:

- Aluminum
- Beryllium
- Cadmium
- Chromium
- Cobalt
- Fluoride
- Iron
- Lead
- Manganese

[24] Chemicals of Potential Concern (COPCs) are those chemicals identified as a potential threat to human health or the environment based primarily on toxicity and magnitude of concentration. Identification of COPCs is based on a direct comparison of measured concentrations of all organic and inorganic chemicals in the various Site media to conservative federal or state numeric regulatory standards and criteria, calculated risk-based screening levels, or commonly accepted benchmarks approved by EPA for screening purposes. The identified COPCs are evaluated further in the baseline risk assessment.

- Nickel
- Sulfate
- Zinc
- Total dissolved solids
- pH (standard units)

5.10 Nature and Extent of Contamination at the Mine Site

This section evaluates the nature and extent of contamination in the physical media at the mine site (surface soil, waste rock piles, catchment water, and ground water), as well as terrestrial biota (vegetation and animals) used for risk assessment.

All chemical data were considered in this evaluation. Chemicals having concentrations exceeding the EPA screening level criteria (SLC) were identified as COPCs for further evaluation in the HHRA and BERA. Each mine site area was evaluated for nature and extent with respect to the COPCs. To evaluate the nature of the COPCs, concentrations were compared to the concentrations in selected mine site reference (background) areas.[25] For the reference comparison, the COPC concentrations for each area were compared statistically to the concentrations of the corresponding reference area. In this comparison, when forms of the term "significant" are used, it implies "statistically significant." Statistical comparisons were made using the area-weighting methodology described in the RI Report (URS 2009a). Potential source areas at the mine site were also evaluated to assess the nature of the COPCs.

Also presented in this section are the Contaminants of Concern (COCs)[26] identified in the FS for the Mine Site Area. The COCs are based on chemicals of concern identified in the

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[25] A reference area represents an area unaffected by mining or mining-related activities.
[26] Contaminants of Concern (COCs) are those contaminants identified in the FS as needing to be addressed by the remedial action selected in the ROD. They are contaminants with concentrations that are significantly

EPA HHRA and ERA, the statistical comparison to reference background concentrations, and further evaluation and screening performed during the FS, including screening of contaminant concentrations to federal and New Mexico standards and criteria, and an assessment of ecological significance[27] by EPA. The COCs will be addressed by the Selected Remedy.

5.10.1 Mine Site Source Characterization

Several potential source areas at the mine site were investigated during the RI though sample and analysis of soil.

5.10.1.1 Mill Area

The mill area includes the crushers, mill, concentrator building, grinding, drying, packaging, chemical storage, assay lab, fuel storage, former drum storage, thickeners, warehouse, decline shop, power plant, vehicle maintenance, bone yard, portal, and historic mine site tailing area. Ninety-nine soil samples were collected within the mill area, of which 10 were from randomly selected locations and the other 89 were collected in areas most likely to have been affected, such as doors of buildings and at storage tanks.

The mill area is characterized by contamination of surface soil (0-6 inches). The COPCs detected are PCBs, metals (arsenic, iron, lead, vanadium, and molybdenum), and polycyclic-aromatic hydrocarbons (PAHs – benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and bibenz(a,h)anthracene). Based on EPA's HHRA, the only

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above reference background concentrations based on statistical comparisons. They include the chemicals of concern identified in the baseline risk assessment that represent a subset of the COPCs evaluated. COCs may also include other chemicals or contaminants that are not identified in the baseline risk assessment but are above federal or New Mexico standards or criteria that are identified as ARARs and would also have to be addressed by the remedial action. Not all contaminants identified as COCs are chemicals (*e.g.,* pH).

[27] The ecological significance of elevated risk estimates differ by COC and media. Furthermore, quantitative estimates of risk that are numerically equal may not represent an equal likelihood of severity of risk. The likelihood and/or severity of risk associated with any quantitative risk estimate must consider the basis on which such estimate is generated (*e.g.,* toxicity reference values that are less certain because the chemical is not well studied). A further assessment of ecological significance was therefore performed by EPA during the FS which focused on COCs and locations associated with confident expectations of, or potentials for, unacceptable ecological effects.

COCs which warrant CERCLA response actions are PCBs and molybdenum. Table 5-2, below, presents a summary of the COCs and their concentrations identified for the Mill Area.

TABLE 5-2
HUMAN HEALTH CONTAMINANTS OF CONCERN
FOR MILL AREA

COC	Concentration (mg/kg)
Aroclor 1248[1]	0.02 – 140
Aroclor 1254[1]	0.02 – 20
Aroclor 1260[1]	0.02 – 7.6
Molybdenum[2]	33 – 38,300

Notes:
1. PCB cleanup levels for soil (total concentrations) are 1 mg/kg for high occupancy land use (i.e., residential) (or 10 mg/kg with capping of 1-10 mg/kg) and 25 mg/kg for low occupancy land use (i.e., commercial/industrial land use) per the Toxic Substance Control Act (TSCA)
2. Molybdenum clean up levels for soil are 503 mg/kg for residential exposure, 2,978 mg/kg for construction worker exposure, and 5,110 for commercial/industrial worker exposure based on an HI =1.

The PCBs (Aroclors 1248, 1254, and 1260) were detected in soil throughout the mill area. The concentrations measured are 0.02 – 140 milligrams per kilogram (mg/kg) (Aroclor 1248), 0.02 – 20 mg/kg (Aroclor 1254), and 0.02 – 7.6 mg/kg (Aroclor 1260). One of 99 sampling locations had an Aroclor concentration greater than 50 mg/kg, the Toxic Substances Control Act (TSCA) upper limit allowed to remain at a cleanup site which is secured with fencing and signage. Five of those sampling locations had Aroclor concentrations greater than 25 mg/kg, the TSCA cleanup level for low occupancy use (commercial or industrial), while 35 sampling locations had Aroclor concentrations greater than 1 mg/kg, the TSCA cleanup level for high occupancy use (residential). PCBs are probable human carcinogens. A map of relative concentrations for Aroclors 1248, 1254, and 1260 is depicted on Figure 5-23.

Elevated molybdenum concentrations exceeding reference background area concentrations and the SLC criteria occur throughout the mill area. Higher concentrations of molybdenum (33 – 38,300 mg/kg) occur at locations around tanks and buildings near the mill complex and in the historic mine tailing material placed within the boundary of the mill area. A map of relative molybdenum concentrations is depicted on Figure 5-24. Molybdenum is a non-carcinogenic metal that poses hazards to human and ecological receptors at elevated concentrations.

The areal extent and volume of affected soil that exceeds TSCA cleanup levels of 25 mg/kg for low occupancy use (commercial/industrial), as well as 1 mg/kg and 10 mg/kg for high occupancy use (residential) are estimated below. The 10 mg/kg TSCA level requires capping of PCB levels between 1 mg/kg and 10 mg/kg. Similar estimates are also provided for affected soil exceeding EPA's human health risk-based residential preliminary remediation goal of 503 mg/kg for molybdenum. The estimates assume an approximate 2-foot depth of contamination, based on the depth of sampling performed during the RI, and a depth of excavation of 2.5 feet.

- Greater than 25 mg/kg PCBs – 0.6 acres and 2,400 yd^3
- Greater than 10 mg/kg PCBs – 0.8 acres and 3,300 yd^3
- Greater than 1 mg/kg PCBs and greater than 503 mg/kg molybdenum – 28 acres and 113,000 yd^3
- Greater than 503 mg/kg molybdenum-only soil – 12 acres and 49,000 yd^3

5.10.1.2 Administration and M&E Areas

Surface soil samples (0-6 inches) were collected from 86 random and biased locations in the administration and maintenance and electrical areas. Four COPCs exceeded human health SLC: arsenic, iron, molybdenum, vanadium, and benzo(a)pyrene. Of these, arsenic, iron, and molybdenum were not significantly greater than the concentrations in the reference background areas. Arsenic and iron in reference background areas exceed SLC.

Benzo(a)pyrene exceeded the SLC at one location near the warehouse. Based on EPA's HHRA, there are no COCs identified for this area which warrant CERCLA response actions.

5.10.1.3 Waste Rock Piles

A number of studies have been conducted by others to characterize the waste rock piles at the mine site (RGC 1999, 2000a, 2000b, 2002, 2003; Golder 2002, 2004, 2005a, 2005b, 2006 and 2007; and Norwest 2004, 2005). These studies evaluated geotechnical and geochemical properties, including acid generating potential and acid neutralizing potential. Further characterization of the waste rock piles was performed during the RI to determine if they are sources or potential sources of contamination. The characterization included collection of surface soil samples on each of the rock piles, sampling of seepage at the toes of Capulin and Goathill North waste rock piles, and a mineralogical and geochemical investigation of the roadside waste rock piles.

Based on these studies, EPA has identified the waste rock piles as known or potential sources of ARD that cause or contribute to ground water and surface water contamination. The characterization of the waste rock piles is presented in Section 5.10.2.

5.10.1.4 Open Pit Soils

Surface soil samples (0-6 and 0-24 inches) were collected from 16 random locations within and near the open pit. Lead is the only COPC exceeding the human health SLC. Lead was detected at two locations along the southwestern area of the open pit at concentrations significantly greater than levels in the reference background area. Copper and thallium are the only two COPCs with concentrations significantly greater than the reference area concentrations and that exceed the ecological SLC. Based on EPA's baseline risk assessment, there are no COCs identified for this area which warrant CERCLA response actions.

5.10.1.5 Subsidence Area

The potential for the subsidence area to be a contaminant source was evaluated in the RI through the ground water investigation of the underground mine workings (Section 5.10.4.4.2.10).

5.10.1.6 Tailing Pipeline and Emergency Sumps

Potential releases associated with the tailing pipeline and emergency sumps (*i.e.,* Upper and Lower Dump Sumps) were investigated through the riparian soil investigation (Section 5.12.1), which included the historic tailing spill investigation.

5.10.1.7 Naturally Occurring Mine Site Scars

Shallow soil samples (0-6 and 0-24 inches) were collected from 10 locations on mine site hydrothermal scars. Two COPCs exceeded the human health SLC: arsenic and iron. The concentrations of these metals were not significantly greater than the reference background scar concentrations. However, the levels in the reference scar did exceed the SLC for human health.

Ten COPCs exceeded the ecological SLC: aluminum toxicity (soil pH less than 5.5), boron, chromium, copper, iron toxicity (soil pH less than 5 and greater than 8), lead, manganese, molybdenum, selenium, and vanadium. The concentrations of these metals were not significantly greater than the reference background scar concentrations. The concentrations of all these metals (except copper) in the reference background scar exceeded the ecological SLC.

5.10.1.8 Mine Site Independent Source Areas

The mine site independent source areas are those independent areas outside of the mill and administration and M&E area. These potential sources include the following areas:

- **Explosives Storage Area** – There are five explosives storage areas on the mine site. One is currently in use and the other four are former storage areas. There is a former explosives stockpile located just north of the administration building. The current explosives storage area is in Goathill Gulch. There is a former explosives area in the mill area, historical ammonium nitrate/fuel oil storage to the north in Sulphur Gulch and a former explosives bunker adjacent to Blind Gulch Waste Rock Pile.
- **Historic Fueling Area** – There are two historic fueling areas on the mine site. One is the former truck shop area and the other is an old fueling area near the entrance to the open pit.
- **Landfills** – Four construction and demolition debris landfills were identified at the mine site. They are the current and historic Spring Gulch landfills located on the north end of Spring Gulch Waste Rock Pile, the former Goathill Landfill located north of the administration and M&E area, and the underground debris stockpile. The underground debris stockpile is currently not in use and could not be located during the field investigation.
- **Former Truck Shop Area** – The former truck shop area is located south of the open pit. Two underground storage tanks were closed in the truck shop area during the RI: a used oil storage tank, and a gasoline storage tank. A no further action status was issued by NMED’s Petroleum Storage Tank Bureau for both of these tanks.
- **Transformers**
- **Core Shack and Former Carpenter Shop**

No explosives (method 8330), polychlorinated dibenzo-dioxins/furans (method 8290), VOCs (method OLM03.2), or pesticides (method OLM03.2) were found in soil samples at concentrations EPA considered high enough to evaluate in risk assessment. The only SVOC (method OLM03.2) detected in soil was 2,6-dinitrotoluene.

No organic COPCs were detected in mine site soil at these independent source areas, with the exception of PCBs. Concentrations of PCBs (Aroclors 1248, 1254, and 1260) exceeded the SLCs in three samples: one next to an oil tank northwest of the mill, one near the water tanks northwest of the primary crusher, and one in the truck shop area. No PAHs were detected; however, many reporting limits were greater than the SLCs.

Based on EPA's baseline risk assessments, there are no COCs identified in the mine site independent source areas that warrant CERCLA response actions.

5.10.2 Waste Rock Pile Characterization

Historic Site-related data and the data collected during the RI were used for waste rock pile characterization. These data are combined for an overall assessment and provide the basis for the nature and extent of contamination of these sources/potential sources.

Each of the waste rock piles contain material removed from various portions of the open pit that consist of a mix of rock types, including aplite, rhyolite, andesite, and mixed volcanics. The material beneath the waste rock piles typically consists of colluvium and/or debris fan material underlying bedrock. In some cases, the waste rock was placed over hydrothermal scar material. There is also scar material exposed at the ground surface adjacent to some waste rock piles.

5.10.2.1 Mineralogy

5.10.2.1.1 X-Ray Diffraction Analysis

X-ray diffraction showed the major minerals of the waste rock to be quartz, sericite mica, and plagioclase feldspar. The quartz and mica are relatively inert, but the plagioclase has moderately fast acid neutralizing properties. Plagioclase is highly variable. There are several other major minerals including pyrite, the most potentially acid generating mineral, potassium feldspar, and chlorite. Pyrite content ranges from less than one percent in debris fan samples to 10 percent in andesite from the waste rock piles (Figure 5-25). Calcite, the most potentially acid neutralizing mineral, was not detected in most samples. The same andesite sample that had 10 percent pyrite, also had three percent calcite, indicating that the sample was relative unweathered.

Another mineral of some importance is smectite (clay). Clay minerals such as smectite may play an important role in the stability of the waste rock piles depending on whether its origin is by *in situ* chemical weathering or hydrothermal alteration. Smectite was observed in an andesite sample at about 2.5 percent.

5.10.2.1.2 Petrographic Analysis of Thin Section Samples

Petrographic analysis is one tool to help determine whether in situ chemical weathering is occurring within the waste rock piles and the extent of such weathering. The most important information gained from the thin sections is the condition of pyrite and calcite grains and their relationship to other minerals. An andesite sample collected from a depth of 99-109 feet below ground surface, where the measured temperature of 70º C (158º F) was the highest temperature recorded in the borehole, showed in thin section a secondary calcite filling a fracture and subhedral pyrite grains which are clean and fresh, with no weathering rinds or mineral replacement around the edges of the grains (Figures 5-26 and 5-27). The occurrence of these two grains in the same slice of rock indicates that little or no weathering has occurred for this sample. The andesite bulk sample from the same depth interval has a paste pH of 6.2. In contrast, weathered pyrite partially replaced by hematite and goethite in andesite was observed in thin section from a sample of colluvium underlying the Sugar Shack Waste Rock Pile (Figure 5-28).

5.10.2.1.3 Heavy Mineral Analysis

The heavy mineral concentrates from the bulk andesite sample collected at the Sulphur Gulch Waste Rock Pile (SI-44) has some pyrite grains rimmed with hematite/goethite (Figure 5-29). This sample is from the bulk sample containing 10 percent pyrite and 3 percent calcite and from the same depth interval as the clean pyrite and a fracture filled with calcite. The result shows some oxidation has occurred, but not enough to exhaust the neutralization potential. In contrast, an aplite sample collected from a depth of 189-199 feet within the Middle Waste Rock Pile at SI-48 has little or no remaining pyrite, but many grains of hematite/goethite showing the original euhedral pyrite shape (Figure 5-30). In this sample, weathering of pyrite is complete, with some neutralization potential remaining.

5.10.2.2 Geochemical and Physical Characterization

5.10.2.2.1 Static Testing – Paste pH and Acid-Base Accounting

In order to provide a conservative estimate of the acid generating capacity of the rocks, a combination of acid-neutralizing potential/acid-generating potential ratios and net neutralizing potential from the acid-base accounting data were used to classify rocks as potentially acid generating, non-acid generating, or uncertain.

Based on the acid-base accounting results, all of the waste rock piles appear to have the potential for acid generation. However, not all rock types or all waste rock piles have a similar distribution. Most of the aplite samples were either non-acid generating or of undetermined potential. Most mixed volcanics and rhyolite/tuff samples are potentially acid generating.

Overall, the Capulin, Sugar Shack West, Sugar Shack South, and Middle waste rock piles tend to be more acid generating; whereas Blind Gulch and Spring Gulch waste rock piles appear to fall in the uncertain range. The Sulphur Gulch Waste Rock Pile is variable. The Goathill North and Goathill South waste rock piles were not characterized using acid-base accounting, but are assumed to be more acid generating as acidic, metals-laden seepage currently flows from the toe of Goathill North, and Goathill South is believed to be of similar composition.

Even though most of the mixed volcanic, rhyolite, and tuff samples are net acid generating, many have mildly acidic (pH 4) to circumneutral pH values. However, the hydrothermal scar, colluvium, and debris fan samples tend to have little or no net neutralizing potential, yet some have pH values of less than 4. When the waste rock piles are compared, it appears that Capulin and Middle waste rock piles are the most weathered in that they consistently have a relatively low pH. On the other hand, potentially acid generating samples from Sugar Shack South and West waste rock piles show variable pH ranging from 2.5 to 8, suggesting that these potentially acid generating rocks have not yet released all their neutralization potential.

Based on these findings, the waste rock piles overall appear less weathered than the hydrothermal scar, colluvium, and debris fan materials underlying the piles and, for the most part, still have some neutralization potential. Because the waste rock has only been exposed for decades, it is still relatively fresh and unweathered, and still contains carbonate, compared to hydrothermal scar and debris fan material, which has been exposed for millennia and has long ago lost any carbonates that it may once have contained. Thus, at present, the rock in most of the waste rock piles tends to have higher overall paste pH than the scars. However, based on the acid-base accounting results, the waste rock is predicted in its current configuration to produce more acid as it continues to weather and may outlast any neutralization potential.

5.10.2.2.2 Kinetic Testing – Humidity Cell Tests

CMI conducted six humidity cell tests on samples from three waste rock piles: (1) Spring Gulch (HC1-aplite; HC2-andesite; HC3-mixed volcanics), (2) Sugar Shack South (HC4-andesite/aplite; HC5-rhyolite), and (3) Sugar Shack West (HC6-tuff). Based on acid-base accounting testing, the mixed volcanics, rhyolite, and tuff samples were considered potentially acid generating. The mixed volcanics sample also had a paste pH of 3.2. The three other samples had acid-base accounting results that fell within the uncertain range.

The humidity cell tests ran from 24 to 44 weeks, depending on the sample. Leachate pH, sulfate, and calcium chemistry from the cells were measured over time. Sulfate is typically interpreted as a measure of pyrite oxidation. Calcium and/or alkalinity are interpreted as indicators of carbonate dissolution.

Other than HC3 (mixed volcanics), which was initially acid, none of the humidity cell tests produced acid leachate at any time during the test. There is some concern that the lengths of those humidity cell tests were too short and tests of over a year should have been conducted. Nevertheless, CMI extrapolated the trend of remaining sulfide sulfur and acid-neutralizing potential over time to estimate whether pyrite or calcite will be depleted first and, thus, whether the sample would eventually generate acid. The projections from the humidity cell tests suggest that, in addition to the mixed volcanics, the aplite (HC1), rhyolite (HC5) and tuff (HC6) are or may become potentially acid generating over time. The andesite (HC2) fell within the range of uncertain to potentially acid generating and the andesite/aplite (HC4) would likely remain non-acid generating.

5.10.2.2.3 Leachate Testing Comparisons

The geochemical extraction leachate data from the Shake Flask 3:1, SPLP 2:1, SPLP 3:1, USGS FLT, USGS 18 Hour, and the SPLP tests are generally comparable when the leachate concentrations are converted to mg/kg of leached rock. In general, the lower the pH, the higher are the leachable metals such as manganese and aluminum for a given rock type.

Based on the results, most rock types cannot be differentiated on the basis of leachate concentrations. Similarly, neither the waste rock piles nor the bench within the pile can be differentiated by leachate concentrations. Rather, most of the rock types, waste rock piles, and benches show a wide range in leachate pH and metals concentrations, with substantial overlap across rock types and waste rock piles.

However, for the Goathill Gulch and Sulphur Gulch South debris fan material there are differences in metal concentrations. Even though the leachate pH values are comparable, the concentrations of leachable constituents are substantially higher in the Sulphur Gulch South debris fan material. This difference suggests that the Goathill Gulch debris fan material is more weathered than the Sulphur Gulch South material, such that most of the leachable constituents have already been leached out of the Goathill Gulch material.

5.10.2.2.4 <u>Patterns in SPLP 2:1 Leachates</u>

A major objective of conducting leach experiments of rock pile and underlying materials is to investigate the role of various rock types as potential sources of constituents to ground water. Because the water/rock ratio in ground water is unknown and may not be the same as any of the tested leachate ratios, two approaches were used to compensate for this uncertainty. First, patterns of constituent concentrations in leachate (SPLP 2:1 concentrations) were compared to the pattern made by the same constituents in the colluvial ground water beneath the waste rock pile. Even though the concentrations may differ, the overall pattern shape should remain constant (similar to comparing the patterns in Stiff diagrams). Second, ratios of constituents in leachates were compared to ratios of the same constituents in ground water beneath the piles.

The comparison of the roadside waste rock piles and the underlying materials for those piles to nearby colluvial monitoring wells allows investigation of the potential source(s) to ground water. For the Sulphur Gulch South Waste Rock Pile, the comparisons tend to point toward a single source for each nearby well. In the first bench, both the concentration and ratio patterns suggest the leachate from the colluvium sample (SI-52) most closely approximates the patterns for water in MMW-39A (Figures 5-31 and 5-32). In the toe of the waste rock pile, leachate from the debris fan material most closely approximates both the concentration and ratio patterns for water from MMW-16 (Figures 5-33 and 5-34).

For the Middle and Sugar Shack South waste rock piles, multiple sources are indicated. In the second bench of the Middle Waste Rock Pile, MMW-38A water appears to be a mixture of waste rock (andesite and mixed volcanics) leachate (SI-45), based on both concentration and ratio patterns (Figures 5-35 and 5-36). In the first bench of the Sugar Shack South Waste Rock Pile, a mixture of leachate from rhyolite (SI-50) and surface scar material most closely approximates MMW-11A water based on concentration patterns. However, based on ratio patterns MMW-11A water appears similar to leachate from colluvium (SI-50) and surface scar material. These results show the complex nature of the ground water and the difficulty of identifying sources

5.10.2.2.5 Geochemical Characterization by Waste Rock Pile

5.10.2.2.5.1 Capulin

Capulin Waste Rock Pile is located in the upper portion of Capulin Canyon. It has a maximum height of 600 feet and a maximum thickness of 260 feet. It covers an area of approximately 65 acres. The estimated total volume of the waste rock pile is 7.7 million yd^3. The overall slope of the pile is 1.7H:1V; the interbench slopes range from 1.4H to 1.1H:1V. The waste rock material is comprised primarily of andesite, tuff, and mixed volcanics. Based on borehole drilling, there does not appear to be colluvium in the drainage channel beneath or at the toe of the waste rock pile. No free water was observed within the borings or test pits.

Capulin Spring (acidic seepage) emerges near the base of the waste rock pile and is collected in a lined catchment. The seepage is characterized as calcium-magnesium-sulfate-type water and contains high sulfate (9,300 to 18,000 mg/L), iron (130 to 650 mg/L), and fluoride (63 to 120 mg/L) concentrations, and non-detectable alkalinity. The pH values are acidic (2.8 to 2.9).

Capulin Waste Rock Pile is presently acidic and, based on acid-base accounting data, has the potential to generate acid in the future. Borehole temperatures up to 88º F have been measured and oxygen levels remained above 10 percent throughout the boreholes. Field paste pH values are typical for mixed volcanics, ranging from 2.3 to 4.5 in acidic areas and 4.5 to 7 in marginally acidic areas. Borehole data indicate the rock pile materials to be acidic throughout their depth. Total metals concentrations in surface and subsurface waste rock samples include aluminum – 1,800 to 13,800 mg/kg, copper – 11.7 to 50 mg/kg, iron – 13,200 to 37,000 mg/kg, manganese – 55 to 1,345 mg/kg, and zinc – 20.4 to 354 mg/kg. The results of leach extraction tests are typical of mixed volcanics, with moderate to high concentrations of aluminum, calcium, copper, iron, magnesium, manganese, zinc, and fluoride. Leachate pH values range between 2.65 and 6.27.

5.10.2.2.5.2 Goathill North

Goathill North Waste Rock Pile is located west of the open pit and south of the Capulin Waste Rock Pile at the headwaters of the Goathill Gulch drainage. It has a maximum height of 630 feet and a maximum thickness of 200 feet. It covers an area of approximately 49 acres. The estimated total volume of the waste rock pile is 6.9 million yd^3. The overall slope of the pile is 2.3H:1V; the interbench slopes range from 5.7H to 1.4H:1V.[28] The waste rock is predominantly comprised of mixed volcanics (including rhyolite tuff) and andesite.

[28] These slopes reflect the regrading performed in 2005 as part of interim reclamation to mitigate instability of the Goathill North Waste Rock Pile.

The waste rock pile partially overlies a hydrothermal scar. The toe of the pile was placed on a colluvium bench underlain by pre-sheared material, the remnants of a natural historic slide. Foundation movement associated with the initial development of the rock pile between 1969 and 1973 continued to occur until July 2005, when interim reclamation of the waste rock pile was completed by CMI to address the instability. The mitigation consisted of (1) an underdrain constructed at the toe of the pile, (2) cutting of upper slopes and filling at toe slopes, (3) slide unloading, regrading, and construction of a non-keyed buttress and toe berm, and (4) surface water control. Approximately 1.25 million yd^3 of waste rock was moved during the regrading.

A moisture content of 4 percent was measured in one test trench. Since there were no boreholes drilled into Goathill North Waste Rock Pile, it is unknown if colluvium is present beneath the rock pile. It is also unknown whether any portion of the waste rock pile is saturated or water bearing. No surface water runoff has been collected. However, based on its similarity to Capulin Waste Rock Pile, it would be expected to be acidic, with elevated concentrations of aluminum, manganese, zinc, and fluoride.

Acid rock drainage (seepage) flows from the toe of the Goathill North Waste Rock Pile. It contains sulfate at concentrations between 15,000 to 18,000 mg/L. Total concentrations of aluminum – 1,540 to 1,750 mg/L, zinc – 120 to 126 mg/L, and fluoride – 78 to 175 mg/L are also elevated. The measured pH ranges between 2.5 and 2.79.

Some of the Goathill North waste rock material is presently acidic. The field paste pH values are typically of mixed volcanics/acid zone materials and range from 2.1 to 5.4. Limited acid-base accounting testing (one sample) showed it to be mildly potentially acid generating, although this may not be representative of the entire pile. Total metals concentrations in surface and subsurface samples include aluminum – 2,500 mg/kg, copper – 18 mg/kg, iron – 21,700 mg/kg, manganese – 196 mg/kg, and zinc – 38 mg/kg.

5.10.2.2.5.3 Goathill South

Goathill South Waste Rock Pile is located approximately 500 feet south of Goathill North Waste Rock Pile. It sits at the headwaters of the western segment of the Slick Line Gulch drainage. The extreme upper portion of the rock pile overlies a hydrothermal scar. It has a maximum height of 500 feet and a maximum thickness of 85 feet. The estimated total volume of the waste rock pile is 1.3 million yd^3. The overall slope of the pile is 1.6H:1V; the interbench slopes range from 1.9H to 1.5H:1V. The waste rock is comprised predominantly of mixed volcanics, including rhyolite tuff and minor andesite. Storm water runoff from Goathill South flows to an earthen-lined catchment located below Sugar Shack West Waste Rock Pile, where it infiltrates into the subsurface.

Some of the waste rock is presently acidic. Field pH values are typical of mixed volcanics/acid zone material, ranging from 3.0 to 6.1. Moisture content varied between 7.6 and 10.2 percent in test trenches. Since there were no boreholes drilled into Goathill South Waste Rock Pile, it is unknown whether colluvium is present beneath the pile. It is also unknown whether there is any saturation or water within the pile. No acid-base accounting tests or leachate extractions have been conducted on Goathill South waste rock material.

5.10.2.2.5.4 Sugar Shack West

Sugar Shack West Waste Rock Pile is located at the headwaters of the eastern segment of Slick Line Gulch drainage. It has a maximum height of 980 feet and a maximum thickness of 225 feet. It covers an area of approximately 48 acres. The estimated total volume of the waste rock pile is 4.4 million yd^3. The overall slope of the pile is 1.6H:1V; the interbench slopes range from 1.7H to 1.5H:1V. The waste rock is comprised predominantly of mixed volcanics.

To address instability concerns, CMI conducted interim reclamation work in 2007 and 2008 to regrade approximately 185,000 yds^3 from the upper portion of the waste rock pile to the lower portion of the pile. Diversions (swales and ditches) were constructed to reduce storm water run-on and erosion and for overall storm water management. Storm water runoff is directed to a sediment basin at the toe of the rock pile where it infiltrates into the subsurface.

No seepage has been observed to occur from the Sugar Shack West Waste Rock Pile. The field paste pH values are typical of acidic mixed volcanics, ranging from 1.5 to 5.1, with the more acidic values in the upper 30 feet of the rock pile. Temperatures range between 56ºF to 78ºF (at a depth of 75 feet). Moisture content ranges from 10 to 3 percent, showing a gradual decrease with depth. No free water was observed in any of the boreholes or test pits/trenches.

Field results from samples collected on the surface and at depth indicate that acid generation is occurring, and within zones is still being buffered by carbonate minerals present in the rock matrix (particularly in the black andesite zones). Based on acid-base accounting results from 13 samples collected at the waste rock pile, 100 percent of the samples were classified as potentially acid generating. It is noted that these samples may not be representative of the lateral and vertical extent of the waste rock pile. Acid titration tests showed some carbonate buffering capacity in the rhyolite tuff and mixed volcanics. One humidity cell test was conducted on a tuff sample. Although it did not become acid generating during the test, it was predicted to eventually be potentially acid generating.

Total concentrations of metals in surface and subsurface samples included aluminum – 4,570 to 13,100 mg/kg, copper – 93 to 235 mg/kg, iron – 22,700 to 43,300 mg/kg, manganese – 382 to 1,285 mg/kg, and zinc – 43 to 320 mg/kg. Results from SPLP 2:1 leach extraction tests included final leachate pH values ranging from 3.0 to 7.5 and leachate metals concentrations varying from low to high, depending on the pH, including (on a dry weight basis) sulfate – 2,940 to 5,040 mg/kg, aluminum – 14 to 358 mg/kg, copper – 2.4 to 25 mg/kg, iron – 1.2 to 22 mg/kg, manganese – 1 to 57 mg/kg, zinc – less than 1 to 34 mg/kg, and fluoride – 1.2 to 9 mg/kg.

5.10.2.2.5.5 Sugar Shack South

Sugar Shack South Waste Rock Pile is located adjacent and to the east of Sugar Shack West along an unnamed drainage approximately 2,000 feet south of the open pit. It is also one of the roadside waste rock piles along State Highway 38. A portion of the waste rock pile overlies a hydrothermal scar. It has a maximum height of 1,580 feet and a maximum thickness of 445 feet. It covers an area of approximately 116 acres. The estimated total volume of the waste rock pile is 27 million yd^3. The overall slope of the pile is 1.6H:1V; the interbench slopes range from 2.1H to 1.4H:1V.

The waste rock is comprised predominantly of mixed volcanics, aplite, and black andesite, with minor rhyolite. The surface of the rock pile has a divide along the 8,650-foot elevation bench, with mainly mixed volcanics above the bench and aplite or black andesite below the bench (except for a small area of mixed volcanics on the west side of the pile).

As part of the 2005 Geotechnical Stability Evaluation, CMI drilled five slope inclinometer boreholes through the Sugar Shack South Waste Rock Pile, colluvium, and debris fan before reaching total depth within bedrock (SI-2, SI-46, SI-47, SI-49, and SI-50). The boreholes for SI-46, SI-49, and SI-50 were targeted for the drainage channel. Colluvium is over 100 feet thick at the toe of the waste rock pile and thins upslope to a thickness of over 50 feet at SI-50 and MMW-37A.

Nested piezometers installed within the same SI boreholes showed the waste rock to be unsaturated. Water was encountered within the colluvium at SI-50 and in bedrock at SI-46. Water was not encountered in MMW-37A, as it was not deep enough to penetrate the entire colluvium section. Therefore, it was not possible to collect a colluvium water sample for analysis.

Temperatures ranged up to 167ºF (SI-46), with the highest temperatures between depths of 70 to 220 feet below ground surface. Temperatures then begin to decrease toward the base of the waste rock pile. These elevated temperatures indicate that oxidation processes in the rock pile are active (Norwest 2005).

Natural moisture contents measured within the waste rock pile ranged from 1 to 13 percent, and were generally less than 6 percent. The field paste pH values were typical of mixed volcanics, aplites, and andesites. The surficial acidic mixed volcanics exhibited field paste pH values between 2.4 and 4.5. Below the 8,650-foot bench, the surficial aplite and black andesite zone typically had field paste pH values between 4.5 and 6.0. At depth, paste pH values for the aplite/black andesite were typically between 6.0 and 8.0 and moisture contents were between 3 and 5 percent (above 135 feet). The mixed volcanics at depth exhibited lower pH values (about 4.0). Moisture content below a depth of 135 feet appeared to decrease from between 3 and 5 percent to less than 1 percent.

Debris fan material was encountered beneath the toe of the waste rock pile near having a field paste pH value of 4.0. The debris fan material is comprised mostly of hydrothermal scar material, as the scar is clearly visible on pre-mining aerial photos.

The results of surface and subsurface sampling indicate acid generation is occurring and, particularly in the black andesite zones, is being buffered to some degree by carbonate minerals present in the rock matrix. The acid-base accounting results from 28 samples collected in the waste rock pile indicate that 89 percent of the samples are potentially acid generating. Forward acid titration tests show mixed volcanics with little to no buffering capacity, rhyolite with moderate carbonate buffering, and andesite with minor calcite having buffering capabilities. It is noted that these samples may not be representative of the lateral and vertical extent of the waste rock pile.

As discussed above, two humidity cell tests were conducted on Sugar Shack South samples consisting of mixed aplite/andesite (HC4) and rhyolite (HC5). Neither sample produced acid leachate at any time during the test. However, it was projected that the rhyolite sample may become potentially acid generating over time. It is noted that mixed volcanics, which are known to be acidic and classified as potentially acid generating, comprise a significant portion of the Sugar Shack South Waste Rock Pile. A sample of the mixed volcanics from Sugar Shack South was not used for the humidity cell test.

Total concentrations of metals in surface and subsurface samples include aluminum – 5,000 to 19,100 mg/kg, copper – 42 to 371 mg/kg, iron – 19,900 to 41,600 mg/kg, manganese – 293 to 1,690 mg/kg, and zinc – 38 to 570 mg/kg.

Eighteen waste rock samples were subjected to the SPLP 2:1 leach extraction. The final leachate pH values ranged from 3.71 to 7.68; acidic samples included both mixed volcanics and an andesite/rhyolite mix. The SPLP 2:1 leachate concentrations were varied depending on the pH, including (on a dry weight basis) sulfate – 2,640 to 6,400 mg/kg, aluminum – 7 to 288 mg/kg, copper – less than 1 to 14 mg/kg, iron – less than 1 to 106 mg/kg, manganese – less than 1 to 49 mg/kg, zinc – less than 1 to 11 mg/kg, and fluoride – 3 to 73 mg/kg.

There are several deep gullies, up to 20 to 30 feet deep that have been initiated by ponding of water on benches and rapid overtopping, and extend from the crest to the toe of the intermediate rock pile slopes. Fans form at the base of these gullies that are cone shaped. The waste rock material from these gullies appears to often flow as a saturated debris or sediment flow. The existing erosion gullies are the result of rainstorm events, some of which were significant. However, none were greater than about the 25-year storm event (Norwest 2005).

5.10.2.2.5.6 Middle

The Middle Waste Rock Pile is located along an unnamed drainage approximately 2,000 feet south-southeast of the open pit, between Sugar Shack South and Sulphur Gulch South waste rock piles. It is also one of the roadside waste rock piles located along State Highway 38. The drainage differs as compared to the drainages beneath Sugar Shack South and Sulphur Gulch South, as it has no hydrothermal scar within the drainage (except for a rather small area of scar overlap from the other drainages that could be within the errors of mapping accuracy). The Middle drainage also has a larger area and is more deeply incised than the other two drainages.

The Middle Waste Rock Pile has a maximum height of 1,300 feet and a maximum thickness of 500 feet. It covers an area of approximately 140 acres. The estimated total volume of the waste rock pile is 53.9 million yd^3. The overall slope of the pile is 2.1H:1V; the interbench slopes range from 1.4H to 1.1H:1V.

The waste rock is comprised predominantly of mixed volcanics, aplite, and black andesite. The surface of the rock pile has a divide along the 8,650-foot elevation bench, similar to the Sugar Shack South Waste Rock Pile, with mainly mixed volcanics above the bench and aplite or black andesite below the bench.

Natural moisture content varied between 6.5 and 16.7 percent. Approximately 5.5 feet of colluvium was penetrated by borehole drilling for MMW-38A before encountering bedrock. Water was encountered in the colluvium and the lowermost 7 feet of waste rock sitting on top of the colluvium for a total saturated thickness of 12-13 feet. The borehole for SI-45, located on the second bench and above MMW-38A along the drainage channel, also encountered water in colluvium beneath the waste rock pile. The thickness of the colluvium at SI-45 is over 30 feet. Beyond the toe of the waste rock pile, the colluvium thickens to over 100 feet.

The field paste pH values are typical for mixed volcanics. The acidic zone has field paste pH values between 2.4 and 4.5. Below the 8,650 bench, the waste rock pile is generally covered in aplite or black andesite, except for a small zone on the west side of the pile. The field past pH for this zone is typically between 4.5 and 6.0.

At MMW-38A, the upper 100 feet of waste rock is predominantly black andesite, and the lower 200 feet is mostly mixed volcanics, with minor aplite or black andesite. Paste pH values in the black andesite are typically between 7 and 8, but decrease to between 4 and 8 in the mixed volcanics.

The acid-base accounting results for 11 waste rock samples collected within the waste rock pile indicated that most of the mixed volcanics are classified as potentially acid generating, while the aplite and andesite vary from non-acid generating to potentially acid generating. It is noted that these samples may not be representative of the lateral and vertical extent of the waste rock pile.

Total concentrations for metals in surface and subsurface samples include aluminum – 5,900 to 6,900 mg/kg, copper – 49 to 136 mg/kg, iron – 2,770 to 31,300 mg/kg, manganese – 413 to 871 mg/kg, and zinc – 53 to 100 mg/kg. For the SPLP 2:1 leach extraction tests, the final leachate pH was acidic in 50 percent of the waste rock samples collected in 2004 and in one colluvium sample collected by CMI. The 2:1 leachate concentrations of metals ranged from low to high, depending on the sample.

5.10.2.2.5.7 Sulphur Gulch South

The Sulphur Gulch South Waste Rock Pile is located along the lower portion of the Sulphur Gulch drainage on its eastern flank, approximately 2,000 feet west of the mill. It also overlies a second unnamed drainage along its western perimeter (see Figure 2-4). It is the eastern most of the three roadside waste rock piles located along State Highway 38. Similar to Sugar Shack South, a small portion of the waste rock pile overlies a hydrothermal scar. The waste rock pile has a maximum height of 750 feet and a maximum thickness of 325 feet. It covers an area of approximately 85 acres. The estimated total volume of the waste rock pile is 32.3 million yd^3. The overall slope of the pile is 3.0H:1V; the interbench slopes range from 2.0H to 1.6H:1V.

Similar to Sugar Shack South and Middle waste rock piles, the waste rock is comprised predominantly of mixed volcanics, aplite, and black andesite. Generally, mixed volcanics cover the surface at higher elevations, while the black andesite and aplite cover the surface at the lower elevations along the southeast edge.

Three boreholes (waste rock drillholes WRD-11, -12, and -13) were drilled into the waste rock pile as part of the CMI investigation. As part of the 2005 Geotechnical Stability Evaluation, CMI drilled five slope inclinometer boreholes through the waste rock pile, colluvium, and debris fan before reaching total depth within bedrock (SI-6, SI-7, SI-44, SI-51, and SI-52). The boreholes for SI-6, SI-7, SI-44 and SI-51 were targeted for the drainage channel. Based on borehole drilling, the colluvium is known to be over 120 feet thick at the toe of the waste rock pile and thins quickly upslope to a thickness of only a few feet at SI-6 and WRD-11.

Borehole WRD-11, located on the first bench and targeted for the drainage channel, encountered predominantly black andesite with some mixed volcanics in the upper 175 feet of the waste rock pile. From 175 feet to 250 feet, mixed volcanics predominated, followed by colluvium to a total depth of 295 feet without encountering bedrock. Borehole WRD-13, drilled along the northwestern portion of the waste rock pile to a total depth of 199 feet, encountered predominantly mixed volcanics. It did not encounter colluvium and was not drilled to bedrock.

No free water was observed during drilling of either of the waste rock pile boreholes, test pits or test trenches at Sulphur Gulch Waste Rock Pile. However WRD-12, located within the Sulphur Gulch drainage channel, was completed as monitoring well MMW-39A in colluvium and water was later reported at approximately 406 feet below ground surface.

The field paste pH values are typical of the mixed volcanics (pH of about 4) and aplite/black andesite (near neutral pH). Moisture content values decreased from about 5 percent at the surface to about 1 to 2 percent near the base of the pile.

A majority of the waste rock at Sulphur Gulch South appears to be non-acid generating. However, some of the potentially acid generating rocks have enough acid-neutralizing potential that they are not presently acidic, suggesting that the rocks have undergone little weathering. The acid-base accounting results for nine samples collected from this waste rock pile suggest that about 33 percent may remain non-acid generating, 22 percent potentially acid generating, and 44 percent classified as uncertain. It is noted that these samples may not be representative of the lateral and vertical extent of the waste rock pile.

Beneath the Sulphur Gulch South Waste Rock Pile, the sampled colluvium and debris fan materials tend to fall into the uncertain range in acid-base accounting testing. Most of the colluvium samples have circumneutral paste pH; whereas the paste pH of the debris fan material is typically less than 4. This indicates that either the colluvium has little scar material or the acidity from the scar material has been leached out.

Total concentrations of metals for the surface sample collected at Sulphur Gulch South include aluminum – 9,700 mg/kg, copper – 202 mg/kg, iron – 33,600 mg/kg, manganese – 1,054 mg/kg, and zinc – 141 mg/kg. The SPLP 2:1 leach extraction tests resulted in final leachate pH values between 6.9 and 7.5. The leachate concentrations were typically low for metals and low to moderate for sulfate.

5.10.2.2.5.8 Sulphur Gulch North/Blind Gulch

The Blind Gulch Waste Rock Pile is located just northeast of the open pit along the Blind Gulch drainage. The northern most portion of this rock pile complex (formerly called North Sulphur Gulch) is located adjacent to a hydrothermal scar. The waste rock pile has a maximum height of 740 feet and a maximum thickness of 375 feet. It covers an area of approximately 128 acres. The estimated total volume of the waste rock pile is 23.6 million yd^3. The overall slope of the pile is 3.7H:1V; the interbench slopes range from 2.0H to 1.4H:1V.

The drilling program in 2,000 included three boreholes (WRD-16, -17, and -18) at Blind Gulch Waste Rock Pile. These boreholes encountered mostly black andesite and aplite. Other rock types include mixed volcanics and rhyolite. The mixed volcanics are inter-layered with aplite and a substantial amount of mixed volcanics is present below about 70 feet.

Aplite bedrock was encountered in WRD-16 and WRD-17 and colluvium in all three boreholes. Although no free water was encountered in any of the boreholes, WRD-17 was converted to monitoring well MMW-41A and, to date, no water has been observed in this well. Moisture content is approximately 3 to 5 percent from surface to about 160 feet. The bottom portions of the boreholes (lower 50 feet) were somewhat drier (about 1 to 2 percent).

The field paste pH values are typical of mixed volcanics and aplite/andesite rock. Paste pH values for the mixed volcanics ranged between 2.3 and 2.7. This area comprises only a small volume of material. The paste pH values for the rest of the Blind Gulch waste rock complex ranges from 2.1 to 6.5. Although these results suggest heterogeneity in the rock pile, distinct zones of varying geochemistry can be defined and differentiated in the field based largely on color.

As may be expected from the variety of the rock types in this waste rock pile, the acid-base accounting results for 27 samples are quite variable. Fifty-two percent are classified as Uncertain with respect to acid-generating potential, 44 percent as potentially acid generating, and 4 percent as non-acid generating. It should be noted that these samples may not be representative of the lateral and vertical extent of the waste rock pile.

Total concentrations detected for metals from surface and subsurface samples include aluminum – 3,200 to 9,400 mg/kg, copper – 74 to 113 mg/kg, iron – 11,000 to 36,300 mg/kg, manganese – 299 to 653 mg/kg, and zinc – 20 to 42 mg/kg. The SPLP 2:1 leach extraction tests have circumneutral pH (5.45 to 7.91), typically low metal concentrations and low to moderate sulfate concentrations (154 to 3,680 mg/L).

5.10.2.2.5.9 Spring Gulch

The Spring Gulch Waste Rock Pile is located along Spring Gulch drainage about 2,000 feet northwest of the mill. The waste rock pile has a maximum height of 750 feet and a maximum thickness of 325 feet. It covers an area of approximately 85 acres. The estimated total volume of the waste rock pile is 17.7 million yd^3. The overall slope of the pile is 3.0H:1V; the interbench slopes range from 2.0H to 1.6H:1V.

The northern most upper lift of the waste rock pile is comprised of mixed volcanics. However, the majority of the rock pile is comprised of aplite and black andesite, estimated at about 10.7 million yd^3. The non-acid generating waste rock at Spring Gulch has been proposed as borrow material for covering the other waste rock piles.

Two boreholes (WRD-1 and WRD-2) were drilled into the Spring Gulch Waste Rock Pile in 1999 and another two (WRD-14, WRD-15) in 2000 by Molycorp. The WRD-15 borehole encountered 17 feet of colluvium beneath the waste rock pile. Free water was observed in WRD-15 within the lowermost 15 feet of waste rock and the underlying colluvium and the borehole was completed as monitoring well MMW-40A. No free water was observed in any of the other boreholes.

Field paste pH values of the mixed volcanics in the northern-most, upper lift typically ranged between 2.8 and 3.7. The majority of the waste rock pile had field paste pH values between 3.9 and 7.1 for the aplite and black andesite. At depth, the aplite and andesite had paste pH values ranging between 6 and 8. The mixed volcanics exhibited paste pH values less than 4 at depth. Temperatures recorded in borehole WRD-2, located in the upper lift of mixed volcanics exceeded 100º F at about 50 feet in depth. The borehole was acidic throughout its depth and moisture content varied from less than 5 percent to approximately 10 percent.

Elevated conductivity and high pH indicate that oxidation is occurring in this waste rock pile, but that any acidity generated is being buffered by calcite, producing gypsum at concentrations up to its solubility.

Currently, the majority of Spring Gulch Waste Rock Pile appears to be non-acid generating. However, acid-base accounting results from 41 samples suggest that only about 7 percent of the waste rock may remain non-acid generating, and that 44 percent is considered potentially acid generating and 51 percent is uncertain. Humidity cell tests were conducted on each of the aplite, andesite, and mixed volcanics. The mixed volcanics were initially acidic and stayed acidic. The andesite sample was projected to become acid over time and the aplite sample was classified as uncertain to potentially acid generating.

Forward acid titration tests showed the black andesite and aplite to have moderate to substantial buffering potential within the pH of 7 to 5, where carbonates are most reactive. However, the mixed volcanics show no substantial buffering until the aluminosilicate feldspars dissolve (at pH<3), thereby providing buffering at pH values below this level.

Total concentrations of metals detected in surface and subsurface samples from Spring Gulch Waste Rock Pile include aluminum – 1,700 to 27,800 mg/kg, copper – 38 to 242 mg/kg, iron – 7,700 to 53,200 mg/kg, manganese – 113 to 1,054 mg/kg, and zinc – 12 to 141 mg/kg. The SPLS 2:1 leach extraction tests produced low leachate pH and elevated leachate metals for the mixed volcanics and circumneutral pH (6.23 to 7.93) with typically low metals and low sulfate concentrations for aplite and andesite.

A substantial portion of the aplite and black andesite waste rock has undergone additional testing to determine its potential suitability as cover material (Golder 2002).[29] A total of 378 samples analyzed for paste pH exhibited an arithmetic mean of 7.25, with values ranging from 2.50 to 8.67 (Golder 2007). The acid-base accounting data indicates a classification of rock types being uncertain or potentially acid generating. However, with further review of 134 aplite/andesite rock type acid-base accounting data, the following is noted:

- Sixty-four samples are from test plot soils: 62 samples are non-acid generating, 1 sample is potentially acid generating, and 1 sample is uncertain;
- Seventy remaining samples: 9 are non-acid generating, 26 potentially acid generating, and 35 uncertain.

[29] The borrow material testing program conducted by Golder was not part of the RI/FS activities and, therefore, its design and implementation were not approved by EPA.

The test plots were constructed of aplite and black andesite rock. Spring Gulch waste rock, specifically the aplite and black andesite, have been proposed by CMI as the potential source for cover material, based upon these resultant non-acid generating characteristics.

5.10.3 Catchment Water

Several catchments have been constructed at the mine site to collect and control seepage from waste rock and storm water runoff. The catchments are part of a mine site management plan to prevent storm water runoff from leaving the property and entering the Red River.

5.10.3.1 Capulin Seepage Catchments

Waste rock seepage mixes with impacted storm water runoff from the rock pile and diverted storm water from the top of the Goathill North Waste Rock Pile in the upper Capulin Canyon catchment. The lower catchment collects seepage and impacted storm water between it and the uppermost catchment.

The seepage-mixed water in the two Capulin Canyon catchments is acidic with pH values ranging from the upper 2's (upper catchment) to lower 3's (pumpback catchment). Both waters are aluminum-sulfate to aluminum-magnesium-sulfate type. The water is dominated by sulfate and contains no alkalinity.

Several metals and inorganic chemicals were identified as COPCs and carried forward for evaluation in risk assessment. Based on EPA's HHRA, three metals are identified as human health COCs: beryllium, cadmium, and manganese. Sulfate is also a COC, as it is present at concentrations above the numeric criterion of the New Mexico ground water standard for sulfate. The COCs and their concentrations and cleanup levels are summarized in Table 5-3, below.

TABLE 5-3
CONTAMINANTS OF CONCERN AND RANGES IN CONCENTRATIONS
CAPULIN SEEPAGE CATCHMENTS

COC	Concentration (mg/L)	Cleanup Level (mg/L)
Beryllium	0.14 – 0.48	NA
Cadmium	0.008 – 0.76	0.005[1]
Manganese	170 – 730	0.05[2]
Sulfate	300 – 17,000	250[2]

Notes:
1. New Mexico Surface Water Standard Domestic Water Supply for Tributaries to Red River
2. New Mexico Secondary MCL Standards for Drinking Water

Ecological risk was not calculated for the catchment waters as they are unlikely to represent a significant source of risk to terrestrial receptors because of the limited area and limited attractiveness of the habitat, and they have little potential for affecting trout in the Red River. Therefore, no ecological COCs have been identified.

5.10.3.2 Storm Water Catchments

Storm water catchments are located in the major drainages of the mine site to collect runoff from rainstorms and snowmelt (see Figure 2-2). Water in the catchments collects only after large storms or rapid snowmelt and typically infiltrates into the ground within a few days.

Storm water catchment samples were collected during the RI at the following locations:

- Mill Area Catchment (Storm1) – April, July, and September 2003
- Upper Sugar Shack West Catchment – September 2003
- Upper Goathill Gulch Catchment – September and October 2003, March 2004
- Lower Goathill Gulch Catchment (Lower Reach) – July, September, October 2003

- Lower Capulin Canyon Catchment – September 2003

Other storm water catchment samples collected after RI field activities as part of the requirements under DP-1055 were also used to characterize storm water quality. They are:

- Mill Area Catchment (Storm1) – 2004, 2005, 2006
- Sulphur Gulch South Detention Basin[30] – 2005, 2006
- Sulphur Gulch North Detention Basin – 2005, 2006
- Upper Sugar Shack West Catchment[31] – 2004, 2005
- Middle Sugar Shack West Catchment (#2 Shaft Catchment Pond) – 2004, 2005
- Upper Goathill Gulch Catchment – 2004, 2005, and 2006
- Lower Capulin Canyon Catchment (upper of two catchment ponds near mouth of canyon – 2004

The results of the sampling indicate that acidic water (pH values between 3 and 5) occurs in storm water catchments near the base of the Sugar Shack West Waste Rock Pile, the North Detention Basin, and the lower Capulin Canyon catchment. Other catchments have more varied pH values: South Detention Basin (6 to 7), which no longer exists, Mill Area catchment (6.5 to 7.5), upper Goathill Gulch catchment (6 to 10), and lower Goathill Gulch catchment (about 5 to 7).

Concentrations of COPCs (primarily metals) exceeded the human health and ecological SLC in one or more samples for each catchment. The highest concentrations of all the metals and inorganic chemicals were found in the upper Sugar Shack West catchment, which correspond to the lowest pH values. Cadmium concentrations were also higher in the lower Capulin Canyon catchment, while higher fluoride levels were found in the North

[30] The basin was removed in late 2006.
[31] The catchment was filled in and leveled off in 2006

Detention Basin. A summary of the concentrations of the COPCs for each storm water catchment is shown in Table 5-4.

All of the storm water catchments are unlined, with the exception of the North Detention Basin and one Mill Area catchment. The unlined catchments allow water to evaporate or infiltrate into the ground, causing contamination of ground water. The storm water collected in the North Detention Basin is conveyed to the open pit as part of the SWPPP under NPDES MSGP NMR05GC01, where it infiltrates into the underground workings and is collected as part of the mine dewatering operations. The Mill Area Catchment is permitted for periodic discharge to the Red River (Outfall 005) under NPDES Permit NM0022306.

Based on EPA's HHRA, manganese is the only COC that has the potential to contribute appreciably to human health risk from exposure to catchment water. However, exposure to surface water in the catchment is likely overestimated based on exposure assumptions used in the HHRA and the estimated duration of water detained in the storm water catchments, which is far fewer than the estimated days of exposure per year.

Based on EPA's ERA, the following metals were identified as ecological COCs: aluminum, barium, cadmium, copper, iron, manganese, and zinc. In the evaluation, trout-based toxicity threshold values were used to assess potential affects to the Red River should storm water come into contact with Red River surface water. Risk to terrestrial receptors was not evaluated as the catchments are unlikely to represent a significant source of risk to terrestrial receptors because of the limited area, limited attractiveness of the habitat, and the ephemeral nature of the water in a storm water catchment.

Although human health and ecological COPCs are identified in storm water at the mine site, no CERCLA response action will be considered because storm water is currently regulated under the MSGP. As a federally permitted release, it is exempt from CERCLA response actions. However, this does not preclude storm water from being regulated by New Mexico for the protection of ground water

5.10.4 Ground Water

The characterization of ground water at the mine site was performed using analytical data from samples collected at monitoring wells and seeps/springs during the RI data collection period (September 2002 through May 2004). Data collected after the RI period (third quarter 2004 through second quarter 2006) as part of the discharge permit DP-1055 monitoring requirements were also used to assess possible trends in the data. The locations of all wells and seeps/springs are depicted on Figure 2-4.

Ground water samples were collected and analyzed for metals and other inorganic chemicals typically present in acid rock drainage. Focused analysis of organic chemicals was performed in areas where organic compounds may have been used or disposed at the mine site (*e.g.,* landfill areas).

Based on the results of the ground water analyses, contamination is found in ground water throughout the mine site. The ground water is contaminated primarily from acid rock drainage and metals leaching. A comparison of the data to EPA's SLC identified several metals and inorganic chemicals as COPCs. One organic COPC, 2,4,6-trinitrotoluene (an explosive) was also detected in less than five percent of the samples analyzed for this constituent.

Subsequently, based on the EPA HHRA, there are several COCs in ground water at the mine site. There are also several COCs which exceed the numeric criteria of New Mexico water quality standards, including sulfate. Although sulfate is not a listed hazardous substance under CERCLA, it is a precursor to the formation of sulfuric acid, which is a CERCLA hazardous substance and it is a primary component of acid rock drainage at the Site. Typical ranges of concentrations or standard units for key COCs and their cleanup levels are presented in Table 5-5 below.

TABLE 5-5
CONTAMINANTS OF CONCERN FOR MINE SITE GROUND WATER

COC	Concentration (mg/L)	Cleanup Levels[2] (mg/L)
Arsenic[1]	0.00029 - 11.9	0.01[8]
Aluminum	0.0099 - 3720	5.0[3]
Antimony	0.0003 - 0.174	0.006[8]
Cadmium	0.00011 - 0.57	0.005[8]
Copper	0.00043 - 139	1.0[6]
Fluoride	0.38 - 180	1.6[7]
Iron	0.018 - 65900	1.0[6]
Manganese	0.0012 - 340	0.2[6]
Molybdenum	0.00092 - 184	0.08[5]
Sulfate	1.77 - 8.73	600[6]
Vanadium	0.00013 - 36.2	0.33[4]
Zinc	0.0037 - 62.7	10[6]
pH (SU)	1.77 - 8.73	6-9

Notes:
(1) Arsenic is the only COC considered a carcinogen
(2) The basis for the cleanup levels is to comply with federal/NM drinking water standards (MCLs) and NM water quality standards as ARARs and EPA health-based criteria as TBCs, except where background concentrations exceed such ARARs or TBCs.
(3) NM Standard for Irrigation
(4) EPA Region 6 Health-Based Screening Level Criterion for Vanadium Pentoxide
(5) EPA Health-Based Criterion
(6) NM Standard for Domestic Water Supply
(7) NM Human Health Standard
(8) NM MCL (adopts by reference federal MCL in 40 CFR Part 141)
SU = Standard Units

Characterization of the nature and extent of COCs in ground water focuses on seven "key" COCs that describe the distribution and temporal changes in ground water at the mine site. They are listed below (metal concentrations are discussed for the total form).

- Aluminum
- Fluoride
- Manganese
- Molybdenum
- Sulfate
- Zinc
- pH

Analytical results from lead and sulfur isotopes, lanthanides (rare earth elements), and stable isotopes of oxygen and hydrogen were used in an attempt to identify sources of contaminated ground water.

Separate discussions of the nature and extent of COCs are provided for the following aquifers and water-bearing units at the mine site: (1) Red River alluvial aquifer[32], (2) colluvial water-bearing unit, and (3) bedrock water-bearing unit. For each of these aquifers and water-bearing units, the following are discussed:

- Potential sources and pathways;
- Concentrations of COCs;
- Distribution of COCs – horizontal and vertical extent and temporal changes;
- Seeps and springs – source of the seeps and COC concentrations and distribution.

In some instances, the colluvial and bedrock water-bearing units were further sub-divided by watershed within separate tributary drainages. This was done because the pathways and migration of water in the colluvium and bedrock are strongly influenced by the steep topography that defines the watersheds.

[32] The Red River alluvial aquifer inter-fingers with the colluvium and debris fan materials at the mouth of the tributary drainages at the mine site. These areas of inter-fingering represent a "mixing zone" of alluvial and colluvial waters. Ground waters within these mixing zones are considered as part of the Red River alluvial aquifer.

The COC concentrations at the mine site were then compared to reference background concentrations (statistical comparison) and to USGS pre-mining concentrations as another component of the evaluation and characterization.

5.10.4.1 Red River Alluvial Aquifer

The Red River alluvial ground water exemplifies the chemical nature of ground water that has mixed with acid rock drainage from mining operations and, in some instances, hydrothermally-altered tributary drainages located upstream and along the mine site. Alluvial ground water mixes with the acid rock drainage-impacted colluvial water from the tributary drainages as it passes along the mouth of the drainages. This results in the alluvial ground water downgradient of the drainages having lower pH values and higher concentrations of metals and other inorganic chemicals compared to ground water in reference background areas. The alluvial ground water discharges to the Red River along certain reaches and ground water is also recharged by river water primarily during high-river stages (spring snowmelt runoff).

5.10.4.1.1 Sources and Pathways

Significant sources of COCs upstream of the mine are the hydrothermal scar drainages (e.g., Hottentot, Straight, and Hanson creeks). The acidity of the upstream alluvial ground water on the north side of the aquifer suggests little mixing with the near-neutral pH water of the Red River alluvial aquifer.

Along the mine site reach, the sources of COCs to the alluvial ground water are the waste rock piles, hydrothermal scars (in some drainages), as well as the colluvium and debris fan materials that are formed within the drainages. For those scar-impacted drainages, the debris fans are partially made up of eroded scar materials. Most of the scars at the mine site have been covered over by the waste rock piles, except in Goathill Gulch, lower Capulin Canyon, and above the open pit. Scar material that was in the area of the open pit was removed as part of the overburden and is now located within the waste rock piles.

The pathway to the alluvial ground water from these sources is the downward infiltration and percolation of acid rock drainage through the waste rock piles to the underlying colluvium, scar, or debris fan materials with eventual flow through colluvium or debris fans to the alluvial aquifer. For those areas where scars are not covered by waste rock, the acid rock drainage moves through the scar material to the colluvium and debris fan materials to the alluvial aquifer.

5.10.4.1.1.1 Sulphur Gulch and Unnamed Drainages under Middle and Sugar Shack South Waste Rock Piles

Downstream of the mill, the primary sources of COCs and acidity to the alluvial ground water are the roadside waste rock piles within the former Sulphur Gulch and unnamed drainages (Middle, and Sugar Shack South). The Sulphur Gulch North/Blind Gulch and Spring Gulch waste rock piles may also be contributing sources, but limited borehole drilling has not found free water in portions of the colluvium within the channels of these former drainages. Hence, water may be discontinuous within these drainage channels (possibly influenced hydraulically by the open pit) or its flow paths may not have been adequately delineated by drilling. Hydrothermal scars underlie Sulphur Gulch and Sugar Shack South waste rock piles and eroded scar material is present in the colluvium and debris fans that formed within those drainages. The scars, colluvium and debris fan materials are additional sources of COCs. The unnamed drainage for the Middle Waste Rock Pile is not associated with a hydrothermal scar.

Non-impacted ground water with near neutral pH commingles with the Red River alluvial ground water from the Columbine Creek drainage to the south and downstream of the roadside waste rock piles.

5.10.4.1.1.2 Goathill and Slick Line Gulches

Goathill Gulch and Slick Line Gulch are the next downstream drainages that impact the alluvial ground water. The primary source within these drainages is the massive debris fan that has formed at the mouth of these two drainages. This debris fan actually represents two coalescing fans which developed for the two drainages. The debris fan contains eroded scar material from the Goathill Gulch drainage. Slick Line Gulch does not contain a hydrothermal scar. However, the Goathill Gulch debris fan appears to be the larger of the two fans and extends over a significant portion of the mouth of Slick Line Gulch.

Acid-rock drainage at Sugar Shack West, Goathill North, and Goathill South waste rock piles is also a source within the Goathill Gulch and Slick Line Gulch drainages. In addition, seepage diverted from the Capulin Canyon drainage via the horizontal borehole is an additional potential source to the Goathill Gulch drainage. However, as discussed above, multiple lines of evidence demonstrate that most acid rock drainage and leachate from these waste rock piles do not currently reach the alluvial aquifer due to the subsidence area and hydraulic ground water capture created by dewatering of the underground mine workings.

However, the influence of the underground mine dewatering on bedrock water under Sugar Shack West Waste Rock Pile is fairly recent (MMW-36B went dry in 2007). The leachate generated by acid rock drainage within the waste rock piles that impacted colluvial/bedrock ground water prior to the influence of the hydraulic capture may still remain in the lower portion of the drainage and may continue to flow to the alluvial ground water for years. The EPA has estimated a range of transit times from 2 to 62 years for waste rock leachate-impacted ground water to travel from the subsidence area to the mouth of Goathill Gulch (MMW-44A). Assuming that capture of leachate from the Goathill North Waste Rock Pile did not occur until 1983 or later, there is the possibility that the leachate from Goathill North (as well as the other waste rock piles within the Goathill Gulch and Slick Line Gulch drainages) is present in colluvial ground water within the lower portions of the drainages and will continue to migrate through the drainages to the Red River alluvial aquifer for years to come.[33]

5.10.4.1.1.3 Capulin Canyon

Capulin Canyon is the next and last downstream drainage at the mine site with sources to the alluvial ground water. There are mining and natural sources present within or near the drainage. Capulin Waste Rock Pile is a source of acid rock drainage which flows as seepage from or near the toe of the rock pile. Currently, the seepage is collected by the Capulin Canyon leachate collection system and diverted and piped out of the watershed to the Goathill Gulch drainage. Seepage may bypass the collection system as it flows over open ground prior to reaching the catchments. It is also unknown whether seepage infiltrates into bedrock beneath the waste rock pile. There appears to be no colluvium near the rock pile.

As with Goathill and Slick Line gulches, EPA has estimated a range of transit times from 0.5 to 23 years for waste rock leachate-impacted ground water to travel from the upper portion of Capulin Canyon at the collection system to its mouth at MMW-2.[34] Hence, it is likely that waste rock leachate is present in colluvial ground water within the lower portions of the drainage and will continue to migrate through the drainage to the Red River alluvial aquifer for years to come.

Other natural sources within Capulin Canyon are a small hydrothermal scar located midway up the drainage and a debris fan at the mouth of the drainage which is partly comprised of eroded scar material. Other potential sources are the bedrock near the canyon mouth that contains a northeast to southwest zone of mineralization connecting the main ore body to the mining district in Bear Canyon (located south of the Red River) and fill material near the mouth of the canyon that was used to stabilize the north bank of the river

[33] CDM Technical Memorandum: Determination of Groundwater Flow Velocity in the Goathill Gulch, Molycorp, Inc. Site, 2010
[34] CDM Technical Memorandum: Determination of Groundwater Flow Velocity in Capulin Canyon Drainage, Molycorp, Inc. Site, 2010

after a large flood in 1976. The fill material came from the mine and likely consisted of waste rock material.

5.10.4.1.2 Ground Water Quality and Concentration Ranges of COCs

Ground water quality and COC concentrations in the alluvial ground water are characterized by sampling of 36 monitoring or supply wells completed in the alluvium. The alluvial ground water along the mine site is characterized as primarily calcium-sulfate type water, with magnesium the second most abundant cation. Sulfate (SO_4) is 80 percent or more of the major anion chemistry, except along the south side of the aquifer at Columbine Park where bicarbonate (HCO_3) is the major anion and indicates a source of alkalinity to the alluvial aquifer. The alkalinity may be sourced by ground water from the Columbine Creek alluvial aquifer. There is also some alkalinity in the ground water at the Mill Area, possibly sourced by a watershed to the south or bedrock ground water in the vicinity of MMW-43A.

Alluvial ground water along the north side of the aquifer has elevated concentrations of COCs and low pH values. Typical ranges of concentrations or standard units for key COCs and their cleanup levels are summarized in Table 5-6 below.

5.10.4.1.3 COC Distribution

The distribution of COCs was evaluated using plots of Stiff diagrams and isoconcentration contour maps to assess the spatial distribution, and graphs of concentrations over time to assess temporal changes. The Stiff diagrams include aluminum, fluoride, manganese and sulfate, as well as other cations and anions. The isoconcentration maps show the magnitude of COC concentrations, geometry of COC-impacted water, and areas where mixing or dilution may occur between different waters. The data include results from monitoring and supply wells and seeps and springs. The contour intervals include the human health SLC established by EPA and, when practicable, the New Mexico ground water standards.[35] The contour maps also include concentration data from the colluvial water-bearing units to show the mixing of alluvial and colluvial ground waters near the mouth of the tributary drainages.

TABLE 5-6
RANGES OF CONCENTRATIONS OR STANDARD UNITS FOR KEY COCs IN ALLUVIAL GROUND WATER WELLS ALONG MINE SITE

COC	Concentration (mg/L)	Cleanup Levels[1] (mg/L)
Aluminum (total)	<0.2 – 78	5.0[2]
Fluoride	0.3 – 39	1.6[4]
Manganese (total)	<0.02 – 28	0.2[3]
Molybdenum (total)	<0.005 – 0.05	0.08[4]
Sulfate	30 – 1,500	600[4]
Zinc (total)	<0.02 - 6	10[4]
pH (SU)	Upper 3's to 7	6 – 9

Notes:
(1) The basis for the cleanup levels is to comply with federal/NM drinking water standards (MCLs) and NM water quality standards as ARARs and EPA health-based criteria as TBCs, except where background concentrations exceed such ARARs or TBCs.
(2) NM Standard for Irrigation
(3) NM Standard for Domestic Water Supply
(4) EPA Health-Based Criterion
SU = Standard Units

5.10.4.1.3.1 Metals and Other Inorganic Chemicals

The overall extent and distribution of metals and other inorganic COCs in the alluvial aquifer along the mine site are generally similar with the exception of molybdenum, which is found at low concentrations throughout the aquifer and frequently below the reporting

[35] The numeric criteria in the ground water standards are based on dissolved concentrations for metals, whereas the contour maps for metals are based on total concentrations. However, dissolved concentrations are similar to the total concentrations and the contour maps should closely resemble the distribution of dissolved metals.

limit (RL). Concentrations of the other metals and inorganic COCs are elevated where the alluvial ground water mixes with more acidic, metals-laden colluvial ground water at the mouths of tributary drainages on the north side of the Red River. The mixing alluvial/colluvial ground waters at the mouth of the drainages tend to hug the north side of the alluvial aquifer as they flow in a downgradient direction (generally from east to west) with COC concentrations gradually decreasing with increasing distance from the drainage.

The concentrations entering the mine site area are also elevated, but decrease in the Mill Area and Columbine Park where the alkalinity buffers the ground water, thereby decreasing the pH. Pumping of supply wells in these areas also contribute to the decrease in concentrations.

This pattern of increasing concentrations with alluvial/colluvial ground water mixing is consistent throughout the mine site reach with the exception of the Spring 13 area, which is located upgradient of the Capulin Canyon drainage. Concentrations of several COCs increase in the Spring 13 area, including aluminum, fluoride, zinc and sulfate. Aluminum concentrations double through the Spring 13 area. Since Spring 13 is located upgradient of the mouth of Capulin Canyon, there is some uncertainty as to the whether the source of Spring 13 is the colluvial ground water flowing out of Capulin Canyon. The possible sources of Spring 13 ground water are discussed further in Section 5.10.4.2.3, below. The Stiff diagram (Figure 5-37) shows Spring 13 water to be similar in chemistry to upgradient alluvial ground water at MMW-50A, as well as colluvial ground water at the mouth of Capulin Canyon (MMW-2). With the complex faulting, fractures and joint sets documented in the area by others (Caine 2007), a flow path created by such features for colluvial ground water to source Spring 13 cannot be ruled out. Figure 5-9 shows a fault that crosses the Capulin Canyon drainage and continues southeast through the Spring 13 area.

Downgradient of Capulin Canyon and the mine site boundary, the concentrations of COCs decrease significantly, as measured in two springs along the north river bank (Spring 14-M and -MA) and a well at the Questa Ranger Station.

The spatial distribution of COCs in alluvial ground water is illustrated in isoconcentration contour maps for aluminum and sulfate (see Figures 5-38 and 5-39).

5.10.4.1.3.2 pH

Generally, the pH of the alluvial ground water at the mine site is acidic along the north side of the aquifer and reflects the mixing of acidic colluvial ground water with alluvial ground water at the mouths of the tributary drainages along the north side of the Red River valley. An isoconcentration contour map of pH (field measured values) is shown on Figure 5-40. The lower pH values are typically associated with the greater concentrations of metals and other inorganic chemicals in the alluvial/colluvial mixed ground water. In areas having alkalinity (*e.g.,* south side of alluvial aquifer in the Mill Area and Columbine Park), pH values are near neutral.

Upstream alluvial ground water entering the mine site reach has pH values in the low 4's along the northern side of the aquifer. However, this acidic ground water is buffered within a short distance downgradient to the mill as the pH reaches near neutral values.[36] Potential reasons for the buffering are pumping of the mill well and bedrock ground water upwelling near the MMW-43A area, as the Stiff diagram for MMW-43A resembles bedrock ground water chemistry (Figure 5-37).

The pH values decrease to the lower 3's at the Goathill Gulch/Slick Line Gulch debris fan and remain in the low 3's until the ground water passes Capulin Canyon and the Spring 13 and Spring 14 areas at the downgradient boundary of the mine site, where it is then buffered to near neutral pH in moving westward toward Questa.

[36] CMI has interpreted low pH waters (lower 4's) that enter the mine site reach from upgradient of the Mill Area to continue hugging the northern side of the alluvial aquifer in a downgradient direction past the mill (Figure 5-40). However, this interpretation is not supported by the data. Three wells in the Mill Area (MMW-43A, Lab Well, and MMW-28A) show pH values near neutral (approximately 6.0 to 7.0). Both monitoring wells MMW-28A and MMW-43A are located along the northern side of the aquifer.

5.10.4.1.3.3 Temporal Changes in Concentrations

Temporal changes in concentrations of key COCs in Red River alluvial ground water were evaluated by constructing time series graphs using data through second quarter 2008. Overall, concentrations of key COCs in the alluvial ground water have been relatively constant over time or exhibit some decreasing trend. A statistical trend analysis was performed for key COCs for select wells using a Mann Kendall test.

Decreasing trends in concentrations (and increasing pH) of some COCs were observed in several alluvial wells along the base of the roadside waste rock piles. The ground water withdrawal well system, which began operation in February 2003, is likely the cause of most of the reduction in concentrations. However, in late 2004/early 2005 the decreasing trends appear to have leveled off at concentrations which still remain above the numeric criteria established in New Mexico ground water standards and/or EPA's health-based SLC. Other wells have shown no decreasing trends over time (MMW-30A, MMW-10A). The time series graphs for MMW-49A and MMW-30A are shown on Figures 5-41 through 5-44.

5.10.4.1.4 Additional Sampling and Analysis

Select wells, seeps/springs, and underground locations were sampled and analyzed for lead and sulfur isotopes, lanthanides (rare earth elements), stable isotopes of oxygen and hydrogen, and tritium and helium age dating. These analyses were performed to assist in evaluating nature and extent of ground water contamination, including sources, pathways, and mixing of ground water in the alluvium, colluvium, and bedrock at the mine site.

5.10.4.1.4.1 Lead Isotopes

Lead isotopes were used in an attempt to identify the origin or source of ground water at the mine site. However, the amount of lead detected in the samples was so small as to preclude accurate measurement of the isotope ratios. Hence, the lead isotopes provided little definitive information on source-related signatures for the alluvial aquifer. As a result the data were not considered useful.

5.10.4.1.4.2 Sulfur Isotopes

Sulfur isotopes were used as a means to lend insight into possible sources of sulfate in ground water at the mine site (*i.e.,* waste rock or natural hydrothermal scar materials). The ratio of sulfur isotopes ^{34}S to ^{32}S was chosen and compared to that of a reference material. The ratio adjusted to the reference is called delta ^{34}S or $\delta^{34}S$ and the relative difference is expressed in parts per thousand, also called per mil ($^{o}/_{oo}$).

Sulfur isotope ratios ($\delta^{34}S$) were measured in a few select alluvial, colluvial, and bedrock ground water samples collected from monitoring wells and springs at the mine site and compared to $\delta^{34}S$ values measured by the USGS from the following:

- Leachate from Capulin, Sugar Shack West, Sugar Shack South, Middle, and Sulphur Gulch waste rock (Smith et al. 2007);
- Leachate from hydrothermal scar material (Smith et al. 2007; Naus et al. 2005);
- Colluvial ground water within scar-impacted Straight Creek drainage (Naus et al. 2005);
- Surface water from Goathill Gulch, Straight Creek, and Hanson Creek drainages – (Verplanck et al. 2006);
- Molybdenite (Naus et al. 2005);
- Pyrite (Naus et al. 2005);
- Supergene gypsum (Naus et al. 2005);
- Hypogene gypsum (Naus et al. 2005).

Significant variability was observed by the USGS in the sulfur isotope ratios for the waste rock leachates. The $\delta^{34}S$ values for the Sugar Shack West and Capulin waste rock leachates were –5.8 $^o/_{oo}$ and –7.9 $^o/_{oo}$ respectively, whereas $\delta^{34}S$ values from Sugar Shack South, Middle, and Sulphur Gulch South leachates were distinctly heavier, ranging from +1.3 to +2.5 $^o/_{oo}$.[37]

The $\delta^{34}S$ values for the hydrothermal scar leachates from samples at Goathill, Hottentot Creek, June Bug, and Straight Creek also show variability, ranging from –1.0 to –7.7 $^o/_{oo}$. Straight Creek leachates (–4.2 to –6.8 $^o/_{oo}$) are slightly lighter than the $\delta^{34}S$ values for Straight Creek colluvial ground water samples (approximately –3.2 to –5.2 $^o/_{oo}$).

The surface water samples collected in streams known to be affected by hydrothermal scars at Goathill, Straight Creek and Hanson Creek had $\delta^{34}S$ values of –8.7 $^o/_{oo}$, –6.9 to –8.7 $^o/_{oo}$, and –3.2 to –6.6 $^o/_{oo}$, respectively.

Sulfur isotope ratios documented by USGS for specific minerals, including hypogene gypsum (–9.8 $^o/_{oo}$), supergene gypsum (–1.4 $^o/_{oo}$), molybdenite (–1.1$^o/_{oo}$) and pyrite (–0.4 $^o/_{oo}$) were also included to provide context for the ranges of $\delta^{34}S$ values observed in the ground water.

The RI ground water sampling sites and sulfur isotope ratios are provided on Table 5-7. The sulfur isotope ratios measured by the USGS for the waste rock leachate samples are also shown on the table for a comparison. The sulfur isotope ratios for all ground water, leachate, and mineral samples are shown on Figure 5-45.

[37] USGS suggests that the difference in the $\delta^{34}S$ values between the roadside waste rock piles and the Capulin and Sugar Shack West rock piles may indicate differences in the source material of these piles. Based on differences observed in the mineralogy and bulk chemistry of the waste rock samples, as well as the history of waste rock placement at the mine site, USGS notes that Capulin and Sugar Shack West may be among the oldest piles constructed during open pit mining and likely received material extracted near the top of the overburden, whereas Sugar Shack South, Middle, and Sulphur Gulch South are younger rock piles that likely received material extracted at a greater depth within the open pit (Smith et al. 2007).

All of the ground water results, with one exception, fall within a cluster bounded by –2 $^{o}/_{oo}$ and about –7 $^{o}/_{oo}$ for $\delta^{34}S$. The exception is alluvial monitoring well MMW-30A, located at the toe of the Middle Waste Rock Pile, which has a slightly heavier $\delta^{34}S$ of –0.4 $^{o}/_{oo}$.

The $\delta^{34}S$ values of sulfate in alluvial ground water ranged from –0.4 $^{o}/_{oo}$ at MMW-30A to –2.5 $^{o}/_{oo}$ at Spring 13, to –5.0 $^{o}/_{oo}$ at downgradient well MMW-50A. The $\delta^{34}S$ values of bedrock ground water were –4.5 $^{o}/_{oo}$ at MMW-7 and –2.5 $^{o}/_{oo}$ at MMW-36B. The alluvial and bedrock ground water $\delta^{34}S$ values, excluding MMW-30A, fall within the $\delta^{34}S$ values bounded by sulfur in natural hydrothermal scar material.

The $\delta^{34}S$ values of sulfate in colluvial ground water fall within the $\delta^{34}S$ values bounded by sulfur in natural hydrothermal scar material as well as Capulin and Sugar Shack West waste rock piles. Sulfate in colluvial ground water within Capulin Canyon was measured at two locations: the upper drainage (MMW-23A) near Capulin Waste Rock Pile and the lower drainage near its mouth (MMW-2). Sulfate in colluvial ground water at MMW-23A has an isotopic composition (–7.1 $^{o}/_{oo}$) that is similar to the Capulin waste rock leachate (–7.9 $^{o}/_{oo}$), suggesting that the Capulin Waste Rock Pile is the primary source of the sulfate in the ground water within the upper drainage. There is no natural hydrothermal scar in the upper drainage.

At MMW-2, the sulfate has an isotopic composition (–4.3 $^{o}/_{oo}$), which is heavier than the Capulin waste rock leachate. It is also slightly heavier than the Sugar Shack West waste rock leachate (–5.8 $^{o}/_{oo}$), but within the range bounded by natural hydrothermal scar material. This suggests that a source of the sulfate in the colluvial ground water at the mouth of the Capulin Canyon is the hydrothermal scar located in the middle portion of the drainage. However, because of the slight difference between the $\delta^{34}S$ values at MMW-2 and the Sugar Shack West waste rock leachate, a contributing source of sulfate from waste rock within Capulin Canyon should not be ruled out.

Sulfate in bedrock ground water (MMW-36B) near the base of the Sugar Shack West Waste Rock Pile has an isotopic composition (–5.3 $^{o}/_{oo}$) that is similar to the waste rock pile

(–5.8 $^{o}/_{oo}$), suggesting that the waste rock pile was once a source of sulfate in the ground water flowing through Slick Line Gulch.[38] Like the upper portion of the Capulin Canyon, there is no observed hydrothermal scar within Slick Line Gulch.

The sulfur isotope ratios for ground water samples from colluvial or bedrock monitoring wells in or downgradient of Sugar Shack South, Middle, and Sulphur Gulch are – 2.4 $^{o}/_{oo}$ (MMW-11A), – 2.8 $^{o}/_{oo}$ (MMW-38A), and – 2.9 $^{o}/_{oo}$ (MMW-39A), respectively. Sulfate in these ground water samples is 4 to 5 $^{o}/_{oo}$ lighter than sulfate in leachate from the waste rock in these three rock piles, suggesting that the sulfur mobilized by ARD-type reactions may not be the leaching of sulfate from these rock piles.

However, these findings are contradictory to other lines of evidence which suggest these waste rock piles are significant sources of sulfate present in the colluvial ground water beneath the rock piles. Similarities in the zinc- and manganese-sulfate ratios of Middle waste rock leachates and MMW-38 ground water samples suggest a correlation. Also, high sulfate concentrations and high temperatures recorded in depth profiles at SI-45 and SI-46 indicate that acid reactions are occurring within the Middle and Sugar Shack South waste rock piles. Furthermore, the waste rock leach tests conducted by the USGS (Smith et al. 2007) were on surface samples collected mostly at or below the 8,650 ft. bench and, therefore, were comprised predominantly of black andesite and aplite. Based on acid-base accounting and field paste pH data, the black andesite and aplite appear to be non-acid generating and have some buffering capacity (field paste pH values from 4.5 to 6.0). Smith (2007) noted excess calcium concentration in leachates from the roadside waste rock piles, an indication of calcium dissolution. Because of the abundance of black andesite and aplite in the USGS samples, they may not be spatially representative of the waste rock material or the isotopic ratios of sulfur leaching from the waste rock to ground water.

In addition, the limited amount of sampling of both rock and water for isotope analysis, the composition of the waste rock piles that includes scar material removed from the area of

[38] The subsidence area and dewatering of the underground mine currently influences ground water flow beneath Sugar Shack West Waste Rock Pile, resulting in draining of the ground water to the underground workings.

open pit mining, and the mixing of source rock within the waste rock pile, makes using sulfur isotopes in this case problematic.

In light of these findings, the sulfur isotope data are interpreted with caution and not used to explicitly differentiate or identify the sources of sulfate in mine site ground water.

5.10.4.1.4.3 Lanthanides

Samples of ground water from select wells at the mine site were analyzed for lanthanides to lend insight into possible source-related signatures for the alluvial aquifer. Lanthanides are a suite of 14 metals (rare earth elements or RRE) from atomic number 57 (lanthanum, La) to 71 (lutelium, Lu): yttrium (Y) was also analyzed.

Samples were collected from three alluvial monitoring wells: two at the toe of the Middle Waste Rock Pile (MMW-29A and MMW-30A) and the third at the downgradient boundary of the mine site (MMW-45A). For comparative purposes, samples were also collected from colluvial and bedrock ground water beneath or near the base of the roadside waste rock piles (MMW-38A, -39A, -11A, and -30B) and in Slick Line Gulch near the base of, or downgradient to, the Sugar Shack West waste rock pile (MMW-21, 7, and 36B).

Overall, the lanthanides provided little definitive information on source-related signatures for the alluvial aquifer.

5.10.4.1.4.4 Oxygen and Hydrogen Isotopes

Nearly all the wells at the mine site and select springs, surface water, and underground locations were sampled for stable oxygen and hydrogen isotope analyses. Stable isotopes of oxygen (^{18}O and ^{16}O) and hydrogen (^{1}H and ^{2}H) can provide useful information to evaluate source(s) of waters and processes (*e.g.,* evaporation, condensation) that have affected the water. The $\delta^{18}O$ and δD ("D" is the heavier ^{2}H isotope named Deuterium) were calculated. They represent the relative difference in parts per thousand (or per mil

[$^{o}/_{oo}$]) between the ratio in the sample and the ratio in a standard (Standard Mean Ocean Water or SMOW).

The local meteoric water line provides a linear relationship between $\delta^{18}O$ and δD that is related to local precipitation. The local meteoric water line was derived from a limited number of precipitation samples by USGS (Naus et al. 2005) and may not be representative of the potential range of $\delta^{18}O$ and δD values in precipitation at the Site.

Values of $\delta^{18}O$ for all waters ranged from –9.8 to –13.9 $^{o}/_{oo}$ and values of δD ranged from –68 to –102 $^{o}/_{oo}$. Given the potential uncertainty in the local meteoric water line for the Site, strict interpretation of potential isotopic evaporative shifts from the water line is limited. However, general trends can be observed.

The isotopic compositions for all waters sampled are plotted on Figure 5-46. Surface water samples from the Red River had the lightest isotopic composition of all the samples and likely reflect recent contributions from snowmelt. Most alluvial aquifer wells had $\delta^{18}O$ values less than about –12 $^{o}/_{oo}$, indicating primary recharge from snowmelt runoff in the Red River. The alluvial aquifer ground water has undergone limited evaporation. The isotopic composition of seep water is similar to that of alluvial ground water.

Colluvium ground water exhibits a relatively large range in isotopic composition, reflecting different proportions of recharge from snowmelt vs. rain or recharge at different elevations. Samples collected at higher elevation colluvium were lighter than samples from lower elevation colluvium.

Bedrock ground water has the broadest range of isotopic compositions, indicating differing relative contributions from snow and rain. Some bedrock samples are shifted from the local meteoric water line generally indicating evaporation of water prior to recharge of bedrock ground water, especially for samples with heavier isotopic compositions. Underground mine water is similar in composition to bedrock ground water.

A plot of the isotopic compositions for alluvial wells and springs is depicted on Figure 5-47. Key observations made for alluvial ground water are as follows:

- Alluvial ground water at wells in the Mill Area (MMW-17A and MMW-43A) has different isotopic compositions, with ground water at MMW-43A being heavier. Based on chemistry data, the area represented by MMW-43A may be a zone of bedrock ground water discharge to the alluvial aquifer. This is supported by differences in major cations and anions (see Stiff diagram, Figure 5-37) and well as the estimated age of 91 years for MMW-43A ground water.

- Two alluvial wells along the base of the roadside waste rock piles (MMW-30A and -32A) exhibit heavier isotopic compositions that fall slightly below the local meteoric water line. This may be due to mixing with heavier bedrock or colluvial ground water. Ground water at MMW-30A periodically resembles bedrock ground water and may be influenced by discharge of bedrock ground water to the alluvial aquifer in the vicinity of this well on a seasonal basis (see Stiff diagram, Figure 5-37 and time series graphs, Figures 5-43 and 5-44).

- Spring 13, Lower Spring 13, and alluvial well MMW-50A have similar isotopic compositions. The grouping of these values suggests that the origin of the spring water is from the same source. The isotopic composition of the water from the two springs is unlike values from colluvial well MMW-2, located at the mouth of Capulin Canyon, suggesting that ground water flow from Capulin Canyon may not be a source of water at Spring 13. However, because of the extensive and variable mineralization and faulting in the area and the uncertainty in the location and well construction of MMW-2 with respect to the positioning and geometry of the drainage, the ground water flow from Capulin Canyon cannot be ruled out.

- Colluvial ground water beneath the Middle Waste Rock Pile (MMW-38A) and near the base of the Capulin Waste Rock Pile (MMW-23A) is enriched in the heavier oxygen isotope and may be a result of biogenic pyrite weathering [oxidation of sulfate via the Fe(III) reduction pathway]. However, the pH (4.1) of ground water at MMW-38A does not strongly support this process.

- Enrichment of the heavier oxygen isotope in colluvial ground water at MMW-38A is similar to the $\delta^{18}O$ values in bedrock ground water at MMW-35B in Blind Gulch and for underground mine water sampling location at Neck Fault. A comparison of the oxygen and hydrogen isotopic compositions for ground water at these three sampling locations falls along a mixing line between MMW-35A and Neck Fault, suggesting that MMW-38A colluvial ground water is a mixture of water from bedrock sources. Furthermore, tritium-helium age dating of MMW-38 ground water indicates an apparent age of 60 years (see discussion on age dating for colluvial ground water, Section 5.10.4.3.4). Thus, the apparent age of ground water at this location predates placement of waste rock in the vicinity of this sampling location. While there may be significant contribution of water from waste rock infiltration at this location, the majority of the water is older than can be explained by waste rock infiltration alone. There is currently insufficient information to confirm the source of the ^{18}O enrichment in ground water at MMW-38A. However, in light of these observations, bedrock ground water is a plausible source of the water interacting with the waste rock pile.

5.10.4.1.4.5 Age Dating

Select alluvial, colluvial, and bedrock wells and springs at the mine site were sampled for age dating of water using the tritium (^3H) and helium-3 (^3He) method. It should be noted that this method is limited to 4.5 half-lives for helium-3 or about 55 years. Results greater than 55 years are presented as reported by the laboratory, but may have uncertainty.

Alluvial ground water samples were collected along the base of the roadside waste rock piles (MMW-28A, -29A, and -30A) and at Spring 13. The youngest age of alluvial ground water was at MMW-29A (14 years), suggesting mixing of ground water and river water. The oldest age of alluvial ground water was at MMW-30A (91 years). The water at MMW-30A is sub-modern and more characteristic of a deep bedrock flow system. The paired bedrock well (MMW-30B) was estimated to have a greater age of 136 years.

Mixing of alluvial and bedrock ground water at MMW-30A is likely, and supported by evaluation of the stable oxygen and hydrogen isotopes discussed above.

Spring 13 was estimated to have an age of 19 years. Mixing of alluvial ground water and river water at Spring 13 does not appear to be substantial; otherwise the spring water would have a younger age. The age of Spring 13 water may also be due to mixing with older bedrock or colluvial ground water.

5.10.4.2 Evaluation of Seeps and Springs Along Red River

Seeps and springs that flow along the north bank of the Red River were evaluated during the RI. Figure 2-4 depicts the location of all seeps and springs at the mine site.

5.10.4.2.1 Cabin Springs

5.10.4.2.1.1 Physical Evaluation

Cabin Springs is located in Columbine Park and issues from the base of a bedrock cliff along the north side of the Red River, approximately 800 feet downstream of the confluence with Columbine Creek. In the mid-1990s, during shutdown of the mine, water from the spring formed a white alumino-hydroxide precipitate along the riverbank. When the spring is flowing, the flow rate is typically low (1-2 gpm), with the highest rate measured in 2003 at 10 gpm. Recently, due to pumping at the mine site, Cabin Springs is typically dry.

During the RI data collection period, Cabin Springs only flowed from June to August 2003. Pumping tests conducted in the vicinity of Cabin Springs in 1996 demonstrated that the flow from the spring is hydraulically connected to the alluvial aquifer system.[39] There is also a strong correlation between high alluvial ground water levels (usually in spring and

[39] The company that conducted the testing (GSi/water) drew a different conclusion that Cabin Springs flowed from the bedrock along the north side of the river.

early summer due to snowmelt runoff) and flow of the spring. If the water table of the alluvial aquifer rises to a certain elevation, then the ground water intersects the bottom of the river or riverbank and discharges.

Another factor that may influence the flow at Cabin Springs is the abundance of manganocrete. Manganocrete is cemented alluvial sediments that are hard and nearly impermeable. The Cabin Springs area is the only area where manganocrete is observed to crop out along both sides of the Red River. The abundance of manganocrete may reduce the overall transmissivity of the alluvial aquifer in the Cabin Springs area, forcing the upwelling of ground water.

5.10.4.2.1.2 Chemical Evaluation

Water from Cabin Springs has elevated concentrations of several COCs, including aluminum – 6.6 to 33 mg/L, fluoride – 7.2 to 15 mg/L, manganese – 2.2 to 17 mg/L, and zinc – 1.1 to 3.4 mg/L. Sulfate is also elevated (250 to 1,040 mg/L). When flowing, Cabin Springs' water commingles with Red River surface water and results in exposure of aquatic receptors to metals and inorganic chemicals at concentrations above EPA's SLC.

5.10.4.2.1.3 Potential Sources of Spring Water

Water from Cabin Springs was statistically compared to surrounding alluvial ground water and the nearest upgradient colluvial and bedrock ground waters that could potentially be sources of the spring water. The results showed Cabin Springs' water chemistry to be mostly similar to alluvial ground water chemistry and generally dissimilar to colluvial and bedrock ground water chemistry. This relationship is shown with the box and whisker plot of aluminum for Cabin Springs and surrounding ground waters depicted on Figure 5-48. The spring water is slightly acidic, with pH values ranging from 4.3 to 5.1.

Results from geochemical mixing modeling with PHREEQC[40] indicated one potential mixing scenario for Cabin Springs to be primarily nearby alluvial ground water, a lesser percentage of river water, with some potential contribution of upgradient colluvial ground water. However, this mixing scenario is not unique.

Even when considering these data and modeling efforts, the complex structural geology of this area, including the fracture-controlled pathways in the bedrock aquifer, adds significant uncertainty to such an interpretation of the Cabin Springs source.

5.10.4.2.2 Spring 39

5.10.4.2.2.1 Physical Evaluation

Spring 39 is located along the north bank of the Red River, approximately 1,000 feet upstream of the confluence with Goathill Gulch. It is within a large (approximately 3,500-foot long) zone of ground water upwelling that is caused by restriction of the alluvial aquifer by the Goathill Gulch debris fan. Upwelling of ground water to the river is measured by gains in surface water flow. The gains measured by USGS (tracer dilution studies) and USGS/EPA (radon-222 studies) along this reach ranged from about 3 to 5 cubic feet per second (cfs). The highest flow rate measured during the RI data collection period was 3 gpm in October 2002. The spring went dry in June 2003 following operational startup of the Spring 39 seepage interception system. The system is operated as part of the Best Management Practices established under NPDES Permit NM0022306 and is designed to control metals loadings to the Red River.

5.10.4.2.2.2 Chemical Evaluation

Spring 39 contains elevated concentrations of several COCs, including aluminum – 0.28 to 21 mg/L, fluoride – 1.0 to 9.4 mg/L, and manganese – 0.19 to 2.5. Sulfate is also elevated

[40] PHREEQC is a USGS computer program for simulating a variety of geochemical reactions and processes in natural waters.

(36 to 850 mg/L). The pH of the spring water has ranged from 4.7 to 6, but is typically near 5. Spring 39 water flows to the Red River and results in exposure by aquatic receptors to metals and inorganic chemicals at concentrations above EPA's SLC. These elevated concentrations have produced white precipitates (aluminum hydroxide) that are visible along an approximate 200-foot reach of the riverbank.

Concentrations decreased from early 2003, following operational startup of the Spring 39 seepage interception system, to early 2006 and have since leveled off, some of which are at concentrations still above the SLC. Statistical trend analyses of the Spring 39 data collected between 1993 and 2008 indicate that aluminum, manganese, and zinc have statistically significant decreasing trends at 95 percent confidence, whereas fluoride (2001 to 2008 data) does not exhibit a statistically significant trend. Concentration vs. time plots for key COCs are depicted on Figures 5-49 and 5-50. Decreases in concentrations are attributed to the operation of the Spring 39 seepage collection system and, to a lesser degree, the ground water withdrawal wells GWW-1, -2, and -3, located upgradient of Spring 39.

5.10.4.2.2.3 Potential Sources of Spring Water

Key COC concentrations at Spring 39 were compared to concentrations in surrounding waters to determine the potential source(s) of water at the spring. Plots of COC concentrations against sulfate concentrations indicate Spring 39 water to have higher sulfate than the upgradient alluvial ground water, suggesting that the spring water is a mixture of upgradient alluvial water and colluvial water from the eastern Goathill debris fan. The plot of fluoride vs. sulfate is shown on Figure 5-51.

Sources of the metals, inorganic chemicals and acidity to the water at Spring 39 are likely the upgradient alluvial ground water, upwelling of bedrock water[41], and the Goathill debris fan sediments, which are inter-bedded with sediments of the Red River alluvial aquifer.

[41] Quantification of Mass Loading from Mined and Unmined Areas Along the Red River, New Mexico; USGS Series Report No. 23, 2006

The debris fan sediments are comprised of eroded material from natural hydrothermal scars and mineralized slopes within the Goathill Gulch drainage. The surface soils in the lower Goathill Gulch are acidic and contain metals that could be leached. The inter-bedded debris fan and alluvial sediments, with relatively low pH alluvial/colluvial-mixed ground water, could provide a condition for long-term leaching of metals that could contribute COPCs to water flowing from Spring 39.

The Goathill North, Goathill South, and Sugar Shack West waste rock piles located at the headwaters of the Goathill Gulch and Slick Line Gulch drainages were once likely contributing sources of metals, organics, and acidity to the alluvial aquifer. Goathill North is currently acid generating, and Goathill South and Sugar Shack West contain waste rock classified as both acid generating and potentially acid generating. However, the development of the subsidence area over the last 20 plus years of underground mining has provided a sink for waste-rock seepage in both these drainages, as well as the diverted Capulin waste rock seepage. Therefore, most, if not all, the seepage-impacted ground waters within these upper drainages are now effectively diverted underground (to the underground mine) by this subsidence area. Waste rock leachate from the Goathill North, South, and Sugar Shack West waste rock piles may still be present within the lower portion of these drainages and continues to flow to the alluvial aquifer (see Section 5.10.4.1.1.2, above).

5.10.4.2.3 Spring 13

5.10.4.2.3.1 Physical Evaluation

Spring 13 is located approximately 700 feet upstream of the Red River and Capulin Canyon confluence. It consists of a series of small seepage points along the northern riverbank. Bear Creek drains the watershed south of the Red River and flows into the river about 400 feet downstream of Spring 13. Flows range from zero to 3 gpm, with an average flow rate around 0.5 gpm. A second point of continuous seepage is approximately 300 feet downstream of Spring 13 and is identified as Lower Spring 13. Flows range from 0.1 to 3 gpm, with an average of about 0.5 gpm.

Spring 13 and Lower Spring 13 are in a reach of the Red River where there are upwelling conditions likely caused by a bedrock valley constriction that reduced the width and cross-sectional area of the alluvial aquifer. Other contributing factors to the upwelling conditions are the debris fans at the mouths of Capulin Canyon and Bear Creek. Upwelling conditions have been measure by increases in stream flow. Gains in stream flow as measured by USGS tracer dilution studies and USGS/EPA ^{222}radon tracer studies ranged from 0.4 to 1.1 cfs. All stream flow gains are attributed to ground water upwelling because there are no tributary entering the river along this reach.

As previously discussed, physical features in the Spring 13 area have been altered. In 1979, fill material was placed along the riverbank for stabilization by the U.S. Army Corps of Engineers after a large flood caused significant erosion of the riverbank. The fill material was provided from the mine and likely included waste rock. In the mid-1990s, a passive treatment system consisting of anoxic drains was constructed within limestone cobble-filled trenches along the northern riverbank by state regulators after concerns were raised about the accumulation of white precipitates (aluminum hydroxide). In February 2003, the operation of the Spring 13 seepage collection system commenced for controlling metals loadings to the Red River. The seepage collection system was constructed as part of Best Management Practices established under NPDES Permit No. 0022306.

5.10.4.2.3.2 Chemical Evaluation

Spring 13 water has elevated concentrations of COCs, including aluminum – 27 to 122 mg/L, iron – 2.7 to 36 mg/L, fluoride – 5.8 to 50 mg/L, manganese – 3.4 to 16 mg/L, and zinc – 0.82 to 4.5 mg/L. Sulfate concentrations are also elevated (573 to 1,990 mg/L). The spring is acidic, with pH values ranging from 3.1 to 4.2. Lower Spring 13 has similar concentrations of metals and inorganic chemicals and similar pH values. Concentration vs. time graphs of key COCs are depicted on Figures 5-52 and 5-53 showing trends that are unchanged over time. Spring 13 and Lower Spring 13 flow into the Red River, resulting in exposure by aquatic life to metals and other inorganic chemicals at concentrations above EPA SLC, as well as low-pH water.

5.10.4.2.3.3 Potential Sources of Spring Water

Multiple lines of evidence indicate that the primary source of Spring 13 and Lower Spring 13 waters is the Red River alluvial aquifer. Stable isotopes of oxygen and hydrogen are nearly identical for Spring 13 and upgradient alluvial ground water in MMW-50A. Lower Spring 13 tends to group with these waters as well. It is noted that the isotopic compositions for colluvial and bedrock ground water at the mouth of Capulin Canyon (MMW-2, MMW-3) are significantly different than Spring 13, suggesting that colluvial or bedrock ground waters from the mouth of Capulin Canyon may not be a contributing source of water at Spring 13 or Lower Spring 13. The isotopic compositions for Spring 13 and surrounding waters are graphed on Figure 5-54.

The chemistry of Spring 13 and Lower Spring 13 waters have similarities with the alluvial aquifer, but exhibit higher concentrations of metals and inorganic chemicals in comparison to upgradient and downgradient alluvial ground water, which is suggestive of another source local to the springs.

Plots of key COC concentrations were made to evaluate similarities between Spring 13 and Lower Spring 13 waters to surrounding waters. A plot of aluminum and sulfate concentrations is shown on Figure 5-55. The alluvial ground water flow path has been superimposed onto the plot to illustrate the movement of water. Aluminum concentrations at Spring 13 increase two fold from the nearest upgradient well MMW-50A. The cause of this increase may be from bedrock as the aluminum concentrations in bedrock monitoring well MMW-45B are some of the highest concentrations measured in bedrock ground water at the mine site. Colluvial and bedrock water from Capulin Canyon (MMW-2, MMW-3) have lower aluminum concentrations and do not appear to be the cause of increased aluminum concentrations at Spring 13. Bedrock ground water beneath the alluvial aquifer near the western edge of the Goathill debris fan (MMW-42B) also does not appear to be the source of elevated COCs because aluminum is not detected in the ground water. Aluminum concentrations decrease at downstream springs 14-M and 15-M.

A plot of pH vs. sulfate concentrations is shown on Figure 5-56. Values of pH are similar to the alluvial ground water and the bedrock ground water at MMW-45B, but dissimilar to colluvial and bedrock ground waters at the mouth of Capulin Canyon.

5.10.4.2.3.4 Possible Source(s) of Increased COC Concentrations

Colluvial and Bedrock Ground Water from Capulin Canyon: Based on multiple lines of evidence (*i.e.,* aluminum concentrations, pH, and stable isotopes), colluvial and bedrock ground waters from Capulin Canyon do not appear to be sources of the increased COCs at Spring 13 or Lower Spring 13. The confluence of the canyon drainage is estimated to be 700 feet downstream of Spring 13, thus, water cannot flow upgradient to Spring 13. Ground water from Capulin Canyon could influence Lower Spring 13, as the spring is closer to the mouth of the drainage.

Fill Material: It is possible that the source of increased COC concentrations is the fill material used for riverbank stabilization. Support for this is that the increase in ground water concentrations generally coincides with the area of fill placement (Figure 5-57). However, a comparison of chemistry data from a nearby shallow piezometer placed in native alluvial sediment and the Spring 13 pump data indicated that the fill material does not contribute higher concentrations of COCs.

Faults Connected to Mine: The potential for faults or fractures to convey bedrock ground water with elevated COC concentrations from the underground mine was considered unlikely. No faults are known to connect the interior of the mine with Spring 13, and the southern wall of the Questa Caldera, which could possibly function as a conduit for bedrock ground water, does not pass through the Spring 13 area (Caine 2007). Secondly, the majority of bedrock ground water at the mine site has near neutral pH and low COC concentrations, including those at the base of the roadside waste rock piles, in lower Goathill Gulch/Slick Line Gulch, and at the mouth of Capulin Canyon. Analysis of bedrock ground water samples collected within the underground mine showed similar chemistry.

Natural Mineralization: Natural mineralization may be a source of increased COC concentrations and acidity at Spring 13 and Lower Spring 13. The following data and information suggests such a source component:

- **Mineralized Iron-Oxide Red Zone** – During trenching for the anoxic drains in 1995, a mineralized iron-oxide "red" zone was encountered in each trench at a depth of 9-10 feet. However, this red zone was never sampled.
- **Mineralized Ferricrete** – The northern riverbank is underlain by mineralized ferricrete that likely formed from erosion of the lower Goathill west scar and associated acid rock drainage. The scar is located east of Spring 13 and across Highway 38. The ferricrete was encountered at shallow depths (5-10 feet) when installing the Spring 13 seepage interception system. It was also encountered at shallow depths in contact with alluvial ground water at MMW-42A (59-85 feet), MMW-50A (45-50 feet), and MMW-45B (45-50 feet).
- **Lower Goathill Gulch West Scar** – This hydrothermal scar may contribute pulses of metals and acidity after rainstorms and snowmelt runoff. It is the closest scar to the Red River of all the scars at the mine site and the orientation of the drainage channel from the scar is aligned toward the Spring 13 area. Leaching test performed by Molycorp on the lower Goathill Gulch west scar (using a 3:1 water to rock ratio) resulted in leachate with very high concentrations of aluminum (17,400 mg/L) and sulfate (98,000 mg/L). Such testing indicates that runoff from the scar can produce leachate with a very high, soluble concentration of metals and inorganic chemicals.
- **Mineralized Bedrock Associated with Molybdenum District** – Mineralized bedrock is present at shallow depths in the vicinity of Spring 13. Aplite porphyry

with pyrite and molybdenum was encountered at a depth of 50 feet in the borehole for MMW-50A. The presence of aplite confirms the extension of the mineralized molybdenum district from the mine site across Red River to the Log Cabin claim in Bear Creek. This connection suggests that bedrock in the vicinity of Spring 13 and upstream to Goathill Gulch may be mineralized and dissolution of minerals in the bedrock may be the source of increased COC concentrations at Spring 13. Figure 5-58 shows the mineralized molybdenum district in relation to Spring 13 and MMW-50A. Evidence of possible dissolution of minerals from bedrock has been measured in MMW-45B as compared to the chemistry of MMW-45A. Figure 5-59 is a graph of COC concentrations for both wells showing metals and inorganic chemical concentrations in bedrock ground water that are two to five times greater than the alluvial ground water. Based on the contrasts in chemical concentrations, the alluvial aquifer does not appear to be the source of the increased concentrations in bedrock water, thus, suggesting bedrock mineral dissolution.

- **Mineralized Bedrock Associated with Faulting at Spring 13** – Mineralized bedrock may also be present along the northwest-southeast trending fault zone in the vicinity of Spring 13 (Figure 5-9). Hydrothermal alteration along this fault zone could have created sulfide mineralization. Oxidation of the sulfide minerals could be partly responsible for the elevated COPC concentrations at Spring 13 and could explain the similarity in the Stiff diagrams for ground water at MMW-45B and Spring 13 (Figure 5-37). It is also noted that stable isotopes for MMW-45B are very similar to those of Spring 13.

5.10.4.2.4 <u>Other Seeps and Springs</u>

Several lesser seeps and springs along the mine site reach of the Red River were sampled. The results ranged from low concentrations (totals) of COPCs and neutral pH to slightly elevated concentrations of COCs and slightly acidic pH. A summary of the results is presented on Table 5-8 below.

TABLE 5-8

RANGES OF CONCENTRATIONS OF KEY COCs OR STANDARD UNITS FOR OTHER SPRINGS ALONG THE MINE SITE REACH OF RED RIVER

Spring	**Ranges of Concentrations of COCs (mg/L) or Standard Units[6]**
Chamber Spring	Neutral pH, low concentrations of COCs
Goathill Gulch Seep	pH[1] – 4.1 to 5.4 aluminum[2] – 11 to 37 fluoride[3] – 2.9 to 6.5 manganese[4] – 2.2 to 6.1 sulfate[5] – 780 to 1,100
Portal Spring	pH[1] – 4.7 to 7.9 aluminum[2] – 1.8 to 6.7 fluoride[3] – 3.5 to 5.0 sulfate[5] – 240 to 410
Shaft Spring	Neutral pH, low concentrations of COCs
Spring 14-M	pH[1] – 4.2 to 5.3 aluminum[2] – 5.5 to 27 fluoride[3] – 1.6 to 5.7 sulfate[5] – 205 to 504
Spring 14-MA	pH[1] – 4.1 to 4.3 aluminum[2] – 13 to 49 fluoride[3] – 3.6 to 5.3 sulfate[5] – 322 to 607
Spring 15-M	pH[1] – 4.1 aluminum[2] – 35 fluoride[3] – 7.3 manganese[4] – 12 sulfate[5] – 770
Sulphur Gulch Seep	pH[1] – 4.7 to 6.0, low concentrations of COCs
Upper Spring 39	pH[1] – 5.6 to 6.1 aluminum[2] – 1.5 to 7.5 fluoride[3] – 5.0 to 8.4 sulfate[5] – 120 to 630
Waldo Springs[7]	pH[1] – 4.5 to 5.6 aluminum[2] – 5.5 to 12 fluoride[3] – 1.1 to 1.4 sulfate[5] – 393 to 520

Note:

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(1) pH cleanup level (SU) range is 6 – 9
(2) Aluminum cleanup level (mg/L) is 5. NM Standard for Irrigation
(3) Floride cleanup level (mg/L) is 1.6. NM Standard for Domestic Water Supply
(4) Manganese cleanup level (mg/L) is 0.2. NM Standard for Domestic Water Supply
(5) Sulfate cleanup level (mg/L) is 600. NM Standard for Domestic Water Supply
(6) The basis for the cleanup level is to comply with federal/NM drinking water standards (MCLs) and NM water quality standards as ARARs and EPA health-basedcriteria as TBCs, except where background concentrations exceed such ARARs or TBCs.
(7) Waldo Spring (reference background spring) is located two miles upstream from the mine site.

5.10.4.3 Colluvial Ground Water

Ground water occurs in colluvium within each of the mine site tributary drainages, although saturation may be discontinuous especially at the higher elevations of the drainage. The colluvium is generally characterized by limited saturation and relatively low permeability. The source of the water is primarily from precipitation and runoff. Infiltration of ephemeral surface water through colluvium and waste rock also occur where they are present. Contribution of water is also from the underlying bedrock where upward vertical gradients may occur. The chemistry of the colluvial ground water is affected by acid rock drainage which leaches metals and other inorganic chemicals from the waste rock, hydrothermal scar material, or debris fan material to ground water. Figure 2-4 depicts the location of all colluvial monitoring wells at the mine site, as well as the tributary drainage and other referenced features.

5.10.4.3.1 Sources and Pathways

All major tributary drainages at the mine site contain waste rock, which is the primary source or potential source of COCs and acidity in colluvial ground water. All of the waste rock piles have been classified as acid generating and/or potentially acid generating. Other sources are the hydrothermal scars within some of the drainages, as well as the debris fans which have aggraded and deposited sediment at the mouths of the drainages. For those drainages with hydrothermal scars, the debris fans which developed at the drainage mouths are comprised of a significant amount of eroded scar material. Acid rock drainage at the mine site has resulted in the leaching of the COCs from the waste rock piles, scars and debris fans to the colluvial ground water present along the drainage channels.

The following additional findings are made regarding sources within the Slick Line Gulch drainage:

- Slick Line Gulch passes over the underground mine workings. Saturated colluvium has not been recently observed in the upper portion of the drainage. Dewatering of the underground mine has most likely desaturated the colluvium within these upper segments of Slick Line Gulch over the last 5-10 years, as water has not been observed in MMW-36A since its construction in 2002. However, the lower portion of the drainage may still have residual waste rock leachate within the colluvium (see Section 5.10.4.1.1.2 above).
- There are no observed scars within Slick Line Gulch. A debris fan has formed at the mouth of the drainage, but it has coalesced with the much larger debris fan of Goathill Gulch. The Goathill Gulch debris fan has aggraded across much of the mouth of Slick Line Gulch and, hence, the two fans are not distinguishable.
- Bedrock ground water may be a source in Slick Line Gulch because data collected in this area indicate that there is an upward hydraulic gradient from bedrock to the colluvium in the maintenance and electrical area. Fill material placed in Slick Line Gulch and forms foundations for structures in the vicinity of the maintenance and electrical area may also be a source. The origin of the fill material is unknown.

5.10.4.3.2 General Chemistry and Concentration Ranges

The colluvial water is typically a calcium-magnesium-sulfate type. Ninety percent of the major cation chemistry is made up of calcium and magnesium. The anion chemistry is dominated by sulfate (85 to 90 percent). There is minimal bicarbonate and colluvial water is typically void of alkalinity. Colluvial ground water beneath the Middle and Sulphur Gulch waste rock piles differs from other colluvial water at the mine site, as magnesium is the predominant cation. Magnesium is also the predominant cation in waste rock leachate at Goathill North and Capulin springs and the spring sources which flow near the base of the waste rock piles (see Stiff Diagram, Figure 5-37).

Colluvial ground water has elevated concentrations of metals and other inorganic chemicals which frequently exceed EPA's SLC. Molybdenum is detected at very low concentrations and often below the reporting limit in all colluvial waters. Colluvial ground water in most tributary drainages is acidic. Values of pH range from near 2 to the upper-6's. Table 5-9, below, depicts concentrations (totals) for key COCs in colluvial ground water within the major tributary drainages at the mine site. Table 5-10 depicts concentrations for the same COCs in the seeps flowing from the Goathill North and Capulin waste rock piles (Goathill Spring and Source; Capulin Spring and Source). Concentrations of COCs are similar between the Capulin and Goathill North seepage.

TABLE 5-9
RANGES OF CONCENTRATIONS FOR KEY COCs OR STANDARD UNITS IN COLLUVIAL GROUND WATER WELLS

COC	Concentrations (mg/L)						
	Spring Blind Gulches	Sulphur Gulch	Drainage Beneath Middle	Drainage Beneath Sugar Shack South[1]	Slick Line Gulch	Goathill Gulch[2]	Capulin Canyon
Aluminum (totals)	< 2.2	39 – 300	320 – 520	53 – 89	90 – 600	14 – 356	3.1 – 180
Fluoride	1.6 – 2.6	37 – 170	82 – 110	27 – 40	28 – 170	<1 – 67	<1 – 78
Manganese (totals)	< 0.18	14 – 120	212 – 340	28 – 44	13 – 48	6.6 – 42	14 – 130
Zinc (totals)	< 0.5	4 – 29	25 – 45	5.5 – 8.4	3.2 – 7.5	2.2 – 11	2.8 – 28
Sulfate	491 – 1,530	1,910 – 5,830	5,800 – 9,800	980 – 1,740	1,500 – 7,600	1,000 – 3,590	1,180 – 3,600
pH (SU)	5.4 – 6.9	3.2 – 4.5	2.8 – 3.3	3.7 – 4.5	1.8 – 3.7	2.7 – 6.2	2.8 – 6.4

Notes:
[1] Unlike Sulphur Gulch (MMW-39A) and Middle drainage (MMW-38A), there is no well directly beneath Sugar Shack South Waste Rock Pile in which to analyze colluvial ground water chemistry higher in the drainage.
[2] Ground water chemistry data are from wells at mouth of Goathill Gulch (MMW-44A, MMW-48A) as there are no wells in the upper drainage in which to analyze colluvial ground water chemistry.

[3] < = Less than
Chemistry data were analyzed in samples collected from the following colluvial wells:
Spring/Blind Gulches: MMW-34A, MMW-35A, MMW-40A, MMW-41A
Sulphur Gulch: MMW-16, MMW-39A
Middle Drainage: MMW-25A, MMW-38A
Sugar Shack South Drainage: MMW-11A, MMW-18A, MMW-19A, MMW-26A, MMW-27A, MMW-37A
Slick Line Gulch: MMW-8B, MMW-21, MMW-22, MMW-36A
Goathill Gulch: MMW-42A, MMW-44A, MMW-48A
Capulin Canyon: MMW-23A, MMW-2
Cleanup levels for this COCs include federal/NM drinking water standards (MCLs) and NM water quality standards, EPA Health-Based Criteria, NM Human Health Standards, and background levels presented in Table 12-11

TABLE 5-10
RANGES OF CONCENTRATIONS FOR KEY COCs OR STANDARD UNITS IN CAPULIN AND GOATHILL NORTH WASTE ROCK PILE SEEPS/SPRINGS

COC	Concentrations (mg/L)			
	Goathill Spring	Goathill Spring Source	Capulin Spring	Capulin Spring Source
Aluminum (totals)	960 – 1,600	1,540 – 1,750	350 – 1,400	1,160 – 1,170
Fluoride	78 – 143	78 – 175	35 – 130	78 – 208
Manganese (totals)	350 – 460	596 – 601	120 – 730	478 – 527
Zinc (totals)	79 – 120	120 – 126	40 – 170	111 – 124
Sulfate	11,000 – 16,600	14,400 – 17,400	4,400 – 17,000	11,600 – 13,700
pH (SU)	2.3 – 3.2	2.5 – 2.7	2.5 – 3.0	2.3 – 2.8

Cleanup levels for this COCs include federal/NM drinking water standards (MCLs) and NM water quality standards, EPA Health-Based Criteria, NM Human Health Standards, and background levels presented in Table 12-11

5.10.4.3.3 COC Distribution

Isoconcentration contour maps for aluminum, sulfate, and pH (Figures 5-38, 5-39, and 5-40) depict the distribution of colluvial ground water contamination and acidity within the mine site drainages and their relationship with Red River alluvial ground water. The distribution of other key COCs within colluvial ground water is similar to aluminum.

Concentrations of COCs tend to be greater in the upper portions of the drainages near the waste rock piles and decrease as the water nears the mouth of the drainages, where it becomes mixed and diluted with Red River alluvial ground water. An example of this dilution is in lower Sulphur Gulch where the aluminum concentration is 163 mg/L at MMW-39A and approximately 800 feet downgradient at MMW-16 it decreases to 39 mg/L. There is also evidence that colluvial ground water may mix with bedrock ground water in discrete areas within some drainages. An example is ground water in the area of MMW-16, which is located at the mouth of Sulphur Gulch. The Stiff diagram signature for MMW-16 supports this interpretation as it is similar to that of the surrounding bedrock in that calcium is the predominant cation.

In Capulin Canyon, the concentrations currently tend to be slightly higher near the mouth at MMW-2 as compared to colluvial ground water at MMW-23A. The lower concentrations at MMW-23A are likely due to the effectiveness of the leachate collection system near the Capulin Waste Rock Pile that inhibits leachate from flowing down the canyon. However, there have been times when concentrations of COCs in the upper drainage are greater than near the mouth, likely due to infrequent overtopping of the Capulin catchments.

The highest concentrations of COCs in colluvial ground water are found beneath the Middle and Sulphur Gulch South waste rock piles (MMW-38A and MMW-39A). Stiff diagrams for MMW-38A and MMW-39A show magnesium to be the predominant cation, whereas calcium is the predominant cation in most all other waters at the mine site. This magnesium-calcium signature suggests that waste rock leachate is a primary component of the water at these locations.

Temporal changes in concentrations of key COCs in colluvial ground water were evaluated. Generally, most of the colluvial wells at the mine site have relatively stable concentrations of COCs, or there may be some variability over time but no discernable increasing or decreasing trend over the period of record, with some exceptions. Decreasing trends in concentrations have been observed in colluvial wells at the base of Sugar Shack

South Waste Rock Pile from 2000 to 2004 but since then, some COCs show increasing trends or have remained stable (MMW-11A MMW-27A). Increasing trends in some COCs have occurred at MMW-38A at the Middle Waste Rock Pile. In upper Capulin Canyon (MMW-23A), concentrations for two COCs show slightly decreasing trends, otherwise there are no trends. At the mouth of the canyon (MMW-2), concentrations exhibit no trends, except for a slightly decreasing trend for sulfate.

5.10.4.3.4 Additional Sampling and Analysis

As previously discussed in Section 5.10.4.1.4, lead and sulfur isotopes and lanthanide analyses did not provide useful information on source identification.

A one-time, limited, sampling for age dating was performed at five colluvial ground water wells. The youngest ages were estimated at MMW-11A (0.32 years) and MMW-21 and -22 (3.5 and 0.4 years respectively), indicating high infiltration rates of younger water. Well MMW-11A is located at the base of Sugar Shack South Waste Rock Pile in an area where runoff temporarily collects and infiltrates rapidly through the coarse-grained waste rock. Wells MMW-21 and MMW-22 are located on a flat area of the M&E with coarse-grained fill used for the foundation of buildings. The age of colluvial ground water beneath the Sulphur Gulch South Waste Rock Pile (MMW-39A) was estimated to be relatively young at 4.5 years. High permeability in colluvial sediments could allow recharge of MMW-39 water from higher elevations in the drainage or possibly a mixture of infiltration water through the waste rock pile and water migrating through the colluvium.

The oldest age of colluvial water was measured at MMW-38A (60.1 years), beneath the Middle Waste Rock Pile. The age is sub-modern and may indicate that bedrock ground water is a contributing source. The age of the water pre-dates open pit mining and development of the waste rock piles at the mine site. The age may indicate mixing of young infiltration water that percolates through the waste rock with bedrock water having an estimated age of 136 years (as measured near the base of the rock pile at MMW-30B), resulting in an overall age similar to MMW-38A.

5.10.4.4 Bedrock Ground Water

Water quality and COC concentrations were characterized in the bedrock ground water by sampling 24 bedrock monitoring wells and underground mine locations. The majority of the wells are located along the Red River with the remaining wells within current and former drainages at the mine site. Water in the underground mine was also sampled and analyzed.

5.10.4.4.1 Source and Pathways

The primary COC sources and pathways are similar to those described previously for the colluvial ground water, and consist of waste rock, hydrothermal scar, and debris fan materials. In addition, the bedrock itself may be a source as mineralization has been observed in some areas. Acid rock drainage leaches metals and other inorganic chemicals from these sources to bedrock ground water.

5.10.4.4.2 COC Concentration Ranges and Distribution

Bedrock water in all tributary drainages is a calcium-magnesium sulfate type, with the exception of the upper portion of Capulin Canyon, where it is a sodium sulfate type (MMW-23B). This is the only well at the mine site that has sodium-rich water. Near the mouth of the canyon, the bedrock water is again a calcium-magnesium sulfate type. Downstream of the mouth of Capulin Canyon at MMW-45B, the bedrock ground water is richer in magnesium and does not contain any alkalinity in the form of bicarbonate.

Overall, the bedrock ground water at the mine site does not appear to be impacted to a large degree, as the ranges in concentrations of COCs are significantly less than the concentrations detected in the colluvial ground water. However, there are some exceptions, as discussed below. Sulfate tends to be elevated, but COCs such as aluminum, manganese and fluoride are relatively low. Bedrock ground water typically has buffering capacity in the form of bicarbonate. The pH values tend to be circumneutral, but there are some places where the bedrock water is acidic.

A summary of the ranges of concentrations for key COCs and sulfate, along with pH values, detected in bedrock ground water samples from all tributary drainages is presented on Table 5-11, below. Additionally, a summary of COC concentrations and pH values measured in ground water samples from the underground mine workings and the Moly Tunnel (one sample in 2003), as well as the bedrock at the downstream boundary of the mine site, is presented in Table 5-12. Concentration dot maps for aluminum, sulfate, and pH are depicted on Figures 5-60, 5-61, and 5-62.

TABLE 5-11
RANGES OF CONCENTRATIONS FOR KEY COCs
OR STANDARD UNITS IN BEDROCK GROUND WATER WELLS

COC	Concentrations (mg/L)							
	Spring Gulch	**Blind Gulch**	**Sulphur Gulch**	**Drainage Beneath Middle**	**Drainage Beneath Sugar Shack South**	**Slick Line Gulch**	**Goathill Gulch**	**Capulin Canyon**
Aluminum (totals)	55 – 85	<1 – 4.6	33 – 71	<1 – 2.8	<1 – 82	<1 – 540	<1 – 9.0	<1 – 5.6
Fluoride	110 – 140	2.1 – 7.4	31 – 59	1.5 – 4.3	1.8 – 38	1.1 – 150	1.1 – 3.3	2.4 – 3.9
Manganese (totals)	17 – 33	4.3 – 21	14 – 20	<1 – 3.9	<1 – 43	2.3 – 52	1.1 – 12	<1 – 6.5
Zinc (totals)	5.5 – 11	<1 – 2.3	2.4 – 4.6	<1	<1 – 81	<1 – 6.0	<1 – 10	<1
Sulfate	1,700 – 2,150	1,380 – 1,600	1,600 – 2,000	394 – 1,530	1,200 – 2,110	1,340 – 6,940	1,190 – 1,750	204 – 1,760
pH (SU)	4.2 – 4.8	6.1 – 6.7	2.9 – 5.5	6.3 – 7.8	4.0 – 7.0	3.7 – 7.1	6.4 – 7.5	4.8 – 8.7

Notes:
< = Less than
Chemistry data are from the following wells:
Spring Gulch – MMW-34B
Blind Gulch – MMW-35B
Sulphur Gulch – MMW 24B
Middle Drainage – MMW-25B, MMW-29B, MMW-30B
Sugar Shack South Drainage – MMW-11B, MMW-18B, MMW-19B, MMW-31B, MMW-32B

Slick Line Gulch – MMW-36B, MMW-7, MMW-8A
Goathill Gulch – MMW-42B, MMW-44B
Capulin Canyon – MMW-23B, MMW-3
Cleanup levels for this COCs include federal/NM drinking water standards (MCLs) and NM water quality standards, EPA Health-Based Criteria, NM Human Health Standards, and background levels presented in Table 12-11

5.10.4.4.2.1 Spring Gulch

Bedrock ground water in Spring Gulch is acidic (mid-4's). At MMW-34B, located at the toe of Spring Gulch Waste Rock Pile, the bedrock ground water has higher aluminum and fluoride than typical Site bedrock ground water, indicating it is impacted by leachate from waste rock. However, the higher concentrations of metals may also be due to localized mineralization in the bedrock, as colluvial well MMW-40A, located in the waste rock pile upgradient of MMW-34B, has low concentrations of aluminum and fluoride and does not appear to be impacted by waste rock leachate.

5.10.4.4.2.2 Blind Gulch

Bedrock ground water in Blind Gulch is near neutral (mid-6's) and concentrations of COPCs are low.

5.10.4.4.2.3 Sulphur Gulch

Bedrock ground water in lower Sulphur Gulch is acidic. The Stiff diagram of the major ion chemistry for well MMW-24, located at the mouth of the drainage, appears to be similar to bedrock ground water in other wells (Figure 5-37). However, the overall chemical signature is more similar to alluvial ground water along the base of the roadside waste rock piles. This indicates that the bedrock water in this area may be mixing with the alluvial ground water. The intrusion of alluvial ground water into the bedrock is likely because the upper bedrock tends to be fractured allowing alluvial water to flow to the bedrock. Furthermore, water levels in bedrock wells respond similar to alluvial wells when subjected to aquifer stresses such as pumping, which is suggestive of hydraulic connection between the two aquifers.

TABLE 5-12
RANGES OF CONCENTRATIONS FOR KEY COCs OR STANDARD UNITS IN UNDERGROUND MINE, MOLY TUNNEL, AND BEDROCK AT DOWNSTREAM MINE BOUNDARY

COC	Concentrations (mg/L)		
	Bedrock at Downstream Mine Boundary	Underground Mine Workings	Moly Tunnel
Aluminum (totals)	140 – 180	2 – 58	< 1.0
Fluoride	53 – 66	6 – 33	2.1
Manganese (totals)	32 – 51	20 – 130	2.3
Zinc (totals)	7.9 – 12	2 – 17	0.1
Sulfate	1,610 – 2,000	1,300 – 2,800	943
pH (SU)	3.0 – 4.4	6.2 – 7.9	7.3

Note:
< = Less than
Cleanup levels for this COCs include federal/NM drinking water standards (MCLs) and NM water quality standards, EPA Health-Based Criteria, NM Human Health Standards, and background levels presented in Table 12-11

There is no bedrock well within the unnamed drainage beneath Sulphur Gulch South Waste Rock Pile (west of Sulphur Gulch) and the water quality and COPC concentrations are unknown.

5.10.4.4.2.4 Unnamed Drainage Beneath Middle Waste Rock Pile

The bedrock ground water at the mouth of the unnamed drainage beneath the Middle Waste Rock Pile is neutral and the concentrations of COPCs are low. Elevated concentrations observed in the overlying colluvium (MMW-38A) do not appear to be impacting the bedrock ground water.

5.10.4.4.2.5 Unnamed Drainage Beneath Sugar Shack South Waste Rock Pile

The bedrock ground water at the mouth of the unnamed drainage beneath the Sugar Shack South Waste Rock Pile shows some variability in COPC concentrations. The concentrations at MMW-18B and MMW-31B tend to be higher than the other bedrock wells. Concentrations in well MMW-18B also vary over the year suggesting some seasonal relationship with infiltrating water through the colluvium. Well MMW-18B is located within a storm water catchment created by the berm at the base of the waste rock pile. Storm water runoff collects in the catchment and infiltrates to the colluvium and possibly into bedrock. Consequently, the elevated concentrations of COPCs in the bedrock ground water in this well may be the result of localized infiltration of storm water through the waste rock and colluvium and not represent bedrock water chemistry at a larger scale.

5.10.4.4.2.6 Slick Line Gulch

The bedrock ground water quality in Slick Line Gulch is variable. Bedrock water is acidic (low 4's) with higher concentrations of COPCs in the upper portion of the drainage (MMW-36B and MMW-7[42]), while it exhibits a near neutral pH with only slightly elevated concentrations of COPCs in the lower drainage (MMW-8A). The Stiff diagrams for MMW-36B and MMW-7 are dissimilar to typical diagrams for bedrock wells (Figure 5-37). The elevated concentrations of COPCs in the upper drainage bedrock water are likely the result of leachate from Goathill South and Sugar Shack West waste rock piles. There are no hydrothermal scars observed in Slick Line Gulch.

5.10.4.4.2.7 Goathill Gulch

Bedrock water in the upper and lower Goathill Gulch is near neutral, with pH values ranging from the upper 6's to the mid-7's. Concentrations of most COPCs, as measured in MMW-42B and MMW-44B, are low. Manganese is one of the only COPCs with elevated

[42] MMW-7 is known to be contaminated by surface runoff at the M&E area and all analytical results are suspect. MMW-36B has been dry since early 2007 as the hydraulic capture zone from the subsidence area and underground mine dewatering have reached the well.

concentrations ranging from 1.1 to 12.0 mg/L. Concentration ranges for fluoride and sulfate are 1.1 – 3.3 mg/L and 1,190 – 1,720 mg/L, respectively.

5.10.4.4.2.8 Capulin Canyon

Bedrock ground water in Capulin Canyon is circumneutral, with pH values ranging from 7 to 8.8 at MMW-23B to the mid-6's at MMW-3 near the mouth of the canyon. The near neutral pH values at MMW-23B indicate that the Capulin Canyon leachate collection system currently prevents most, if not all of the leachate from entering the bedrock.

The concentrations of COPCs in bedrock ground water within Capulin Canyon are relatively low. For each metal or inorganic chemical, concentrations are higher at the mouth of the canyon than in the upper canyon. This may indicate that waste rock leachate has yet to flow out of the lower drainage due to relatively long transit times or there is another source between the mouth and the upper drainage, such as the hydrothermal scar in the middle portion of the drainage or mineralized bedrock.

5.10.4.4.2.9 Bedrock at Downstream Boundary of Mine Site

Ground water in bedrock monitoring well MMW-45B, located at the downstream boundary of the mine site, is acidic with pH values ranging from 3.0 to 4.4. The ground water also contains elevated concentrations of COPCs, including aluminum – 140 to 180 mg/L, fluoride – 53 to 66 mg/L, and sulfate – 1,610 to 2,000 mg/L. The neutral pH and low COPC concentrations in bedrock ground water at the mouth of Capulin Canyon (MMW-3) is in contrast to the water quality at MMW-45B.

The Stiff diagram for MMW-45B is not typical for bedrock ground water. It is more similar to the paired alluvial well MMW-45A, except that the cations and anions (other than bicarbonate) are higher in the bedrock well (Figure 5-37). No bedrock water along the two nearest and upgradient tributary drainages (lower Goathill Gulch or the mouth of Capulin Canyon) or upgradient alluvial ground water has concentrations as high as those measured in MMW-45B. This suggests that the higher concentrations in MMW-45B may be due to mineralization within the bedrock.

5.10.4.4.2.10 Underground Mine Workings

Water in the underground mine was sampled at a location identified as Mine-1. The location is at the eastern edge of the workings near the bottom of the decline. Ground water at this location is a mixture of all underground water before it is pumped to the mill. It includes storm water that comes into contact with the waste rock piles as well as leachate from the rock piles that drain to the underground mine workings. Waste rock leachate from Capulin, Goathill North and South, and Sugar Shack West waste rock piles drains to the subsidence area and infiltrates into the underground mine. Waste rock leachate from Blind Gulch, Sulphur Gulch North and South, Middle, and Sugar Shack South waste rock piles drains to the open pit and infiltrates into the underground mine workings. Water in the underground mine also includes water from the surrounding bedrock.

Bedrock water in the underground mine is a calcium-magnesium sulfate type. The water has a neutral pH and lower concentrations of most key metals as compared to the source of those waters, indicating a commingling of unimpacted bedrock water with impacted waters. Concentration vs. Time charts of select constituents show increasing trends in concentration, excluding molybdenum which shows no trend over the past five years. Concentrations of all key COCs, excluding zinc, are above reference background concentrations for the Mine-1 sampling location for the period of record. Molybdenum concentrations (about 5 mg/L) are two orders of magnitude greater than any other concentrations observed in bedrock ground water at the mine site.

5.10.4.4.2.11 Moly Tunnel

A water sample was collected from the Moly Tunnel once during the RI in 2003. The chemistry of the water is similar to bedrock ground water within the historic workings, as the tunnel extends from near the Red River approximately one mile north into the historic mine. Concentrations of COPCs are relatively low, with manganese, fluoride and sulfate significantly less than concentrations in the underground mine workings.

5.10.4.4.3 Temporal Changes in Concentrations

Overall, most of the bedrock wells at the mine site have no trends in concentrations or decreasing trends in concentrations for some COPCs. A statistical trend analysis was performed for key COPCs using a Mann-Kendal test for concentration data through 2008. Decreasing trends in concentrations are exhibited at bedrock wells along the roadside waste rock piles (MMW-18, -28B, and -30B). An exception to this is at the base of Sugar Shack South waste rock pile (MMW-31B), where increasing trends in aluminum and fluoride occur, but sulfate is decreasing. These trends may be associated with ground water pumping in nearby ground water withdrawal well MMW-2. Increasing trends in key COPC concentrations were also observed at the base of Sugar Shack West waste rock pile (MMW-36B). However, the well went dry in 2007 due to the expanding influence of the subsidence area and dewatering of the underground mine. Other areas of decreasing trends in concentrations are lower Goathill Gulch, maintenance and electrical area, and at the downstream boundary of the mine site.

Ground water in the underground mine workings show an increasing trend in concentrations of all key COCs, with the exception of molybdenum. Concentration vs. time graphs for Mine-1 are depicted on Figures 5-63 and 5-64.

5.10.4.4.4 Additional Sampling and Analysis

The results of the lead isotope, sulfur isotope, and lanthanide analyses on bedrock ground water were similar to the results for colluvial ground water discussed previously.

5.10.4.4.4.1 Oxygen and Hydrogen Isotopes

Several observations are apparent between the isotopic composition of bedrock water at wells and at underground locations that may provide information on flow paths and the influence of dewatering of the underground mine. The isotopic compositions are graphically depicted on Figure 5-65.

There are two distinct clusters of isotopic compositions for underground waters and one isolated value. Samples taken in the northeast portion of the underground mine in the "rainforest" area[43] or at locations that collect water from the old underground workings (P6, P9, C3) comprise one group, while the samples collected from the western portion of the underground mine at Shafts Nos. 1 and 2, access tunnel, and below the subsidence area comprise the second group (P1, P4, F1). All sampling locations are depicted on Figure 2-4

Many of the bedrock wells plot fairly close to one of these two clusters. The isotopic composition of bedrock water at MMW-36B, located near the base of Sugar Shack West Waste Rock Pile, is nearly identical to the composition at the underground location P4. P4 collects water from the Shafts Nos. 1 and 2 and the access tunnel to the mine. This coupled with the colloidal borescope flow direction measured in MMW-36B that is toward the P4 underground location supports other lines of evidence that the bedrock water in the vicinity of MMW-36B drains to the underground mine and is within the hydraulic capture zone created by the subsidence area and mine dewatering.

The remaining underground location that was sampled was the neck fault, which is along the southern haulage road. Its isotopic composition is dissimilar to the other underground locations and bedrock wells. The reason for such dissimilarities is unknown.

[43] "Rainforest" is a term used by CMI to describe an area within the underground mine which is always wet and dripping water, indicating it is draining significant amounts of water from the bedrock.

5.10.4.4.4.2 Age Dating

The age of the bedrock ground water ranges from about 2 years to 136 years. Old bedrock water is consistent with a deeper regional flow system that is recharged at high elevations, has low flow velocities, and is somewhat isolated from surficial waters. The results of the age dating of bedrock ground water are depicted on Figure 5-66.

Younger bedrock waters observed in wells along the Red River (MMW-24 – 2 years, MMW-17B – 13.5 years, and MMW-28B – 18.9 years) suggest that the bedrock ground water at these wells is hydraulically connected to the overlying alluvial aquifer and the ages reflect a mixing of older bedrock and younger alluvial ground waters.

The young age at MMW-24, which is located near the base of Sulphur Gulch South Waste Rock Pile, may also be the result of infiltration of runoff from the waste rock pile because the well is at the base of the rock pile where storm water runoff temporarily collects, then infiltrates to ground water.

Older bedrock ground water measured in wells near the base of the Middle (MMW-29B and -30B) and Sugar Shack West (MMW-36B) waste rock piles suggest that infiltration through waste rock piles into bedrock at these locations is minimal. Water in MMW-30B and MMW-36B are “tritium dead” (<0.2 tritium units), which is typical of water with extremely long residence time and recharged prior to 1952.

5.10.4.5 Mine Site Reference Background

Reference background monitoring wells were selected to represent the wide range of ground water types encountered at the mine site. This ranged from non-scar-impacted, non-mineralized ground water to scar-impacted and mineralized ground water. To achieve this range of ground water types, ground water quality was monitored at several wells within tributary drainages upstream of the mine, including Hottentot, Straight, and Hansen creeks and along the Red River. All of these drainages are impacted by hydrothermal scars. Wells unaffected by hydrothermal scars (as well as waste rock) in upper Capulin Canyon were also monitored for ground water quality for comparison to ground water quality in non-scar impacted drainages at the mine. Based on initial water chemistry data, some of the upper Capulin Canyon reference background wells were found to represent a mineralized zone. In addition to the upstream alluvial wells, ground water quality was monitored at five alluvial wells along the mine site: three wells at the upgradient boundary of the mill and two wells located in the southern portion of the aquifer downgradient of the confluence of the Red River and Columbine Creek alluvial aquifers. All of the reference background wells are identified on Table 5-13.

The locations of the off-mine site reference wells and springs are depicted on Figure 5-67. Most of the wells within the upstream drainages were installed as part of the USGS Baseline Investigation. The locations of the reference wells at the mine site are depicted on Figure 2-4.

5.10.4.5.1 <u>COC Concentrations and Distribution</u>

A summary of concentrations for key COCs and pH values in reference background ground water for alluvium, colluvial, and bedrock wells is provided in Tables 5-14, 5-15, and 5-16.

5.10.4.5.1.1 Alluvial Ground Water

Reference background alluvial ground water upstream of the mine is acidic to neutral, with pH values ranging from 3.3 to 7.2. The range of COC concentrations and pH values near the mouth of Straight Creek is large and represents the mixing of acidic metals-laden colluvial ground water with more neutral pH ground water of the Red River alluvial aquifer. This area is where scar-impacted colluvium and debris fan materials inter-finger with alluvium. Monitoring well SC-7A, located in the northern portion of the alluvial aquifer and closer to the mouth of the drainage, is acidic (pH values from 3.7 to 3.8) and contains greater concentrations of key COPCs, including aluminum – 37 to 39 mg/L, manganese – 5.8 to 6.2 mg/L, fluoride – 3.8 to 4.5 mg/L, and sulfate – 833 to 990 mg/L.

Well SC-8A, located close to SC-7A but further away from Straight Creek and more in the middle of the alluvial aquifer has near neutral pH values (6.3-6.5) and low concentrations of COCs.

The more acidic, metals-laden ground water at SC-7A is assumed to continue hugging the northern portion of the alluvial aquifer as it flows downgradient (to the west) while mixing with, and becoming diluted by, the less acidic alluvial ground water. By the time the ground water has reached the next downgradient well at the Elephant Rock Campground site, it has near neutral pH values (6.1 to 6.9) and low concentrations of COCs. The campground site well is located just upstream of Hanson Creek drainage. This pattern of COC input, mixing, and dilution observed in the alluvial aquifer from Straight Creek to Hanson Creek is likely repeated from Hanson Creek to the upgradient mine site boundary.

The COC concentrations in reference background alluvial wells were relatively constant during the RI.

The ground water at reference background alluvial wells downstream of the Red River and Columbine Creek confluence is neutral, with pH values ranging from 6.2 to 7.9. Concentration ranges for key COCs are very low, reflecting the water quality of the Columbine Creek alluvial aquifer before it mixes with Red River alluvial ground water.

5.10.4.5.1.2 Colluvial Ground Water

Colluvial ground water at reference wells within scar drainages is acidic (2.5 to 4.3). Concentration ranges of key COCs include aluminum – 41 to 107 mg/L, manganese – 3.9 to 20 mg/L, zinc – 1.7 to 12 mg/L, and fluoride – 2.7 to 13 mg/L. Sulfate concentrations range from 617 to 2,360 mg/L. Of all the colluvial wells, COC concentrations are almost always highest in SC-1A, which is the well closest to a scar. The COC concentrations were relatively constant during the RI.

The chemistry of colluvial ground water in Straight Creek changes along a near-linear flow path down the drainage, with some exchange or mixing between colluvial and bedrock water (Nordstrom 2008). As illustrated on Figure 5-68, concentrations of constituents decrease going from upgradient to downgradient along the drainage. Correspondingly, pH values of the colluvial ground water increases downgradient.

Precipitation runoff from the scar into the receiving drainage and subsequent infiltration of the surface water is the main input of water to the colluvium.

Colluvial ground water in reference background wells (CC-1A and -2A) located in the non-scar-impacted upper Capulin Canyon is slightly acidic to neutral (4.4 to 7.7). Concentration ranges of key COCs include aluminum – less than 1 to 29 mg/L, manganese – less than 1 to 46 mg/L, zinc – less than 1 to 4.7 mg/L, and fluoride – less than 1 to 19 mg/L. Sulfate concentrations ranged from 95 to 848 mg/L. Although CC-1A and CC-2A are located in a drainage not impacted by waste rock leachate, these wells have water chemistries reflecting unmineralized and mineralized rock.

5.10.4.5.1.3 Bedrock Ground Water

Bedrock ground water at the upstream reference background wells is slightly acidic to neutral (5.6 to 7.3). Concentration ranges of COCs are significantly lower than colluvial ground water, including aluminum – less than 1 to 7.3 mg/L, manganese – 2.5 to 28 mg/L, zinc – less than 1 to 5.9, and fluoride – 1.1 to 7.7 mg/L. Sulfate concentrations in the Straight Creek reference background wells are comparable to the colluvial ground water in the drainage, ranging from 1,300 to 1,980 mg/L.

Bedrock ground water quality at the reference background wells in upper Capulin Canyon is slightly acidic to neutral, with pH values ranging from 4.7 to 7.7.

The COC concentrations in reference background bedrock wells were relatively constant during the RI.

5.10.4.5.2 Comparison of Mine Site Concentrations to Reference Background Concentrations

A comparison of mine site ground water concentrations to reference background concentrations was performed using a two-phase statistical testing strategy to minimize the potential false positive and false negative errors. The method compares concentrations from mine site wells to the Upper Tolerance Limit and Upper Prediction Limit of the reference populations. The statistical comparison was performed for mine site COCs using the RI data set for fall 2002 through second quarter 2006. The reference populations for alluvial, colluvial, and bedrock ground water are shown on Table 5-13.

The selected alluvial reference background wells were used as two separate reference populations. For Site wells from the mill to the confluence of the Red River and Columbine Creek, all of the reference background alluvial wells upgradient of the confluence were used as a reference population (first six alluvial wells listed on Table 5-13). For Site wells downstream of the Red River and Columbine Creek confluence, the reference background population includes all of the alluvial wells in the first population, plus the two wells (F1GW[44] and Company Cabin Well) located downgradient of the confluence. These wells were added to account for ground water that is from the Columbine Creek drainage before it mixes with Red River alluvial water.

The colluvial ground water in the unnamed drainage beneath the Middle Waste Rock Pile was compared only to CC-1A and CC-2A in upper Capulin Canyon, as no hydrothermal scar has been observed in the drainage.

The procedure for comparing mine site concentrations to the reference Upper Tolerance Limit/Upper Prediction Limit was as follows:

[44] Monitoring well F1GW was previously named the Fagerquist well, a private water well.

- Maximum concentration of COC was compared to the reference Upper Tolerance Limit for that COC. If the maximum concentration was below the Upper Tolerance Limit, then it was concluded that the concentration was statistically less than reference; if the maximum concentration was greater than the Upper Tolerance Limit, verification was performed.
- For verification, a minimum of four consecutive point values or the most recent one-year of consecutive point values (whichever provided the longest duration of monitoring) that are the temporally next consecutive samples collected from a given well. If one or more of the consecutive verification samples for a given concentration exceeded the Upper Prediction Limit, it confirmed the initial exceedance. The use of four consecutive monitoring points takes into account seasonal effects.

The results of the comparison are presented on Table 5-17. The table presents each mine site well categorized by Red River alluvial wells, colluvial wells, and bedrock wells, along with the mine site COCs. Since reference background water quality evaluated as part of the RI focused significantly on ground water within scar-impacted drainages, including the scar-rich colluvium and debris fan material at the mouth of those drainages, any exceedance of a mine site COC over the reference population is considered to be a mining-related exceedance.

5.10.4.5.2.1 Alluvial Ground Water COCs Exceeding Reference Background

For the Red River alluvial ground water, most of the COCs in wells along the roadside waste rock piles and at the downstream mine boundary are greater than reference background concentrations. Fewer COC concentrations exceed reference background in Columbine Park and the mill area. No COCs exceeded reference background in only two wells (US-1 and US-2).

5.10.4.5.2.2 Colluvial Ground Water COCs Exceeding Reference Background

For colluvial ground water, all mine site wells had COC concentrations greater than reference background concentrations with the exception of MMW-2[45], located at the mouth of Capulin Canyon, and MMW-8B located on the eastern margin of the Goathill Gulch debris fan within the Slick Line Gulch drainage. Wells with the most COC concentrations exceeding reference background concentrations are located at the roadside waste rock piles (MMW-38A and MMW-39A), the maintenance and electrical area (MMW-21 and -22) and in upper Capulin Canyon (MMW-23A).

5.10.4.5.2.3 Bedrock Ground Water COCs Exceeding Reference Background

For bedrock ground water, nearly all of the bedrock wells had at least one COC that exceeded reference background concentrations. Wells with the most COC concentrations exceeded reference included MMW-45B at the downstream mine boundary, and MMW-7 and MMW-36B located within Slick Line Gulch.

5.10.4.5.2.4 Summary of Comparison of COC Concentrations and Reference Background

The results of the comparison of COC concentrations to reference background are summarized in Table 5-18 below. The summary presents the percentage of wells with COCs that are greater than reference background for alluvial, colluvial, and bedrock ground water.

[45] Reference background concentrations for the lower Capulin Canyon colluvial ground water were proposed by USGS (Nordstrom 2008) based on the chemistry from MMW-2. Nordstrom assumed that MMW-2 was not impacted by mining activity.

TABLE 5-18
PERCENTAGE OF MINE SITE WELLS WITH COC CONCENTRATIONS STATISTICALLY GREATER THAN REFERENCE BACKGROUND CONCENTRATIONS

COC	Red River Alluvium	Colluvium	Bedrock
Aluminum	35	46	37
Antimony	5	--	0
Arsenic	--	--	--
Cadmium	79	57	5
Copper	76	50	--
Fluoride	81	71	32
Iron	4	7	10
Manganese	69	29	26
Molybdenum	--	--	23
Sulfate	0	50	16
Vanadium	--	--	--
Zinc	77	29	21

Notes:
-- Comparison was indeterminate for more than half the wells; thus, a percentage was not calculated.

5.10.4.5.3 Comparison of Mine Site Concentrations to USGS Pre-Mining Concentrations

Mine site ground water concentrations from the RI (fall 2002 through second quarter 2006) were compared to inferred pre-mining concentrations from the USGS Baseline Investigation. The pre-mining concentrations inferred by USGS for colluvial and bedrock ground water are summarized in Tables 5-19 and 5-20 for each of the mine site drainages.

Several colluvial and bedrock wells were not included in the comparison. Colluvial wells not included were MMW-18A, -14, -34A, -35A, and -41A because the wells are dry. Bedrock wells MMW-45B, -10B, and -28B were not included in the comparison because the bedrock ground water is below Red River alluvium and not below colluvium within a mine site drainage for which pre-mining concentrations were developed. Lastly, bedrock wells MMW-11, -17B, 13, and P-5C were not included because they are screened across two water-bearing units and likely to be a mixture of ground waters.

Table 5-21 summarizes the results of the comparison between current and pre-mining concentrations for colluvial and bedrock wells. The comparison is not based on rigorous statistical procedures, rather the maximum detected concentration (dissolved) or minimum field pH value from the RI period was compared against the pre-mining concentration. Because many of the pre-mining concentrations are based on medians, use of the maximum value is a conservative comparison. As with the comparison to reference background concentrations, concentrations of COCs greater than the pre-mining concentrations are attributed to mining-related activities.

5.10.4.5.3.1 Capulin Canyon

Concentrations of COCs in colluvial ground water in the upper Capulin Canyon drainage are greater than the pre-mining concentrations for most of the COCs. Bedrock ground water concentrations are within the pre-mining range.

Near the mouth of Capulin Canyon, concentrations in both colluvial and bedrock ground water are within pre-mining ranges. However, since the pre-mining ranges inferred by USGS for colluvial ground water is based on the chemistry from MMW-2, located at the mouth of the drainage, the concentrations of COCs are the same as the pre-mining ranges as they are both from MMW-2. The USGS thought it possible that colluvial ground water downgradient from the Capulin Leachate Collection System might be dominated by natural processes (scar) with little effect from waste rock leachate (although impacts to MMW-2 from waste rock leachate could not be ruled out) (Nordstrom 2008).

Acid rock drainage and leaching of metals from the Capulin Waste Rock Pile into Capulin Canyon drainage has been occurring since the late 1960s. The Capulin Leachate Collection System was constructed in 1992 to capture this waste rock leachate. The system was improved upon in 2006 because of overtopping and leaking from the catchments, as well as potential bypassing of the system over the years. The EPA has calculated a transit time of approximately 23 years (based on yield analysis) for waste rock leachate-impacted ground water to travel from the lower catchment (pumpback pond) to MMW-2 at the mouth of Capulin Canyon.[46] In light of this estimated transit time, it is likely that waste rock leachate is still present in colluvial ground water within the Capulin Canyon drainage and that it continues to flow downgradient to the mouth of the drainage and ultimately to the Red River alluvial aquifer. The colluvial water chemistry measured at MMW-2 would therefore reflect waste rock leachate impacts.

Plots of water chemistry were prepared by USGS (Nordstrom 2008) to attempt to determine (1) whether the chemistry of the waste rock leachates could be distinguished from natural hydrothermal scar weathering, and (2) the range of water chemistry from scar weathering in Capulin Canyon. The plots show waste rock leachate samples from the Capulin Leachate Collection System have generally higher concentrations of most constituents than water derived from scar weathering. Sulfate concentrations are commonly 8,000 to 18,000 mg/L in the catchment water compared to less than 2,500 mg/L for scar-weathering water. The pH values for both waters are consistently low (2.5 – 3.5). It is unclear how much of the higher concentration is caused by evaporation of the catchment water compared to the greater dissolution rate of the minerals within the waste rock. Both factors could be significant (Nordstrom 2008).

Concentrations of trace and minor elements, especially fluoride and beryllium, seem characteristic of waste rock leachates. This is illustrated in the plots of fluoride and zinc concentrations relative to sulfate and manganese depicted on Figures 5-69 and 5-70. The

[46] Technical Memorandum: Determination of Groundwater Flow Velocity in the Capulin Canyon Drainage, Molycorp, Inc. Site (CDM 2010)

plots show how much higher the concentrations are in waste rock leachate as compared to ground water at MMW-2 and the Capulin scar leachate seep waters. The plots also show that the concentrations in MMW-2 are higher than the scar leachate seep waters, suggesting a contribution from waste rock leachate.

5.10.4.5.3.2 Goathill and Slick Line Gulches

Concentrations of COCs in colluvial ground water in both Goathill and Slick Line gulches are greater than the pre-mining concentrations, including cobalt, fluoride, nickel, sulfate and zinc. Concentrations of COCs in bedrock ground water are greater than pre-mining concentrations in MMW-42B and -44B. Bedrock wells within Slick Line Gulch (MMW-7, MMW-36B) have concentrations of COCs greater than pre-mining concentrations.

5.10.4.5.3.3 Roadside Waste Rock Pile Drainages

Concentrations of COCs in colluvial ground water at the roadside waste rock piles are greater than the pre-mining concentrations. There are no colluvial or bedrock wells in the lower Sulphur Gulch West drainage beneath the Sulphur Gulch South Waste Rock Pile, therefore no comparison was made.

5.10.4.5.3.4 Sulphur Gulch

Concentrations of COCs in colluvial ground water within the lower Sulphur Gulch drainage (MMW-39A) and at the mouth of the drainage are greater than pre-mining concentrations.

Concentrations of COCs in bedrock ground water (MMW-34B, MMW-35B) are greater than pre-mining concentrations. Most of the bedrock concentrations (MMW-24) near the mouth of the drainage are also greater than pre-mining concentrations, but the well may have a mixture of bedrock and colluvial ground water.

5.10.5 Surface Soil

Surface soil on the mine site exists on four types of features: (1) natural areas undisturbed by mining, (2) ground disturbed by mining operations, including development of the open pit, the subsidence area overlying the underground mine, and the mill and mine facilities areas, (3) natural hydrothermal scars, and (4) the surface of the waste rock piles.

The mine site was divided into several soil investigation areas for the RI and, based on the analytical results, refined by EPA into four soil exposure areas (EAs) during performance of the Site risk assessment. The soil exposure areas are shown on Figure 5-71. A description of the four EAs is presented in Table 5-22 below.

TABLE 5-22
MINE SITE SOIL EXPOSURE AREAS

Mine Site Surface Soil		
Type of Exposure	**Soil Exposure Area (EA)**	**Description of Area**
Human Health	Soil EA 1	Administrative Area
	Soil EA 2	Mill Area
Human Health and Ecological	Soil EA 3	Sulphur Gulch, Middle, Sugar Shack South, Sugar Shack West, Blind and Sulphur Gulch North, and Spring Gulch waste rock piles, truck shop slice area, other independent sources, including between the rock piles and the riparian soil along the Red River
	Soil EA 4	Capulin, Goathill North and Goathill South waste rock piles, other mine site soil, open pit, mine site scars, other independent sources

All soil chemical data were compared to the EPA SLC (Table 5-23). Those exceeding the SLC were selected as COPCs for the purpose of human health and ecological risk assessments. Subsequently, a refined list of COCs was developed based on EPA's HHRA and BERA. The COCs are discussed below for each soil EA.

To evaluate the extent of COCs in the mine site soil, the soil concentrations were compared to the concentrations in the mine site reference background area. For the comparison, the COC concentrations for each soil investigation area were compared statistically to the concentrations of the reference background area. When forms of the term "significant" are used in context with the comparison, it implies statistically significant.

5.10.5.1 Soil Exposure Area 1

The results of the sample analyses for Soil EA 1 (administrative and maintenance and electrical areas) are discussed in the section on Mine Site Source Characterization, above. Based on the results of EPA's HHRA and BERA, there are no COCs in soil EA 1 that warrant CERCLA response actions.

5.10.5.2 Soil Exposure Area 2

The results of the sample analyses for soil EA 2 (mill area) are discussed in the section on Mine Site Source Characterization, above. Based on the results of EPA's HHRA and BERA, the COCs identified in soil EA 2 are PCBs and molybdenum.

5.10.5.3 Soil Exposure Area 3

Soil EA 3 includes Sulphur Gulch, Middle, Sugar Shack South, Sugar Shack West, Blind and Sulphur Gulch North, and Spring Gulch waste rock piles, the Truck Shop Slice area, and other independent sources which fall into this area.

Several metals and PCBs exceeded human health SLC and were identified as COPCs (Table 5-23). The PCBs (Aroclors 1248, 1254 and 1260) were detected next to an oil tank northwest of the Mill Area, near water tanks northwest of the primary crusher, and in the

Truck Shop Slice area. Based on the EPA HHRA, none of these contaminants are considered human health COCs in soil EA 3.

Twenty metals and one organic compound (phenanthrene) were identified as COPCs which exceeded EPA's ecological SLC in soil EA 3 (Table 5-23). The extent of these COPCs is not limited to specific areas, but is located throughout soil EA 3. Molybdenum concentrations were greater than ten times the ecological SLC for most sampling locations. Maps showing locations where molybdenum and vanadium concentrations exceed the ecological SLC are depicted on Figure 5-72. Phenanthrene was found at the Truck Shop Slice and near the water tank northwest of the primary crusher.

Based on EPA's BERA, six of the metals are identified as ecological COCs in soil EA 3: cadmium (food web only), chromium, copper, manganese, molybdenum, and thallium. Statistical evaluation indicated that these metals were present at concentrations significantly greater than at reference background areas. However, after a more in-depth evaluation of terrestrial toxicity data, expectation of low bioavailability (for select COCs), and the poor quality habitat currently existing at the waste rock piles, it was concluded that adverse effects are unlikely to result from exposure of terrestrial biota to all of these metals except molybdenum.

A re-evaluation of molybdenum toxicity and bioavailability in upland mine site soil was subsequently performed. Site-specific toxicity testing based on laboratory exposure of rye grass and earthworm to mine site soil and extensive laboratory evaluation of uptake and bioavailability of different forms of molybdenum were used to derive a Site-specific soil toxicity reference value of 300 mg/kg for molybdenum in upland, mine site soil. Molybdenum concentrations exceeding 300 mg/kg in soil EA 3 are limited to the waste rock piles. Applying the revised Site-specific soil toxicity reference value and considering the unsuitable ecological habitat of the waste rock piles resulted in eliminating molybdenum as a COC in soil EA 3.

Therefore, there are no ecological COCs in soil EA 3 which warrant CERCLA response actions.

5.10.5.4 Soil Exposure Area 4

Soil EA 4 includes all other mine site soils (not included in other areas), the open pit, the mine site scars, and Capulin, Goathill North, and Goathill South waste rock piles.

The following four COPCs exceeded the human health SLC in soil EA 4: arsenic, iron, lead, and molybdenum. However, based on the EPA HHRA, none of these contaminants are considered COCs for soil EA 4.

Seventeen metals were identified as COPCs exceeding ecological SLC in soil EA 4 (Table 5-23). Exposure to chromium, copper, lead, manganese, molybdenum, selenium, silver, thallium, vanadium and zinc presented some ecological risk. However, concentrations of these metals were not statistically higher than reference background concentrations or the level of uncertainty in the risk calculations (copper) was too high to warrant further consideration in the BERA.

Therefore, based on the EPA BERA and the statistical comparison of COPC concentrations to reference background concentrations, none of these metals are considered ecological COCs that warrant CERCLA response actions.

5.10.6 Terrestrial Vegetation

Three lines of evidence were evaluated to investigate nature and extent of contamination and potential effects on vegetation – measurement of plant communities, ryegrass bioassay, and analysis of chemicals in soil and unwashed vegetation. The mine site ecological area includes those portions of the mine site where vegetation is found to grow. The presence of vegetation generally coincides with soil EA 4 (Figure 5-71), but excludes the open pit and the waste rock piles. In recognizing the importance of waste rock as a potential source of metals which could be taken up in plants, an effort was made to locate vegetation growing on waste rock in soil EAs 3 and 4 for sampling. However, vegetation could not be found by the field sampling team in sufficient amounts on any waste rock pile at the mine site for sampling (see Vegetation Sampling, Section 5.8.4 above). As nearly all of soil EA 3 consists of waste rock and the Truck Shop Slice, no vegetation was sampled in soil EA 3. Also, since soil EAs 1 and 2 are active areas of mining operations with little or no vegetation, no vegetation sampling was performed. The extensive terrestrial vegetation data were used by EPA to develop estimates of risk.

Because vegetation samples were not collected at EAs 1 through 3, only the ecological area of EA 4 was evaluated. The three lines of evidence show no adverse effects of mining-related COPCs on vegetation in the EA 4 ecological area. They are discussed below.

5.10.6.1 Plant Community Measurement

Plant community data collected included vegetation cover and species richness by strata, percent and type of ground cover, and topographic data.

The results show there is little difference in plant cover between the EA 4 ecological area and the reference background area. Where differences are present, such as shrub cover, they appear to result from natural factors such as elevation, aspect, and past disturbances. There is also no apparent difference in plant species diversity between the two areas. No visible symptoms of chemical toxicity were observed in the field.

5.10.6.2 Ryegrass Bioassay

Bioassay data were collected from those areas of the mine site that were likely to have complete exposure pathways for populations of terrestrial receptors (*i.e.,* areas considered likely to be terrestrial habitat). This excluded the mine site waste rock piles and other disturbed areas affected by mining related activities that no longer supported terrestrial habitat.

Results showed that plant survival and growth were not reduced in plants grown on soil and scar material collected from the EA 4 ecological area compared to the reference background area based on statistical analysis of bioassay data.

The standard operating procedure for the ryegrass bioassay has an allowable soil pH range of 6 to 10. If soil pH was below 6, the soil was buffered to bring the soil within the allowable range. The pH was adjusted on 32 percent of the soil samples, approximately half were from the mine site reference background area. Because it is recognized that mine-related pH toxicity, in addition to metals toxicity, can be associated with acid-generating or potentially acid-generating waste rock, the results from the ryegrass bioassays must be interpreted with caution. For those samples with pH adjustment, the ryegrass bioassay cannot account for direct pH-related toxicity (reduced plant survival and growth). In addition, the bioassay cannot account for the degree of metal toxicity associated with pH. Due to these limitations, the toxic affect of pH cannot be quantified and has been described qualitatively.

5.10.6.3 Analysis of COPCs in Soil and Vegetation

As discussed above, twenty metals were identified as ecological COPCs in soil at the mine site. A comparison was made between the concentrations of these metals in plants from the EA 4 ecological area and reference background area. Chemical results were obtained from plant parts (above and below ground) and life forms (grasses, forbs, and shrubs) collected in each of the two areas.

The results showed the percentage of detects of metals was higher in below-ground plant tissue than in aboveground tissue, but were generally similar between the EA 4 ecological area and reference background area. This is consistent with the soil chemistry data which showed no statistical difference between the EA 4 ecological area and reference background area for all but two of the twenty metals.

Concentrations of COPCs were generally similar among grasses, forbs, and shrubs. Differences among these plant types were not analyzed statistically.

5.10.6.3.1 Bioaccumulation

Uptake and bioaccumulation of COPCs by plants were evaluated by comparing COPC concentrations in vegetation and soil from co-located sample sites. Uptake was evaluated by two methods: (1) calculation of bioaccumulation factors from vegetation and soil concentrations, and (2) graphical analysis of the results from each sample site and each COPC. Bioaccumulation factors over 1 indicate that concentrations are higher in vegetation than in soil, suggesting that bioaccumulation may be occurring. Significant graphical correlations between plant and soil concentrations at the sampling site provide a means of evaluating whether soil concentrations are a reliable predictor of plant concentrations.

For aboveground vegetation, three COPCs (boron, molybdenum, and zinc) had bioaccumulation factors of 1 or higher in the EA 4 ecological area. For below ground vegetation, four COPCs (copper, manganese, molybdenum, and zinc) had bioaccumulation factors higher than 1. However, the bioaccumulation factors from the EA 4 ecological area and the reference background area were generally comparable.

For aboveground vegetation, the graphical results generally did not indicate significant trends between COPC concentrations in soil and aboveground vegetation at the EA 4 ecological area. The results for below-ground vegetation showed a larger number of COPCs with significant correlations between soil and vegetation.

5.10.7 Terrestrial Animals

Characterization of terrestrial biota at the mine site was focused on areas likely to be terrestrial habitat. The extensive data were used by EPA to develop estimates of risk. The abiotic media data were used to develop hazard quotients in risk assessment.

5.10.7.1 Small Mammals and Invertebrate Communities

Deer mice (*Peromyscus maniculatus*) were the only small mammals captured at every sampling location. Brush mice (*Peromyscus boylii*) and least chipmunks (*Eutamias minimus*) were captured at both the mine site ecological area and reference background area. Golden-mantled ground squirrels (*Spermophilus lateralis*) were only captured at the base of Capulin Waste Rock Pile.

Numerous metals were detected in small mammals. However, no COPC concentrations were statistically higher than those in reference areas, indicating that chronic exposure is not significantly different between the EA 4 ecological and reference background areas.

The results of the soil fauna investigation showed the median density for invertebrates was similar between the mine site and reference background areas. Species richness was slightly higher at the reference background area than the EA 4 ecological area. Conversely, species richness at the mine site scar area was slightly higher than at the reference background scar area.

5.10.7.2 Earthworm Bioassay Results

Earthworm bioassays were performed on soils collected from the mine site ecological area, mine site scars, mine site reference background area and the scar reference area. Earthworm bioassays were not performed on soils from waste rock piles because it was assumed that such testing would show toxicity to earthworms in soil samples with pH below 4.0. Much of the surface soil on the waste rock piles is known to exhibit pHs below 4.0. Additionally, since the grain size was so large (gravel and larger) and the organic material so low that earthworms could not have survived.

There was no statistically significant difference in earthworm survival or body weight between the mine site ecological area and the reference background area. There was a statistically significant reduction in earthworm survival between the mine site scar (average of 92 percent) and reference background scar (average of 98 percent) areas, but no statistically significant difference in body weight. When combining the ecological and scar areas, a difference was still observed in survival between the mine site (median of 95 percent) and reference background (median of 98 percent).

There was no significant effect on earthworm reproduction between the mine site ecological area and the reference background area.

Similar to the SOP for ryegrass bioassay, the earthworm bioassay has an allowable soil pH range of between 4 and 10. However, because the bulk soil samples sent to the laboratory were used for both earthworm and ryegrass bioassays, the pH was buffered if outside the range of 6 to 10 (still within the range of both methods). The pH was adjusted on 32 percent of the soil samples, approximately half were from the mine site reference background area. Four of the 10 mine site soil samples were buffered. Therefore, the results of the earthworm bioassay must be interpreted with caution. The earthworm bioassay cannot account for direct pH related toxicity (reduced plant survival and growth). In addition, the bioassay cannot account for the degree of metal toxicity associated with pH. Due to these limitations, the toxic effect of pH cannot be quantified and has been described qualitatively.

5.10.7.3 Presence of COPCs in Tissue Samples

Small mammals were analyzed for metal concentrations in homogenized whole body samples. There were no significant differences between the mine site ecological area and reference background area in small mammal metal concentrations for any analyte evaluated.

Five small mammals were collected from the toe of the Capulin, Goathill North, and Goathill South waste rock piles for determination of bioaccumulation into different organs (*i.e.,* liver, kidney, and carcass). Each component was analyzed separately for metals and other inorganic chemicals.

Some analytes (aluminum, antimony, arsenic, and thallium) were only detected in carcass, and not in liver and kidney. Some concentrations of analytes were higher in carcass than other tissue (barium, manganese, lead, nickel, and zinc). Boron, cadmium, and selenium concentrations were higher in kidneys, whereas concentrations of molybdenum were higher in kidneys and livers, than in carcass.

In addition, a comparison of estimated whole body metals concentrations in small mammals from the toe of waste rock pile to mammals from other mine site and reference background areas showed metal concentrations to be generally similar.

There were no significant differences between earthworm tissue concentrations at the mine site ecological and scar areas and reference background areas for any analyte evaluated.

5.11 Nature and Extent of Contamination at the Tailing Facility Area

This section evaluates the nature and extent of contamination in the physical media investigated at the Tailing Facility Area (surface water and sediment, surface soil, tailing, ground water, air), as well as aquatic and terrestrial biota and garden vegetables used for risk assessment.

Similar to the evaluation for the Mine Site Area, the evaluation of nature and extent is performed with respect to the COPCs having concentrations exceeding the EPA SLC. To evaluate the nature of the COPCs, concentrations are compared to the concentrations in selected reference background areas. The comparison of data from the Tailing Facility Area to data from reference background areas is a statistical comparison. When forms of the term “significant” are used in context with this comparison, it means “statistically significant". Potential source areas at the Tailing Facility Area are also evaluated to assess the nature of the COPCs.

Also presented in this section are the COCs identified in the FS for the Tailing Facility Area which will be addressed by the Selected Remedy.

5.11.1 Tailing Facility Area Source Characterization

The potential sources of contamination at the Tailing Facility Area, which are depicted on Figure 2-1, are as follows:

- Tailing impoundments
- Tailing pipeline and Lower Dump Sump
- Dry maintenance area
- Ion exchange plant
- Pope Lake

5.11.1.1 Tailing Impoundments

Both water and tailing solids from the tailing impoundments were considered as potential sources of contamination.

Petrographic analysis of four samples showed tailing to be composed primarily of quartz and feldspars, with lesser amounts of clay. Calcite was present in each sample examined. Pyrite was the dominant sulfide mineral, although galena (lead sulfide), chalcopyrite (copper-iron sulfide), and molybdenite (molybdenum disulfide) were also identified. Pyrite grains were fresh in three of the four samples.

Results of paste pH and conductivity testing (SRK 1996, 1997) indicate the tailing have near-neutral pH. The results suggest that some oxidation is taking place but any acid produced is currently being neutralized by carbonate within the tailing. Mineralogical examination of six samples indicates that calcite composes approximately three percent of the tailing.

Chemical analysis of 12 surface and near-surface tailing samples and 14 subsurface tailing samples showed relatively little geochemical variability within the tailing spatially or over time (depth). The acid-base accounting results indicate that there is sufficient neutralizing capacity to neutralize any acid that is generated (RGC 1998).

Leachate from nine (20-week) humidity cell tests maintained slightly alkaline pH values through testing.

Tailing solid samples at the mill as part of DP-933 requirements had a paste pH value of 7.9 and somewhat elevated concentrations of copper, molybdenum, and zinc. The tailing pond water at the tailing facility had pH values ranging from 7.84 to 8.07. Concentrations of sulfate (1,200 – 1,400 mg/L) and fluoride (greater than 4 mg/L) were elevated above New Mexico surface water standards, but metals concentrations were generally low and did not exceed the standards (chronic) except for aluminum (0.15 mg/L).

5.11.1.2 Other Potential Sources at Tailing Facility Area

Based on the findings of the RI, the tailing pipeline and Lower Dump Sump, dry maintenance area, ion exchange plant, and Pope Lake were determined not to be sources of contamination at the Tailing Facility Area.

5.11.2 Surface Water and Sediments

Surface water and sediment from the tailing impoundments, irrigation ditches, irrigation return flows, and Hunt's Pond were characterized.

The general water quality within the tailing impoundments reflects the chemical nature of the tailing and process water from milling operations. Lime is added in the milling process and the resulting neutralization is evident as the water is neutral to slightly alkaline. Values of pH range from upper 6's to mid 8's. The irrigation ditch water, irrigation return flow, and Hunt's Pond water all have neutral pH with values ranging from about 6.5 to 8.

Specific conductance values (400 – 1,000 µS/cm) for the irrigation return flow were somewhat higher than the irrigation ditch water and indicate that the irrigation return flow mixes with shallow ground water south of the tailing facility near the Red River. The water table is less than a foot below ground surface where the samples were collected.

Several metals were identified as human health and ecological COPCs for surface water and sediment in each of these areas, based on comparison to EPA's SLC. Additionally, diesel fuel No. 2 and gasoline were detected in a few samples in tailing impoundment water near the tailing discharge pipe.

Based on the EPA HHRA and BERA, the only COCs are in tailing impoundment sediment. Table 5-24 is a summary of the COCs and their concentrations. There are no other COCs in any other surface water and sediment within the Tailing Facility Area.

5.11.3 Aquatic Biota in Tailing Impoundment

No fish inhabit the tailing impoundments. Benthic macroinvertebrate populations were quantitatively sampled and macroinvertebrate and filamentous algae tissue were sampled for metals analysis.

TABLE 5-24
CONTAMINANTS OF CONCERN AND CONCENTRATION RANGES FOR TAILING IMPOUNDMENT SEDIMENT

Human Health COC	**Concentration (mg/kg)**
Molybdenum	85 – 19,400
Ecological COC	**Concentration (mg/kg)**
Cadmium	0.4 – 4.7
Copper	51 – 2,100
Lead	21 – 357
Manganese	488 – 4,760
Molybdenum	85 – 19,400
Nickel	26 – 79
Silver	0.5 – 8.4
Zinc	97 – 569

Note: Although COCs are present in tailing impoundment sediment, cleanup levels were not developed for ecolocial receptors because of the temporary nature of these facilitites and the lack of potential for population effects.

The results showed that benthic macroinvertebrate populations generally have low densities and number of taxa. Benthic macroinvertebrate tissue contained levels of beryllium, copper, manganese, molybdenum, nickel, and vanadium that were higher than other lake or stream sample sites. In the algae tissue, beryllium, cadmium, manganese, and molybdenum were found at higher concentrations in comparison to other lake and stream sample sites.

Three-brood screening-level chronic water toxicity testing using *Ceriodaphnia dubia* was conducted on surface water samples. Ten-day chronic sediment tests using *Hyalella azteca* and *Chironomus tentans* were conducted on sediment samples.

The results of the chronic water toxicity testing for tailing impoundment water indicated toxicity. Chronic toxicity tests for tailing impoundment sediment showed no significant toxicity in two tests using *Chironomus tentans* and one test using *Hyalella azteca*. However, the other *Hyalella azteca* test had significantly lower survival.

5.11.4 Surface Soil

Surface soil was evaluated in the Tailing Facility Area, including the dry/maintenance area, the ion exchange plant area, Pope Lake, and the tailing impoundments (soil EA 7). A summary of the soil areas is presented in Table 5-25 below. A map of the soil areas is shown on Figure 5-71.

TABLE 5-25
SOIL AREAS EVALUATED AT TAILING FACILITY AREA

<table>
<tr><th>Type of Exposure</th><th>Area</th><th>Description of Area</th></tr>
<tr><td rowspan="6">Human Health and Ecological</td><td rowspan="6">Risk Assessment Soil EA 7</td><td>Dry/Maintenance Area</td></tr>
<tr><td>Ion Exchange Plant</td></tr>
<tr><td>Pope Lake</td></tr>
<tr><td>Tailing Impoundments</td></tr>
<tr><td>Windblown Particulate Deposition (portion of transects within EA 7)</td></tr>
<tr><td>South of Tailing Facility
(upland portion)</td></tr>
<tr><td>Human Health</td><td>Windblown Particulate Deposition Evaluation Area</td><td>Windblown Particulate Deposition</td></tr>
<tr><td>Ecological</td><td>Risk Assessment Tailing Material (Soil EA 7)</td><td>Tailing Impoundment</td></tr>
</table>

Four human health COPCs were identified for soil at the Tailing Facility Area based on comparison with EPA's SLC: arsenic, iron, molybdenum, and benzo(a)pyrene. Fourteen metals were identified as ecological COPCs in soil, including molybdenum. No VOCs, pesticides, dioxin/furans were found in soil at concentrations considered high enough to warrant evaluation in risk assessment.

5.11.4.1 Soil Exposure Area 7

Based on the EPA HHRA, no human health COCs were identified for soil EA 7. Based on the EPA BERA, exposure to chromium, copper, manganese, molybdenum, vanadium, and zinc (including via food web) presented some risk to ecological receptors. However, concentrations of chromium, manganese and vanadium were not statistically higher than reference background. In addition, the estimated risk for these metals is based on no effect toxicity reference values and adverse effects would be unlikely at the low level of risk estimated. Therefore, no ecological COCs are identified for soil in soil EA 7. The characterization of soil does not include tailing, which is discussed below.

5.11.4.2 Windblown Particulate Deposition

Two human health COPCs (arsenic and iron) were identified in the windblown particulate deposition areas. However, concentrations of arsenic and iron were not significantly greater than reference background concentrations. Molybdenum concentrations were significantly higher in windblown particulate samples when compared to reference, but they did not exceed the EPA SLC.

The EPA HHRA evaluated potential exposure associated with inhalation of dust blowing from the tailing facility for current and future school children. Exposures to school children were assessed by estimating COPC concentrations in dust particles in the air from the concentration of the contaminant in soil. The soil data collected for the windblown transects were used in the evaluation of cancer risks. Potential non-cancer effects associated with inhalation of dust were not estimated due to a lack of inhalation reference concentrations for molybdenum and iron.

Based on the EPA HHRA, there are no COCs identified for windblown particulate deposition areas.

5.11.4.3 Tailing Material in Exposure Area 7

Samples of tailing material underlying the shallow interim soil cover at the tailing impoundments (EA 7) were collected for analysis to (1) characterize tailing as a source of contamination, and (2) estimate risk from exposure to tailing. The tailing samples were collected from tailing material at a depth from 0 to 28 inches.

Several metals exceed the EPA ecological SLC and are considered COPCs. Based on a re-evaluation of risk for tailing material by EPA[47], molybdenum was found to present a risk to terrestrial mammals [deer, elk and other untested herbivorous mammals (not including domestic livestock)] and is therefore considered a COC for tailing material. A summary of the COC, range of concentrations and cleanup level, is presented in Table 5-26 below.

TABLE 5-26
CONTAMINANT OF CONCERN AND CONCENTRATION RANGE FOR TAILING MATERIAL WITHIN EA 7

COC	Concentration (mg/kg)	Cleanup Levels (mg/kg)		
		Wildlife[1]	Livestock[2]	Avian[3]
Molybdenum	102 – 334	41	11	54

Notes:
(1) Protects Against Molybdenosis in Livestock (Cattle, Sheep)
(2) Protects Against Molybdenosis in Wildlife (Deer, Elk)
(3) Protects Avian (Bird) Receptor based on Western Kingbird
Refer to Table 12-15

[47] *See also* Technical Memorandum: Re-evaluation of Risk Estimates for Tailing Facility Surface Samples – Addendum to BERA (CDM 2009c).

5.11.5 Ground Water

Ground water characterization at the tailing facility and surrounding areas is based on analytical data collected from monitoring wells and seeps and spring at and in the vicinity of the tailing facility. The statistical comparisons made with the reference background area were similar to those conducted for the mine site ground water characterization.

Ground water samples were analyzed primarily for metals and other inorganic constituents. Limited analysis of organic compounds was performed at the dry maintenance area where organics may have been used. Based on the analytical results, the following nine metals are identified as human health COPCs in ground water at the tailing facility:

- Aluminum
- Arsenic
- Chromium
- Iron
- Lead
- Manganese
- Molybdenum
- Uranium
- Vanadium

Sulfate was found in concentrations that did not exceed the EPA human health screening level criterion (1,500 mg/L) but did exceed the numeric criterion of the New Mexico ground water standard of (600 mg/L).

Tailing seepage from the impoundments and possibly the historic tailing disposal area outside of the impoundments is the source of the metals and sulfate contamination in the ground water. The geochemical testing of the tailing material shows it to be currently non-acid generating (net acid consuming). The lack of acid production results in lower potential for dissolution or leaching of most metals, which is why fewer metals are detected at elevated concentrations in ground water at the tailing facility when compared to the mine site.

Uranium has been detected in ground water at the tailing facility. Since uranium can be associated with Climax-type molybdenum ore bodies (see Geology, Section 5.6), it is likely that the source of the uranium is the tailing material in the impoundments, which originated at the mine.

Based on the EPA HHRA for the alluvial aquifer, exposure to arsenic presents a cancer risk which exceeds the upper end of the EPA risk range. However, arsenic doesn't exceed the federal or New Mexico MCL of 0.01 mg/L and therefore is not included with the list of COCs which warrant response actions under CERCLA.[48] COCs which contribute appreciably to non-cancer risks are aluminum, molybdenum, iron, and vanadium, the most significant of which is molybdenum. Concentrations of these metals (excluding aluminum) are significantly higher than reference background concentrations. However, of these COCs, only the risk associated with molybdenum exceeds the reference background risk estimated in the HHRA.

Based on the EPA HHRA for the basal bedrock aquifer, arsenic, manganese, and molybdenum are identified as COCs that contribute appreciably to risk. However, molybdenum is the only human health COC with concentrations that are significantly higher than reference background concentrations. Molybdenum concentrations exceed the Site-specific health-based criterion of 0.08 mg/L established by EPA Region 6, as discussed below.

[48] The NCP at 40 C.F.R. § 300.430(e)(2)(i)(B) requires that non-zero MCLGs or MCLs established under the Safe Drinking Water Act shall be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water where they are determined to be relevant and appropriate requirements. Section 300.430(e)(2)(i)(D) also states that in cases involving multiple contaminants or pathways where attainment of these chemical-specific relevant and appropriate requirements (MCLGs or MCLs) are not sufficiently protective (*i.e.*, result in cumulative risk in excess of EPA's upper bound lifetime cancer risk of 10^{-4}), criteria set forth in § 300.430(e)(2)(i)(A) may also be considered when determining cleanup levels. Since multiple carcinogenic contaminants or multiple pathways are not identified for the tailing facility ground water (arsenic is the only carcinogen identified in the HHRA), the MCL of 0.01 mg/L for arsenic would be the cleanup level. Therefore, arsenic at levels below 0.01 mg/L would not warrant response actions.

The HHRA did not identify uranium as contributing appreciably to human health risk. However, concentrations exceed both the federal and New Mexico drinking water standard (MCL) of 0.03 mg/L for uranium. Therefore, uranium is also considered a human health COC in ground water at the tailing facility. Uranium was not analyzed in reference background wells and therefore no statistical comparison could be made.

Future residents and commercial/industrial workers could be potentially exposed to these risk-based COCs by using contaminated ground water as drinking water. Molybdenum is a non-carcinogenic COC. Natural uranium is both a heavy metal and radionuclide. However, uranium gives off very small amounts of radiation, thus, is considered more hazardous from a standpoint of chemical toxicity.[49] Uranium in its soluble form is a kidney toxicant. The federal and New Mexico MCL is considered protective for both kidney toxicity and cancer. The EPA has withdrawn its carcinogenicity classification for uranium, but other health organizations consider uranium as a potential or confirmed human carcinogen.[50]

Other COCs that exceed the numeric criteria of New Mexico ground water quality standards in ground water at the Tailing Facility Area and are significantly higher than reference background concentrations are fluoride, iron, manganese, sulfate and total dissolved solids (TDS).

Table 5-27 summarizes the COCs identified, concentration ranges, and established cleanup levels for ground water in the Tailing Facility Area and the cleanup levels.

[49] ATSDR Uranium Toxicity Profile

[50] National Institute of Occupational Safety and Health (NIOSH) considers uranium to be a potential occupational carcinogen; American Conference of Governmental Industrial Hygienists (ACGIH) considers insoluble and soluble uranium compounds confirmed human carcinogens (A1).

TABLE 5-27
CONTAMINANTS OF CONCERN AND CONCENTRATION RANGES FOR TAILING FACILITY AREA GROUND WATER

COC	Concentration (mg/L)	Cleanup Levels[1] (mg/L)
Fluoride	0.38 – 2.4	1.6[4]
Iron	<0.1 – 17	1.0[4]
Manganese	<0.01 – 2.0	0.2[3]
Molybdenum	<0.001 – 3.2	0.08[4]
Sulfate	152 – 1,480	600[4]
TDS	184 – 2870	1,000[4]
Uranium	<0.001 – 0.085	0.03[2]

Notes:
(1) The basis for the cleanup levels is to comply with state of NM drinking water standards (MCLs) and NM water quality standards as ARARs and EPA health-based criteria as TBCs.
(2) NM MCL (adopts by reference federal MCL in 40 CFR Part 141)
(3) NM Standard for Domestic Water Supply
(4) EPA Health-Based Criterion
TDS = Total Dissolved Solids

Characterization of the nature and extent of ground water contamination in the alluvial and bedrock aquifers focuses on molybdenum, sulfate, and uranium to define the distribution and temporal changes of the contaminants.

5.11.5.1 Alluvial Aquifer

The alluvial aquifer occurs primarily beneath and south of the Dam No. 1 impoundment as alluvium is not present or has limited extent beneath the Dam No. 4 and Dam No. 5A impoundments.

5.11.5.1.1 Source and Pathways

Tailing seepage from both the Dam No. 1 and Dam No. 4 impoundments is the source of the elevated concentrations of COCs and sulfate in the alluvial aquifer. Tailing seepage infiltrates and moves downward to the shallow ground water beneath the impoundment or flows laterally through the dam in the form of seeps along the dam face. It may also infiltrate downward from the historic tailing disposal area or flow outward through the eastern flank of the impoundment near Dam No. 1B, in the area of the Change House. The seepage-impacted ground water then flows south-southwest in the direction of regional ground water flow. Seepage impacts are observed in ground water samples collected from a number of wells and seeps/spring between Dam No. 1 and the Red River. Regional ground water flow directions are depicted on the potentiometric surface contour map (Figure 5-22).

5.11.5.1.2 Concentrations and Distribution

The alluvial ground water has a neutral pH, with values ranging from the upper 6's to the upper 7's.

Molybdenum concentrations in the alluvial aquifer range from non-detect levels (less than 0.001 mg/L) to 3.2 mg/L. The molybdenum concentrations exceed both the New Mexico ground water quality standard for irrigation use of 1.0 mg/L and the health-based criterion of 0.08 mg/L developed by EPA as part of the HHRA in some areas[51].

The highest molybdenum concentrations are measured in extraction wells at the base of Dam No. 1 (EW-5A) and on the eastern flank of the Dam No. 1 impoundment (MW-17) near the Change House. Elevated concentrations of molybdenum continue southward from Dam No. 1 along the axis of the arroyo to the Red River. Two isoconcentration contour

[51] EPA initially developed a health-based criterion of 0.05 mg/L for molybdenum in ground water as a preliminary remediation goal in the HHRA. The 0.05 mg/L value was based on the EPA IRIS reference dose (RfD) of 0.005 mg/kg-day and a daily consumption rate of 1.5 L of water. After a further literature review, a PRG of 0.08 mg/L was selected as the revised health based criterion for molybdenum based on the daily consumption rate of 1 L of water in the EPA Child Factors Exposure Handbook published in 2008.

maps of molybdenum (dissolved) in alluvial ground water are depicted on Figures 5-73 and 5-74. Figure 5-73 depicts molybdenum data collected in April 2004; Figure 5-74 depicts molybdenum data from 2008. Overall, the extent of seepage-impacted ground water is similar from 2004 to 2008, but higher concentrations are observed in the area of the Change House. Fewer data points were used in preparing the 2008 contour map, as the drive point samples south of Embargo Road to Outfall 002 were not available and seeps along the eastern flank of the Dam No 4 impoundment (*i.e.,* Outfall 003 drainage) are no longer sampled.

The area of molybdenum contamination in ground water near the Change House was a former arroyo where historic tailing deposition occurred. Infiltration of unused irrigation water in the eastern diversion channel contacts this tailing material, resulting in elevated molybdenum concentrations in the water. As this seepage-impacted water infiltrates and percolates downward, it may be the source of the molybdenum contamination present in alluvial ground water in this area. This molybdenum contamination may also be the result of tailing seepage migrating southeastward from the eastern flank of the Dam No. 1 impoundment, similar to that which occurs along the eastern flank of the Dam No. 4 impoundment.

Sulfate concentrations range from 152 to 1,480 mg/L. The highest sulfate concentrations are found at the base of Dam No. 1 and along the eastern flank of the Dam No. 4 impoundment (including the Outfall 003 drainage). The higher sulfate concentrations in the Outfall 003 drainage are similar to the tailing water behind the Dam No. 4 impoundment, suggesting that little attenuation of sulfate occurs. Sulfate concentrations decrease slightly going southward to the Red River. The lowest sulfate concentrations are found along the eastern flank of the tailing impoundment and in Spring 17, which is a ground water discharge area south of Embargo Road near the river. An isoconcentration contour map of sulfate in the upper portion of the alluvial aquifer for April 2004 is depicted on Figure 5-75.

Uranium concentrations range from non-detect (<0.001 mg/L) to 0.085 mg/L. Some of the highest concentrations of uranium have been measured in tailing seepage collected from the Upper 003 Seepage Barrier (0.069 mg/L), which captures seeps along the Outfall 003 drainage on the eastern flank of the Dam No. 4 impoundment. High uranium concentrations are also found in seeps along the face of Dam No. 1 (East Seep – 0.056 mg/L) and in the extraction wells at the base of Dam No. 1 and near Embargo Road (EW-5D – 0.053; EW-6 – 0.067 mg/L). Isoconcentration contour maps of uranium in alluvial ground water at the Tailing Facility Area are depicted on Figures 3-1 and 3-2.

5.11.5.1.3 Temporal Changes

Temporal changes in concentrations of key COCs and sulfate in the upper alluvial aquifer were evaluated by constructing time series graphs and performing statistical trend analysis. The time series graphs were updated through second quarter 2008 and cover a period of increased mining activity from approximately 2006 to 2008.

Overall concentrations in the alluvial aquifer exhibit both increasing and decreasing trends. Decreasing trends in molybdenum concentrations occur in some wells south of Dam No. 1 in the vicinity of the seepage interception system. However, increasing trends in molybdenum concentrations occur in MW-17 and MW-4, located south of the Change House. The changes in molybdenum concentrations in alluvial ground water can be observed by comparing isoconcentration contour maps of 2004 and 2008 molybdenum data (Figures 5-73 and 5-74).

Increasing and decreasing trends in sulfate are also occurring, with five of the eight wells that exhibit trends south of Dam No. 1showing increasing trends. Some of these increasing trends have been gradual, while others started in late 2006/early 2007 (EW-5B) and may reflect impacts from the increased level of mining activity. A comparison of isoconcentration contour maps of 2004 and 2008 sulfate data show significant increases in sulfate near Dam No. 1 and along the eastern flank of the Dam No. 4 impoundment (Figures 5-75 and 5-76).

The concentrations of COCs and sulfate in the deeper portion of the alluvial aquifer[52] have been relatively constant over time, with some exceptions. Increasing trends in sulfate are occurring in extraction well EW-2 and the Change House monitoring well, MW-CH, indicating tailing seepage impacts are increasing at greater depths within the alluvial aquifer. The time series graph for EW-2 is depicted on Figure 5-77. The sulfate concentrations in the deeper portion of the alluvial aquifer are still well below the numeric criterion established for the New Mexico ground water standard.

5.11.5.2 Basal Bedrock (Volcanic) Aquifer

The basal bedrock aquifer occurs within volcanic rocks (andesite and basalt). It is a regional aquifer underlying the Guadalupe Mountain, the tailing facility, and presumably Questa, although no wells have been drilled deep enough to reach the volcanic rocks in Questa.

5.11.5.2.1 Sources and Pathways

The source of contamination in the basal bedrock aquifer is tailing seepage from primarily the Dam No. 4 impoundment, including the area behind Dam No. 5A, an interior dam on the western side of the impoundment. Most of the Dam No. 4 impoundment is underlain by thick beds of lacustrine clay (as discussed in Section 5.7.2.2). However, tailing seepage can enter the volcanics in the Dam No. 5A area, which abuts the Guadalupe Mountain front and is in contact with the volcanics. Another significant area where tailing seepage likely flows to the basal bedrock aquifer is the area upstream from the face of Dam No. 4. It is unknown if the thick clay beds are present in this area. Tailing seepage infiltrates directly into the volcanics near Dam No. 5A or into alluvial sediment beneath the face of Dam No. 4 and then into the basal volcanic aquifer.

5.11.5.2.2 Chemistry, Concentrations, and Distribution

[52] The deeper portion of the alluvial aquifer is referred to as the basal alluvial aquifer in the RI Report.

The pH of the basal bedrock aquifer is very similar to the alluvial aquifer and typically ranges from the upper 6's to the lower 8's. The Stiff diagrams illustrate that the ion concentrations of the basal bedrock aquifer are low as compared to concentrations in the upper alluvial aquifer (Figure 5-78). This is the case for wells at the Dam No. 4 impoundment and downgradient springs along the Red River Gorge (Springs 12, 12A, 14T, and 15T). They are more similar to the concentrations of the lower portion of the alluvial aquifer, which has not been impacted by tailing seepage to the same degree as the upper portion of the alluvial aquifer.

Exceedance of the molybdenum health-based criterion (0.08 mg/L) in the basal bedrock aquifer is limited to the area south of Dam No. 4, with the exception of piezometer TPZ-5B near the Outfall 002 discharge at the river. The highest concentrations are in the wells south of Dam No. 4 (MW-11, MW-13), ranging from 0.3 to 0.95 mg/L. Elevated molybdenum concentrations are also observed at Springs 12, 12A, 14T, 15T and 18. Sampling at TPZ-5B was limited during the RI and additional characterization of the basal bedrock aquifer in this area is warranted as part of the Selected Remedy. An isoconcentration contour map of molybdenum (total) in the basal bedrock aquifer is shown on Figure 5-79.

5.11.5.2.3 Temporal Changes

Based on time series graphs and statistical trend analysis, molybdenum and sulfate concentrations have been shown to exhibit increasing trends in the basal bedrock aquifer. Two wells (MW-11, MW-13) have increasing trends, both of which are at Dam No. 4. In MW-11, sulfate increased from about 60 mg/L in the mid-1990s to 210 mg/L in 2008. Molybdenum concentrations increased from 0.07 mg/L to 0.7 mg/L over the same timeframe. Molybdenum concentrations at MW-13 sharply increased from about 2006 to 2008, possibly indicating the effect of increased mining activity for that period of time. Time series graphs for MW-11 and MW-13 are depicted on Figures 5-80 and 5-81. Well MW-23 also exhibits increasing trends in molybdenum and sulfate, but concentrations are very low. Molybdenum concentrations at Spring 12, located about a half mile downstream of MMW-11 along the Red River Gorge, have been on an increasing trend from the mid-1990s and in 2008 the concentration exceeded the health-based preliminary remediation goal of 0.08 mg/L by three times.

5.11.6 Terrestrial Vegetation

Two studies were completed for terrestrial vegetation at the tailing facility: the RI and the Wildlife Impact Study. These studies were used to assess metals bioaccumulation for performance of ecological risk assessment. Sampling of garden vegetables was also conducted at home gardens located near the tailing facility for assessing potential human health effects. Multiple lines of evidence included vegetation community measurement, bioassay, and the presence of COPCs in vegetation samples. Bioaccumulation factors were also calculated for specific metals.

5.11.6.1 Vegetation Community Measurement

Vegetation community data for the RI study were collected at sites from the tailing facility as well as the reference background area located several miles north of the tailing facility on property owned by CMI (known as Cater Ranch). Data collection included vegetation cover and species richness by strata, percent and kind of ground cover, topographic data and observations of plant health.

Both the tailing facility and reference background area are dominated by shrubs and grasses, although forbs provide the most diversity in terms of number of species. In general, the sample sites at the tailing facility had higher vegetation cover and species richness than the reference background area. However, overall numbers of species and vegetation cover are similar. There were no observations of plant symptoms that were likely to be related to metal toxicity.

Based on the EPA BERA, it was inconclusive whether the concentrations of metals in soil at the tailing facility posed a risk for toxic effects (survival, growth, and reproduction) to the terrestrial plant community. Although some differences in plant communities were observed between the tailing facility and Cater Ranch, these results cannot be interpreted with regard to soil toxicity because the sensitivity of observed taxa to metals contamination in soil is unknown.

5.11.6.2 Bioassay

Bulk soil samples for bioassay were collected from the surface soil at the tailing facility. The surface soil consists of a mixture of alluvial soil which has been placed at the tailing facility as interim cover, along with tailing. The results of the ryegrass bioassay showed no statistically significant reduced growth or survival at the tailing facility as compared to the reference background area.

5.11.6.3 Presence of COPCs in Vegetation Samples

Fourteen metals were identified as ecological COPCs in soil at the tailing facility for purposes of ecological risk assessment. These metals were analyzed in vegetation samples collected at the tailing facility and reference background area. Similar to the vegetation study at the mine site, chemical results were obtained from aboveground and below-ground plant parts for shrubs, forbs and grasses.

Results showed that concentrations were significantly higher at the tailing facility for boron, cadmium, copper, lead, molybdenum, and zinc as compared to the reference background area. Three of these metals (copper, molybdenum, and zinc) were significantly higher in both aboveground and below-ground vegetation. Molybdenum and zinc exhibited higher concentrations in aboveground tissues than below ground. Molybdenum concentrations in vegetation (1.9 – 284 mg/kg wet weight) were 30 to 120 times higher at the tailing facility than the reference background area. Concentrations were generally similar among forbs, grasses, and shrubs.

In comparing washed and unwashed vegetation [Wildlife Impact Study data], washing reduced the concentrations of most metals in aboveground and below-ground vegetation. The greater effects were seen in below-ground vegetation. Molybdenum had the highest washed to unwashed concentration ratio of the metals analyzed.

5.11.6.4 Bioaccumulation

Using RI and Wildlife Impact Study data, uptake and bioaccumulation of COPCs by plants were evaluated by comparing concentrations of key metals in vegetation and soil from co-located samples. Bioaccumulation factors were calculated for aboveground and below-ground vegetation. Table 5-28 presents the bioaccumulation factors that are greater than 1.0 for key COPCs.

TABLE 5-28
KEY COPCS WITH BIOACCUMULATION FACTORS GREATER THAN 1.0 IN VEGETATION AT TAILING FACILITY

COPC	Tailing Facility		
	Forb	Grass	Shrub
Aboveground			
Cadmium	--	<	1.40
Molybdenum	2.61	<	1.13
Zinc	<	<	1.05
Below Ground			
Cadmium	--	<	1.59
Molybdenum	4.02	<	<

Note:
< = Less than 1

A soil to plant bioaccumulation factor (for combined forb, shrub, and grass data) was developed in the EPA BERA for molybdenum to evaluate potential risk to terrestrial receptors foraging on plants growing in soil (soil/tailing mixture) or tailing material. The calculated bioaccumulation factor values ranged from 0.17 to 5.55, with a mean of 1.31 (CDM 2009b and 2009c).

Based on the bioaccumulation factor of 1.31 and a mean plant concentration of 44.7 mg/kg (wet weight) for the aboveground portion of unwashed plants, molybdenum has been shown to present a risk of molybdenosis to large herbivores (mule deer, Rocky Mountain elk) and livestock (cattle, sheep) that would forage on plants growing in tailing material at the tailing facility (CDM 2009c). These receptors can contract molybdenosis if too much molybdenum is ingested via diet. Molybdenosis is caused by copper deficiency due to molybdenum competing with copper, an essential element. The absorption of copper is decreased when molybdenum concentrations are increased.

Therefore, molybdenum is a COC in tailing within EA 7 that could be accumulated by terrestrial plants at levels which warrant CERCLA response actions.

For the soil/tailing mixture, molybdenum levels do not appear to present a significant risk to terrestrial receptors through plant uptake. However, some noted observations add to the level of uncertainty about such assessment. First, in the Wildlife Impact Study Molycorp did not describe the depth of contact between the interim soil cover and tailing for soil samples collected, so the results do not discern the degree of tailing material mixed with the soil samples. Molycorp describes a situation where, in most cases, samples were collected from 0.5- to 6-inch depths and the depth of interim cover was usually at least 7 inches. Second, tailing material is commonly transported to the surface of shallow covered tailing by burrowing mammals, probably pocket gophers. At least some of the cover soil/tailing mixing found in the Wildlife Impact Study samples is likely the result of this pedoturbation, though it has never been quantified.

5.11.6.5 Garden Vegetables

Green beans, leaf lettuce, and zucchini were sampled at three gardens near the tailing facility and at three reference locations. The reference background was comprised of two organic gardens located 3 to 13 miles from the tailing facility and a grocery store. Washed samples were analyzed for the same 14 COPCs identified for the tailing facility.

The results of sampling garden vegetables near the tailing facility did not show any effects related to potential exposure to contaminants from the tailing facility, with the exception of molybdenum and manganese in beans. Molybdenum concentrations in beans are about five times higher than other vegetables at reference background locations, but well below EPA's screening level criterion for molybdenum. Based on the EPA HHRA, the uptake of metals into vegetables was not significant and adverse non-cancer health effects are not likely for future gardeners in the area based on current conditions.

5.11.7 Terrestrial Animals

Small mammals collected at the tailing facility and reference background were deer mice (*Peromyscus maniculatus*), Ord's kangaroo rats (*Dipodomys ordii*), and pocket gophers (*Thomomys sp*.). Several other mice were also collected from the tailing facility.

Numerous metals were detected in the small mammals. However, only three COPCs (lead, manganese, and molybdenum) had concentrations that were significantly elevated above reference background concentrations. A higher number of species were found at the tailing facility (7) as compared to the reference background area (3), indicating a higher diversity at the tailing facility.

A significant effect on earthworm reproduction was observed at the tailing facility compared to reference background. This was indicated by a decreased number of samples in which reproduction was observed, and a decreased number of cocoons produced (tailing facility 0-3 cocoons; Cater Ranch 0-15 cocoons). However, metrics for the native soil fauna community indicated that there were no adverse effects. Invertebrate density and species richness was higher at the tailing facility compared to Cater Ranch.

Numerous metals were detected in bioassay earthworm tissue. However, Molybdenum was the only COPC that was significantly different between earthworm tissue concentrations at the tailing facility as compared to reference background. This suggests that chronic exposure is not significantly different between the two areas. As bioaccumulation factors are approximately 100 times for Cater Ranch, it indicates that earthworms are regulating molybdenum uptake such that more molybdenum is taken up at low soil concentrations compared to high soil concentrations.

Based on the EPA BERA, the risk to earthworms does not warrant remedial consideration. Risk associated with exposure of large herbivores (deer, elk) and livestock (cattle and sheep) to molybdenum in terrestrial plants are discussed above.

5.11.8 Air Quality

An air monitoring network has been maintained by CMI at the tailing facility since February 2003. Three air monitoring stations were installed at the start of the air monitoring program. The locations of the three air monitoring stations are shown on Figure 5-82.

5.11.8.1 Wind Speed and Direction

Wind speed and direction were collected in hourly averages simultaneously with PM_{10} data. Wind conditions are similar across all three air monitoring stations.

5.11.8.2 PM_{10} Concentrations

During four years of PM_{10} monitoring, there were no exceedances of the 24-hour National Ambient Air Quality Standard (NAAQS) of 150 $\mu g/m^3$ at two of the air monitoring stations

(Sites 2 and 3). Site 2 is of particular interest as this location is in the northeast corner of the tailing facility and nearest to the Questa Elementary School.

There were several exceedances of the 24-hour standard for Site 1 in late 2005 and a total of 15 exceedances in 2006. Most of these exceedances were in the last quarter of 2005 and first quarter of 2006 (fall/winter) and were related to unusually dry conditions at the tailing facility. Site 1 is the location closest to the ongoing tailing operations and the high dust levels were localized to the south tailing area where active operations are taking place. The facility implemented a number of dust control measures in the first quarter of 2006, which have been somewhat effective since overall dust levels are lower and the number of exceedances decreased over 2006.

5.11.8.3 Metals Concentrations

Metals with the highest concentrations detected at the three air monitoring stations are silicon (2.4 $\mu g/m^3$), aluminum (0.8 $\mu g/m^3$), iron (0.47 $\mu g/m^3$), and calcium (0.49 $\mu g/m^3$). The metal detected at the lowest concentration was beryllium (0.00004 $\mu g/m^3$). Molybdenum was detected at an average concentration of 0.0004 $\mu g/m^3$ for the three stations, with little variability between stations.

An examination of the aerosol metal composition using (1) reconstruction of mass, (2) specific source rations (silica to iron ratio), and (3) potential elemental enrichment factors indicate that the aerosol is not comprised of material solely from tailing and that soil is the major source.

5.11.8.4 Comparison of Tailing Facility Ambient Air Metals Concentrations to Risk-Based Concentrations and Background Concentrations

Eighteen metals were analyzed for in air monitoring samples and compared to EPA's SLC and background concentrations. Background concentrations were taken from ATSDR toxicological profiles. Based on the results of the comparison, chromium was found at concentrations higher than ambient air risk screening levels.

Additionally, based on the EPA HHRA, cancer risks associated with inhalation of dust blowing from the tailing facility for school children was below EPA's target cancer risk range. The cancer risk was estimated from the concentration of contaminants in windblown transect soil data. EPA derived air concentrations for use in risk assessment by modeling from measured soil concentrations using a generic particle emission factor. The existing air monitoring data for PM_{10} and metals in the PM_{10} fraction were used to verify the modeling.

5.12 Nature and Extent of Contamination in Red River and Riparian Areas

This section evaluates the nature and extent of contamination in the physical media investigated at the Red River and riparian areas (riparian soil, surface water and sediment), as well as the aquatic ecology and terrestrial vegetation (edible riparian plants) used for risk assessment. Ground water-to-surface water interaction (GSI) between the Red River and the underlying alluvial aquifer is also evaluated.

Similar to the evaluation for other areas at the Site, the evaluation of nature and extent is performed with respect to the COPCs having concentrations exceeding EPA's SLC. To evaluate the nature of the COPCs, concentrations are compared to the concentrations in selected reference background areas. The comparison of data from the Red River and riparian areas to data from reference background areas is a statistical comparison. When forms of the term "significant" are used in context with this comparison, it implies "statistically significant."

Also presented in this section are the COCs identified in the FS for the Red River and riparian areas which will be addressed by the Selected Remedy.

5.12.1 Riparian Soil

Riparian soil was sampled along the mine site, in the tailing facility area, and in reference background areas. A summary of the exposure areas defined in the EPA HHRA and BERA, the type of exposure, and a description of the area is presented in Table 5-29 below. Figure 5-71 depicts a map of these exposure areas.

TABLE 5-29
DESCRIPTION OF RIPARIAN SURFACE SOIL AREAS AND TYPES OF EXPOSURE

Riparian Surface Soil		
Type of Exposure	**Area**	**Description of Area**
Human Health and Ecological	Risk Assessment Soil EA 5	Riparian Area in Mine Site Vicinity
Human Health	Campgrounds	Campgrounds along Mine Site
Human Health and Ecological	Risk Assessment Soil EA 6	Riparian Area along Tailing Facility
Human Health	Risk Assessment Soil EA 8	South of Tailing Facility (riparian portion)
		Windblown Particulate Deposition (1 sample in Soil EA 8)
Ecological	Risk Assessment Soil EA 9[1]	South of Tailing Facility (riparian portion)
		Windblown Particulate Deposition (3 samples)

Note:
1. Soil EA 9 includes the area of soil EA 8 (*see* Figure 5-71).

5.12.1.1 Soil Exposure Areas 5 and 6

Soil EA 5 is the riparian area along the Red River reach which extends from the eastern mine site boundary to the confluence of Cabresto Creek and Red River. Soil EA 6 is the riparian area along the Red River from Cabresto Creek to the Red River State Fish Hatchery. The riparian area is comprised of densely vegetated (grasses, forbs, shrubs, and trees) lands along the banks of the Red River. The majority of this EA is good habitat that attracts animal receptors.

Soil samples collected as part of the Historic Tailing Spill Investigation (including tailing spill soil samples, Hunt's Pond soil samples, and private residence soil samples) were included with the data collected for soil EA 5 and EA 6.

Three COPCs (arsenic, iron, and molybdenum) had concentrations that exceeded the human health SLC. Concentrations of all three COPCs were significantly greater than reference background concentrations in soil EA 5. Only iron had concentrations significantly greater than reference background for soil EA 6. Concentrations of lead were also significantly greater than reference background concentrations, but they did not exceed the SLC.

The following COPCs had concentrations which exceeded the ecological SLC:

- Aluminum toxicity (soil pH <5.5)
- Barium
- Boron
- Cadmium
- Chromium
- Copper
- Iron toxicity (soil pH <5 and >8)
- Lead
- Manganese
- Molybdenum
- Selenium
- Vanadium

- Zinc

Of these COPCs, barium, copper, lead, manganese, molybdenum, selenium, and zinc had concentrations significantly higher than reference background. Molybdenum concentrations were greater than or 10 times greater than the SLC at 12 of 13 sampling locations in soil EA 5. Relative concentrations for molybdenum and lead in soil EA 5 and molybdenum in soil EA 6 are depicted in Figures 5-83 and 5-84, respectively.

To determine the mobility of COPCs during weathering of tailing spill material, SPLPs were conducted on three tailing spill samples collected as part of the Historic Tailing Spill Investigation. Analysis of solid samples indicated that tailing ranged from acidic to near neutral (paste pH values of 3.2 to greater than 7.0), with the acidic tailing containing greater metals concentrations. The leachate data for the acidic tailing samples had greater concentrations of most of the COPCs (except molybdenum). The SPLP leachate results were all below the EPA Region 6 Human Health Tap Water Screening Level Criteria, with the exception of fluoride.

Based on the EPA HHRA, there are no human health COCs identified for riparian soil in soil EA 5 and EA 6 which warrant remedial consideration.

Based on the EPA BERA, five COPCs present some risk to ecological receptors: manganese, molybdenum, selenium, zinc, and lead (food web only). Except for zinc, the greatest risks are typically associated with tailing spills or soil mixed with tailing spills. Statistical analysis of the historic tailing spill samples and the associated soil samples showed that the tailing contain statistically higher concentrations of many metals and other inorganic chemicals than the adjacent soil.

When considering animals with large home or foraging ranges, small extent of the remaining spills, and much larger areas of higher quality habitat, population-level effects from these five COPCs is unlikely. Additionally, estimated risk from manganese, selenium, zinc, and lead is very low and nearly insignificant for population-level effects.

Therefore, no remediation of the riparian soil in soil EA 5 and EA 6 is necessary to protect terrestrial ecological receptors (CDM 2009b).

Hot spot concentrations of molybdenum (3 – 642 mg/kg) in these tailing spills exceed the EPA ecological PRG of 54 mg/kg, applicable to birds and non-grazing mammals. However, the removal of many tailing spills in soil EA 5 and EA 6 has already been performed by CMI under the direction and oversight of NMED. The remaining tailing spills are generally small in aerial and vertical extent, with an estimated volume of approximately 3,800 yd^3, most of which is located near the Lower Dump Sump. A map of the tailing spills identified during the Historic Tailing Spills Investigation is depicted on Figure 5-85.

To be consistent with prior response actions under the direction of NMED, remediation of tailing spills with "hot spot" molybdenum concentrations is warranted for soil EA 5 and EA 6. Table 5-30 provides a summary for the COC identified and the associated concentration range..

TABLE 5-30
CONTAMINANT OF CONCERN, CONCENTRATION RANGE, AND SOIL VOLUME FOR SOIL EA 5 AND EA 6

COC	Concentration (mg/kg)	Medium Type	Volume of Material
Molybdenum	3 – 642	Tailing Spill Material	3,800 yd^3

Note:
Protective level for this COC is presented in Table 12-15

5.12.1.2 Campgrounds

Goathill and Eagle Rock Lake campgrounds are located in the riparian area along the mine site. Only two COPCs (arsenic and iron) had concentrations which exceeded the EPA SLC. However, concentrations were not significantly higher that reference background concentrations. No human health COCs were identified for the campgrounds.

5.12.1.3 Soil Exposure Area 8

Soil EA 8 is located just south of the tailing facility. It is designated as a human health exposure area geographically included with soil EA 9 (ecological evaluation). Several of the samples were collected in transects along drainages. Three human health COPCs were identified in soil EA 8: arsenic, iron, and molybdenum. Iron and molybdenum concentrations were significantly higher than reference background concentrations.

5.12.1.3.1 Garden Vegetables

See Section 5.11.6.5 above.

5.12.1.3.2 Ingestion of Meat or Milk from Livestock

Areas around the tailing facility do support livestock and people could potentially be exposed to COPCs through this pathway. Soil EA 8 is identified as an area where contaminated ground water may be a source of COPCs to grasses and other forage. Livestock grazing on this forage might take up these COPCs. People that ingest meat or milk from the livestock could therefore be exposed.

No measured concentrations of COPCs were available for livestock tissue. Therefore, a screening level analysis was conducted as part of the EPA HHRA to assess exposure to humans that might occur through consumption of beef and milk assuming that cows were maintained in soil EAs 6, 7, 8, and Cater Ranch (reference background area). The assessment was made for farmers that may raise and eat their own beef or milk products.

Based on the EPA HHRA, no human health COCs were identified for soil EA 8.

5.12.1.4 Soil Exposure Area 9

Soil EA 9 is an area located south of the tailing facility which provides a small, but suitable habitat for terrestrial plants and animals. It includes soil EA 8. This area was only evaluated for ecological COPCs. Several metals were identified as COPCs that also had concentrations significantly greater than reference background concentrations. They are barium, boron, cadmium, chromium, copper, lead, manganese, molybdenum, and vanadium. Molybdenum and vanadium concentrations exceed 10 times the SLC at many sampling locations, the majority being in soil EA 8. Figure 5-86 depicts relative concentrations of copper, lead, manganese, and molybdenum.

Based on the EPA BERA, there is a concern for uptake of molybdenum by plants growing in soil EA 9 and the potential for molybdenosis in livestock and other sensitive wildlife (deer/elk) foraging on those plants. Therefore, molybdenum is considered an ecological COC in soil EA 9. A summary of the COC, concentration range, and volume of contaminated soil above EPA's preliminary remediation goal for molybdenum of 11 mg/kg for soil EA 9 is presented in Table 5-31 below.

TABLE 5-31
CONTAMINANT OF CONCERN, CONCENTRATION RANGE, AND SOIL VOLUMES FOR SOIL EA 9

COC	Concentration (mg/kg)	Volume of Contaminated Soil
Molybdenum	0.75 – 596	26,000 yd^3

Note:
Protective level for this COC is presented in Table 12-15

5.12.2 Terrestrial Vegetation

Terrestrial vegetations samples were collected from Red River riparian areas within soil EA 5 and soil EA 6, as well as soil EA 9 located south of the tailing facility for risk assessment. Three lines of evidence were evaluated to investigate nature and extent of contamination and potential effects on vegetation: measurement of plant communities, bioassay, and analysis of COPCs in soil and vegetation. Bioaccumulation factors were also calculated to assess potential uptake of COPCs by plants. Vegetation samples included edible riparian vegetation.

The measurements of plant community cover and species diversity did not suggest any adverse ecological effect that could be attributed to metal concentrations in soil.

The ryegrass bioassay results showed that none of the bioassay parameters were lower at the mine site riparian area compared to the reference riparian area. However, the tailing facility riparian sample sites had significantly reduced root biomass and total biomass compared to the reference riparian sample sites.

For Red River riparian vegetation (soil EA 5 and EA 6), only molybdenum had concentrations significantly higher in both aboveground and below ground vegetation samples. For non-riparian vegetation south of the tailing facility (soil EA 9), molybdenum concentrations were not significantly higher than reference riparian areas, but are somewhat elevated. Box and whisker plots showing minimum, maximum, and median concentrations of molybdenum in forbs, grasses, and shrubs are depicted on Figure 5-87.

Calculated bioaccumulation factors did not show that there was a consistent relationship between COPC concentrations in vegetation and soil at the exposure areas.

The COPCs detected in the edible riparian plants (winter cress leaves and chokecherry berries and juice) and their concentrations were similar to other forbs samples collected from riparian and reference background areas.

Based on the EPA BERA, there is a low potential of observable vegetative community or population level effects due to COPCs in soil EA 5 and EA 6. Therefore, there are no COCs that warrant remedial consideration to protect terrestrial vegetation.

5.12.3 Terrestrial Animals

There were no apparent differences in soil fauna biometrics at the mine site riparian or tailing facility riparian areas compared to reference background areas. Density was not significantly different and the number of taxa identified at each location was similar. In addition, there were no significant effect on earthworm bioassay endpoints of survival, growth, or reproduction at the exposure areas compared to reference background areas.

Small mammals collected for analysis were primarily deer mice, montane vols (*Microtus montanus*), white-throated woodrats (*Neotoma albigula*), masked shrews (*Sorex cinereus*), and least chipmunks (*Eutamias minimus*). Numerous metals were detected in small mammals. However, only boron was significantly elevated above reference background. Also, there was no correlation between soil and tissue concentrations.

Numerous metals were detected in bioassay earthworm tissue. However few COPCs had concentrations significantly higher than reference background concentrations. Only copper at the mine site riparian, and molybdenum at the tailing facility riparian area exhibited a significant correlation with soil concentrations.

5.12.4 Surface Water

The nature and extent of contamination in Red River and tributaries to Red River were characterized based on surface water data collected during the RI. Surface water sampling locations are depicted on Figure 5-88. Two hydrologic flow conditions of the river were characterized: low- and high-flow conditions.

The Red River has been divided into several exposure areas for the purpose of human health and ecological risk assessment. Figure 5-89 shows the locations of the human health and ecological exposure areas. For human health, there are two exposure areas: from the mine site to Cabresto Creek (HHEA-1), and from Cabresto Creek to the Red River State

Fish Hatchery (HHEA-2). The exposure scenario evaluated for Red River surface water was the recreational visitor/trespasser.

There are eight ecological exposure areas (EEA-1 through EEA-8). The divisions for ecological exposure areas are based on river reaches between major tributaries, known ground water upwelling zones, and relationship to potential source areas. The ecological exposure areas are described below.

- EEA-1: From the former Zwergle gage station to upstream of the confluence of Bitter Creek
- EEA-2: Bitter Creek confluence to eastern mine property boundary
- EEA-3: Eastern mine property boundary to confluence with Columbine Creek
- EEA-4: Confluence of Columbine Creek to midway between RR-11A1 and RR-11B
- EEA-5: Midway between RR-11A1 and RR-11B to upstream of RR-13
- EEA-6: Upstream of RR-13 to Cabresto Creek confluence
- EEA-7: Cabresto Creek confluence to upstream of LR-5 and Outfall 002
- EEA-8: Upstream of LR-5 and Outfall 002 to Red River State Fish Hatchery

Segments EEA-1 and EEA-2 are reference background areas for the other downstream ecological exposure areas. There are no scar-impacted drainages within EEA-1. Segments EEA-3 through EEA-6 are mine reaches. Upper Cabresto Creek (CC-1) is an additional reference area for ecological exposure areas EEA-3 through EEA-6. Segment EEA-7 is a reach upstream of tailing facility and EEA-8 is the tailing facility reach. Lower Cabresto Creek (CC-2) is an additional reference area for ecological exposure areas EEA-7 and EEA-8. Additionally, the exposure area immediately upstream of EEA-4 through EEA-8 serves as a reference for indicating a potential source within the exposure area. The aquatic ecological receptors potentially exposed to contaminants in Red River surface water are primarily fish (trout) and benthic macroinvertebrates.

For the human health exposure areas, EEA-1 and EEA-2 are used as reference background as well as the Cabresto Creek reference background areas CC-1 and CC-2. Upper Cabresto Creek (CC-1) is part of the reference background for HHEA-1 (mine site reach), and lower Cabresto Creek (CC-2) is part of the reference background for HHEA-2 (tailing facility reach).

Based on a comparison of the exposure areas to reference background areas, the following human health COPCs were identified with concentrations significantly greater than concentrations in all three reference background areas (EEA-1, EEA-2, and CC-1) for Red River surface water:

<u>HHEA-1 (mine site reach)</u>

- Aluminum
- Beryllium
- Cadmium
- Fluoride
- Manganese
- Nickel
- Sulfate
- Zinc

<u>HHEA-2 (tailing facility reach)</u>

- Fluoride
- Sulfate
- Manganese
- Molybdenum

The following ecological COPCs are identified with concentrations significantly greater than reference background areas EEA-1, EEA-2, and CC-1 or CC-2, and/or the immediate upstream reference background EEA:

EEA-3

- None

EEA-4

- Cobalt (EEA-1, EEA-2, CC-1)
- Barium (immediate upstream reach EEA-3)

EEA-5

- Cadmium (EEA-1, EEA-2, CC-1)
- Nickel (EEA-1, EEA-2, CC-1, immediate upstream reach EEA-4)
- Zinc (EEA-1, EEA-2, CC-1, immediate upstream reach EEA-4)
- Selenium (immediate upstream reach EEA-4)

EEA-6

- Aluminum (total and dissolved; EEA-1, EEA-2, CC-1, immediate upstream reach EEA-5)
- Cadmium (all EEAs, as above)
- Cobalt (all EEAs, as above)
- Manganese (total and dissolved; all EEAs, as above)
- Molybdenum (all EEAs, as above)
- Nickel (all EEAs, as above)
- Zinc (all EEAs, as above)

EEA-7

- Similar to EEA-6 (EEA-1, EEA-2, CC-2; none are significantly greater than the immediate upstream reach EEA-6)

EEA-8

- Similar to EEA-7 (EEA-1, EEA-2, CC-2; barium, boron, and molybdenum are significantly greater than the immediate upstream reach EEA-7).

The New Mexico WQCC has established numeric acute and chronic criteria to protect aquatic life and designated uses of the Red River. The ecological criteria established by the WQCC are the same as the EPA SLC.

5.12.4.1 Red River Low Flow

For most of the year Red River experiences low flow conditions that generally range from around 10 cfs in the wintertime to around 30 cfs in the late summer into fall. Low-flow conditions typically correspond to times when constituent concentrations are greatest because a larger portion of the flow is from ground water upwelling that tends to be higher in constituent concentrations than the river water.

5.12.4.1.1 Source of COPC Loading

Mine-related sources of COPCs at the mine site are primarily the waste rock piles located within the tributary drainages. Other sources at the mine site include hydrothermal scars in some of the drainages, and debris fan sediment at the mouth of the drainages. For those drainages with scars, the debris fan sediments include eroded scar material. Acid-rock drainage results in the leaching of COPCs (metals and other inorganic chemicals) from these sources and their infiltration and percolation to ground water, with subsequent migration to the river in areas where ground water upwelling occurs.

Sources of COPC loading upstream of the mine site include the natural hydrothermally-altered terrains of Bitter Creek, Hottentot Creek, Straight Creek, and Hanson Creek tributary drainages and anthropogenic sources of urban runoff from the town of Red River, and the small abandoned mines of the Red River Mining District.

Along the tailing facility, mine-related sources are the tailing and process water in the impoundments which infiltrate as tailing seepage to ground water that eventually flows into the Red River. Another source of COPCs is effluent discharged to the Red River from the NPDES-permitted Outfall 002.

Natural or anthropogenic sources of COPCs upstream from the tailing facility include the tributary inflow from Cabresto Creek and the urban runoff and farmlands in and around Questa.

5.12.4.1.2 Chemistry and COPC Concentrations

The river water is neutral to slightly alkaline, with pH values ranging from the mid-6's to the mid-8's.

Concentrations of COPCs from the four seasonal, low-flow sampling events performed during the RI are graphed in profile along the river in an upstream to downstream manner, beginning upstream of the town of Red River to downstream of the tailing facility. The profiles illustrate how concentrations change, where the major changes occur, and the magnitude of the change with respect to other sampling locations. The Red River sampling stations are identified at the top of the profile. Their locations are depicted on Figure 5-88. Each graph also shows the human health and ecological SLC, if and when appropriate, for comparison purposes. Values that are non-detect or below reporting limits are plotted at the reporting limit and given a hollow (unfilled) symbol. The concentration profiles for aluminum and cadmium (Figures 5-90 and 5-91) are chosen to illustrate the distribution of key COPCs in the Red River.

The aluminum and cadmium concentration profiles show increasing concentrations both upstream and along the mine site reach of the river. After each increase, the concentrations typically decrease gradually or remain constant in a downstream direction until the next increase occurs. The increases upstream of the mine site occur through the town of Red River and along the scar-impacted tributary drainages. The increases are associated with upwelling of ground water as well as from surface water inflow when tributaries are flowing in the spring and summer. The increases along the mine site occur at major areas of ground water upwelling in the Goathill Gulch/Spring 39 area (Red River sampling stations RR-11A, RR-11B, RR-11C, and RR-12) and the Capulin Canyon/Spring 13 area (RR-13, RR-14, and RR-15). The highest concentrations measured throughout the entire reach of the river studied often occur at or in the vicinity of RR-15. Concentrations are generally constant or slightly decreasing from the mill to Columbine Creek. Concentrations also decrease or remain constant downstream of the Columbine Creek and Cabresto Creek confluences due to dilution from those tributaries.

For aluminum, the greatest increases in concentrations occur downstream of Goathill Gulch to the USGS gage. This increase is due to upwelling alluvial ground water in the Spring 13 area, which has been shown to exhibit elevated concentrations of aluminum. Aluminum concentrations are above both chronic and acute SLC along this reach of the river.

At the Spring 39 area, there are noticeable spikes in aluminum concentrations but they are not nearly as great as in the Spring 13 area. These increases are detected by the focused sampling conducted along 1,000-foot transect spacings (transect location TR-13 on Figure 5-92), the ^{222}radon tracer study, and the quarterly sampling required by DP-1055 (RR-11C).

A correlation between higher aluminum concentrations and slightly lower flows is also apparent from the concentration profile. The sampling events of October 2002 and March

2003 had higher concentrations at most all locations compared to the July and September 2003 events, which had slightly higher flows.

For cadmium, concentrations increase at the upstream end of the Goathill Gulch/Spring 39 area and continue increasing along the Spring 13 area to the Cabresto Creek confluence. Cadmium concentrations exceed the chronic screening level criterion along this reach, but not the acute screening level criterion.

Concentrations of other COPCs (zinc and fluoride) increase significantly at Spring 39, similar to cadmium, while others (manganese) increase in the Spring 13 area, similar to aluminum. Manganese concentrations were uncharacteristically high in the Columbine Park area (RR-10A1 to RR-11A1) during moderately high-flow conditions in August 2001 and August 2005 (based on the USGS tracer dilution studies and the quarterly sampling required by DP-1055). Both sampling events were conducted when the alluvial aquifer was full and the water table was high. The higher manganese concentrations may be due to the presence of manganocrete. This area has been observed to have the most manganocrete in outcrop along the river and within the alluvial sediments. The fact that this notable increase only occurs for manganese, without showing increases in other inorganic chemicals, further suggests that manganocrete is a source of increased manganese in the river at times when the alluvial aquifer is full.

Molybdenum concentrations are very low throughout most of the river reach studied. Although molybdenum is below the chronic ecological and human health screening level criterion, there is a dramatic increase in the concentration along the tailing facility reach, which is attributable to the discharge at the NPDES permitted Outfall 002. The molybdenum concentration profile is depicted on Figure 5-93.

5.12.4.1.3 Seasonal Changes in Concentrations

Time series graphs of select COPCs were prepared for locations sampled multiple times during the RI and quarterly for DP-1055 monitoring (fall 2002 through June 2006).

Overall, there is a fairly strong seasonal correlation from year to year at each location. Figure 5-94 depicts a time series graph for RR-14. For the most part, concentrations are greatest in the winter months (January to March) when stream flow is typically at its lowest. The higher concentrations during this period are due to a greater portion of the stream flow coming from the alluvial ground water system. Since the alluvial ground water has COPC concentrations that are up to about two orders of magnitude greater than concentrations in the river water, concentrations in the river increase in areas of ground water upwelling.

5.12.4.2 Red River High Flow

Sampling of the Red River under high-flow conditions was performed. High flows typically occur from late April through June when the snowpack in the Red River watershed melts, resulting in increased stream flow.

5.12.4.2.1 Onset of Snowmelt Runoff

Automatic samplers (ISCO™) were positioned on the riverbank at five Red River sampling locations [RR-6 (reference background), RR-8, RR-12, RR-15, and Lower River (LR)-16] to collect river samples during the onset of snowmelt runoff. River samples were collected in April 2003. Figure 5-95 is a hydrograph of the flow in the river at the USGS gage near the time of sampling. Average daily stream flows on the three days of sampling were 32, 35, and 36 cfs.

Overall, median pH values are near or slightly higher than most of the values from the four seasonal low-flow sampling events, indicating much lower loads of acidity are received by the river during snowmelt runoff.

All aluminum concentrations from the snowmelt runoff sampling are greater than chronic screening level criterion. The acute screening level criterion is also exceeded at all locations except RR-12. The pattern of median values from location to location is similar to the low-flow sampling events (*e.g.,* concentrations increase at RR-15).

With the exception of aluminum, all mean concentration values of COPCs are generally less than all values from the low-flow sampling event, indicating that snowmelt runoff in the Red River Watershed has a dilution effect on the water quality of the river. The higher aluminum concentrations may have been caused by turbidity in the sample.

Snowmelt to the Red River decreases the hardness of Red River surface water, which in turn affects the toxicity of certain metals, including silver, cadmium, chromium, copper, lead, nickel, and zinc.

Snowmelt runoff from the mine site does not appear to reach the river and, therefore, does not appear to affect the water quality of the river via this pathway. Observations of the mine site drainages during snowmelt runoff sampling in April 2003 found that if runoff occurred, it was contained in catchments which rapidly allows infiltration to ground water. A sample of snowmelt water from a catchment at the mill contained molybdenum at an elevated concentration of 2.8 mg/L. If snowmelt runoff with molybdenum at 2.8 mg/L had reached the river, it should have been detected at higher concentrations in the river samples. Elevated molybdenum concentrations were not detected in the samples.

5.12.4.2.2 Rainstorm Events

Red River was sampled during rainstorm events during summer 2003 to assess water quality impacts under high-flow conditions. The same Isco automatic samplers and locations used for snowmelt runoff sampling were used for rainstorm events. Storm event river samples were collected every 30 minutes over four sampling intervals for a collection duration of two hours.

Samples were collected for four rainstorms from late July through early September, 2003. On September 9, 2003, after completion of the fourth storm sampling event, the largest rainstorm of the season occurred. The EPA decided to collect data from this large storm. Since all of the automatic samplers had been removed except for at the RR-6 location, the sampler at RR-6 was manually triggered the day after the rainstorm on September 10, 2003.

General observations of the rainstorm events are as follows:

- Inspection of the drainages upstream of the mine site after the August 13, 2003 storm event revealed that Hottentot Creek, Hansen Creek, and Straight Creek drainages had flowed during the rainstorms. Photographs of Hansen Creek and Hottentot Creek flows are depicted on Figure 5-96. The discharge of these sediment-laden flows to the Red River resulted in a visible plume of discolored (yellowish) water (Figure 5-97). Sampling of the flows from the Hottentot and Hansen creek drainages after the large rainstorm on September 9, 2003, showed the water to be acidic (pH as low as 2.8) and metals-laden. Concentrations of dissolve aluminum, copper, manganese, nickel, and zinc were elevated and exceeded the human health SLC and chronic/acute ecological SLC.

- Each of the mine site drainages and storm water catchments was inspected the day after the storms and runoff had been contained on site and did not reach the river.

- Acidic runoff from the upstream drainages reduced the river pH to as low as the mid-3's for at least two hours upstream of the mine and the low pH continues along the mine site during large storms. Pulses of acidic conditions in the river were observed over the two hour sampling intervals and may be due to changes in rainfall intensity.

- Pulses of poor quality water having elevated COC concentrations were also associated with the acidic runoff from the upstream drainages. More so than any other COC, aluminum concentrations increase when the acidic runoff discharges to the river. Aluminum is transported in total form and is most likely associated with suspended solid load in the runoff. Concentrations of total aluminum ranged from less than 1.0 mg/L to about 190 mg/L; typical aluminum concentrations during low-flow conditions range from 0.6 to 1.4 mg/L.

- The highest total aluminum concentrations are two orders of magnitude greater than low-flow concentrations and exceed both the chronic and acute ecological SLC by three and two orders of magnitude, respectively.

- The high aluminum concentrations also exceed the human health screening level criterion of 37 mg/L by two to nearly five times. The only time the human health screening level criterion is exceeded in the river for aluminum or any other COC is when runoff from upstream drainages occurs during large rainstorms. Other COPCs exceeding the human health SLC are arsenic, chromium, copper, fluoride, iron, lead, manganese, thallium, and vanadium. Such increases in the concentrations of these metals illustrate the acute impact the runoff has on the water quality of the river.

- For the larger storms, dissolved manganese and zinc concentrations exceeded both the chronic and acute ecological SLC. Fluoride concentrations increased, but the increase was not as great as the other contaminants. Figure 5-98 depicts COPC concentrations in river samples collected at RR-8 for the forth rainstorm.

- Layers of sediment in the bottom of some sample bottles at RR-15 and LR-16 for larger rainstorms indicate that storm water runoff upstream of the mine results in a high sediment load in the river that extends downstream of the mine at least as far as the Red River State Fish Hatchery. A photograph of the river conditions at LR-16 is depicted on Figure 5-99.

5.12.4.3 Contaminants of Concern for Red River Surface Water

Based on the EPA HHRA and comparison to reference background, there are no human health COCs identified for Red River surface water.

Based on the EPA BERA and comparison to reference background, three ecological COCs are identified for Red River surface water: aluminum, cadmium, and copper. The ecological COCs and their concentration ranges (excluding storm events) are summarized in Table 5-32, below.

5.12.4.4 Comparison to Reference Background for Aluminum

Mean concentrations of aluminum (outside storm events) were compared statistically to the upstream reference ecological exposure area 2 (EEA-2), which is the reach of the river with scar-impacted drainages. Aluminum concentrations in EEA-6, EEA-7, and EEA-8 were significantly greater than concentrations in the reference reach. For EEA-3, EEA-4 and EEA-5, the concentrations were not significantly greater than reference. The outcome of the statistical analysis for EEA-5 (Spring 39 area) is likely affected by the reduction of aluminum concentrations in alluvial ground water by the pumping of ground water withdrawal wells GWW-1, -2, and -3 along the roadside waste rock piles, which subsequently affects the concentration of aluminum in Red River surface water.

TABLE 5-32

ECOLOGICAL CONTAMINANTS OF CONCERN AND CONCENTRATION RANGES FOR RED RIVER SURFACE WATER

COC	Concentration (mg/L)	Cleanup Levels[2] (mg/L)	
		Acute	Chronic
Aluminum	0.5 – 3.7	37.2 – 45.5	0.6 – 1.2
Cadmium	0.0002 – 0.0013	_	_
Copper	ND – 0.041	_	_

Notes:
1. Cleanup levers are not selected for cadmium or copper. Remedial measures to reduce aluminum concentrations in surface water are also expected to reduce level in copper and cadmium.
2. Cleanup levels for aluminum are hardness dependant.

Mean concentrations of aluminum (outside of storm events) within each ecological exposure area reach were compared statistically to the reach immediately upstream to evaluate contribution of sources within the given reach. Ecological exposure area EEA-6 (Spring 13 to Cabresto Creek) was the only reach with a mean aluminum concentration that was significantly greater than the mean concentration in immediate upstream reach EEA-5, indicating an additional source of aluminum in EEA-6. Again, such comparison between EEA-5 and the immediate upstream reference background reach EEA-4 may be affected by the reduction of aluminum concentrations in alluvial ground water at the Spring 39 area by pumping of ground water withdrawal wells GWW-1, -2, and -3 along the roadside waste rock piles.

5.12.4.5 Red River Seeps and Springs

A statistical comparison of seeps and springs along Red River at the mine site and tailing facility reach to reference seeps and springs was performed. The nature and extent of seeps and springs was evaluated as part of ground water (see Evaluation of Seeps and Springs along the Red River, Sections 5.10.4.2 and Ground Water, Section 5.11.5). However, the seeps and springs are evaluated in the baseline risk assessment as part of surface water and a surface water exposure area was identified. For this reason, the statistical comparison of the seep/spring surface water exposure area to reference seeps and springs is present in this section. Sample locations that comprise the reference population include Waldo and Chamber springs.

Several human health and ecological COPCs in the seep/spring exposure area along Red River have concentrations that are significantly greater than reference seeps and springs.

Based on the EPA BERA, and the 7-day subchronic toxicity testing (serial dilution test) on young rainbow trout, the spring water at Spring 13 and Spring 39 is toxic at low dilutions (see Focused Sampling, Section 5.12.6.6 below for additional discussion on serial dilution test).

5.12.5 Sediment

The nature and extent of contamination in sediment in the Red River were characterized based on sediment data collected during the RI. Consistent with the evaluation of surface water, the portion of the Red River included in the sediment characterization begins at the upstream sampling location (Zwergle) and ends at the downstream sampling location near the Red River State Fish Hatchery (LR-16). A map of the sediment sampling locations is depicted on Figure 5-100.

Characterization of Red River sediment is based on four, comprehensive sampling events. The metals concentrations are compared to human health and ecological SLC to identify COPCs for risk assessment. They are also compared statistically to reference background concentrations in areas not affected by the Site.

The human health and ecological exposure areas for sediment are the same as Red River surface water and are used for risk assessment.

The human health COPCs identified for Red River sediment are the following:

<u>HHEA-1 (Mine Reach)</u>

- Arsenic
- Iron
- Manganese

<u>HHEA-2 (Tailing Facility Reach)</u>

- Arsenic
- Iron
- Molybdenum

The ecological COPCs identified for Red River sediment in all ecological exposure areas are the following:

- Aluminum (mine reach EEAs only)
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Chromium (tailing facility reach EEAs only)
- Cobalt (mine reach EEAs only)
- Copper
- Iron
- Lead
- Manganese
- Mercury (mine reach only)
- Molybdenum
- Nickel
- Selenium
- Silver
- Thallium
- Zinc

5.12.5.1 COPC Concentrations

Concentrations of COPCs in Red River sediment were measured during the four seasonal sampling events and during the focused sampling at 1,000-foot transects along the mine site. Concentrations were graphed for each COPC in profile along the river in an upstream to downstream manner, illustrating how concentrations change along the river from Zwergle to LR-16. Concentration profiles are shown for riffle, depositional, and composite samples collected for each sampling date. Each graph also shows the human health and ecological SLC, if applicable, for comparison purposes. Based on the concentration profiles, the following observations are made:

- Generally, riffle samples are lower in COPC concentrations than the depositional and composite samples for the entire length of the river investigated.

- Aluminum, chromium, and manganese were elevated at the Zwergle sampling site as compared to other reference sites.

- Several COPCs were elevated at the RR-3 sampling sites just below Mallette Creek.

- An increase in several COPCs in either or both riffle and depositional samples occurred from sites RR-13 to RR-15 located downstream of Spring 13. The COPCs include aluminum, beryllium, cobalt, copper, manganese, molybdenum, nickel, and zinc. The zinc concentration profile is depicted on Figure 5-101.

- An increase in manganese concentrations are also observed downstream of Columbine Creek (RR-10 to RR-11A1) and cadmium concentrations in the Columbine Creek to Spring 39 reach (RR-10 to RR-12).

- An increase in most COPC concentrations occurred at site LR-8A below Outfall 002, in particular arsenic, iron, lead, molybdenum, selenium, and thallium. The molybdenum concentration profile is depicted on Figure 5-102. Concentrations decrease to within typical concentrations at the next downstream site (LR-11A).

5.12.5.2 Comparison to Reference Background Concentrations

For human health exposure area HHEA-1, only arsenic concentrations in sediment were significantly greater than all reference background area concentrations. For HHEA-2, arsenic and iron concentrations in depositional samples and molybdenum in riffle and depositional samples were significantly greater than reference background areas.

All ecological exposure areas (except EEA-3) had several COPCs in depositional and/or riffle samples with concentrations significantly greater than reference background areas. They include aluminum, arsenic, barium, beryllium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, silver, thallium, and zinc.

5.12.5.3 Contaminants of Concern for Sediment

Based on the EPA HHRA, no human health COCs were identified for Red River sediment, as exposure to a recreational visitor/trespasser by the COPCs did not pose an unacceptable risk for either HHEA-1 or HHEA-2.

Based on the EPA BERA, with hazard quotients (HQs) calculated using a toxicity reference value for benthic macroinvertebrates, the ecological COCs identified for sediment are lead, nickel, molybdenum and zinc. A summary of the COCs identified for Red River sediment within individual ecological exposure areas and the basis for determination are presented in Table 5-33 below.

The ecological HQs associated with sediment in various locations in the Red River are within the uncertainty of the HQ (less than or equal to 2), which allow these COCs and locations to be eliminated from the CERCLA response action. Additionally, sediment in the Red River is dynamic and moves downstream as a function of flow. Hence, locations with elevated COCs in sediment likely change both spatially and temporally, which would make remediation efforts difficult.

5.12.6 Aquatic Ecology

The nature and extent of contamination in Red River and riparian areas is also evaluated using aquatic biota and habitat data collected from 1997 through 2005 as part of the RI as well as CMI's long-term Red River Aquatic Biological Monitoring program. These data are used by EPA in the BERA. The results are discussed for specific reaches of the Red River from upstream of the mine to below the tailing facility, Cabresto Creek (reference background), and focused sampling at Spring 13 and 39.

TABLE 5-33
ECOLOGICAL CONTAMINANTS OF CONCERN FOR
RED RIVER SEDIMENT

Ecological Exposure Area	COC	Basis
Mine Reach		
EEA-3	None	No COPC HQs greater than 1.0; all COPC concentrations less than upstream reference EEA-2
EEA-4	None	No COPC HQs greater than 1.0; nickel concentration greater than upstream reference EEA-2
EEA-5	None	No COPC HQs greater than 1.0; nickel and zinc concentrations greater than upstream reference EEA-2
EEA-6	Zinc	Copper and zinc HQs greater than 1.0; nickel and zinc concentrations greater than upstream reference EEA-2
Tailing Facility Reach		
EEA-7	Lead Nickel Zinc	Copper, lead, nickel, and zinc HQs slightly above 1.0; lead, molybdenum, nickel, and zinc concentrations greater than upstream reference EEA-2
EEA-8	Lead Molybdenum Zinc	Lead, molybdenum, and zinc HQs greater than 1.0; lead, molybdenum, nickel, and zinc concentrations greater than upstream reference EEA-2

Specific biotic (*e.g.*, fish population density) and biotic-related variables (fish tissue concentrations) were analyzed spatially for relevant sampling reaches along the Red River. Correlations between COPCs and physical habitat variables to biotic variables were also examined. These correlations were not run with data from the individual reaches defined as exposure areas because the limited number of sampling sites (one to three) does not provide a large enough sample size to effectively or statistically determine if water or sediment chemistry or habitat parameters are influencing biologic variables. Instead, all sites were used simultaneously so that adequate variance was present in the biotic and abiotic variables to determine if such relationships exist.

5.12.6.1 Fish

5.12.6.1.1 Fish Populations

Fish populations are healthy upstream of the town of Red River (Zwergle site) in terms of density (588 resident trout/acre) and biomass (45.7 pounds [lbs]/acre). These parameters decline in the reference reach located upstream of the mine (sampling sites RR-4, RR-5, and RR-6), which is affected by acidic flows and sediment from hydrothermal scar tributary drainages during rainstorm events.

None of the four reaches along the mine exposure area were significantly different than each other or the mine reference reach (RR-4, RR-5, and RR-6) in terms of density or biomass. All significant differences were associated with the Zwergle site, as all mine exposure reaches and the upstream mine reference reach were significantly lower than the Zwergle site for density. Sites RR-12, RR-15, and the mine reference reach were significantly lower than the Zwergle site for biomass.

Fish populations increase along the tailing facility reference reach and tailing facility exposure reach in terms of density and biomass: RR-20 – 38 resident trout/acre, 7.4 lbs/acre; LR-1 – 155 resident trout/acre, 28.5 lbs/acre; LR-8A – 290 resident trout/acre, 56.3 lbs/acre; and LR-16 – 376 resident trout/acre, 44 lbs/acre). The mean density and biomass for the tailing facility exposure reach is significantly higher than the tailing facility reference reach.

No significant trends were observed at any sites since 2002 for density and biomass. Graphs of mean fish density and biomass are depicted on Figures 5-103 and 5-104.

5.12.6.1.2 Fish Tissue

Analysis of the concentrations of metals in fish tissues were examined by comparing mean concentrations in fish tissue from the Red River to the EPA Region 3 risk-based concentration values.

A comparison of concentrations in brown trout greater than 8 inches from the mine exposure area (RR-8, RR-11A1, RR-12, and RR-15) to Zwergle and upstream mine reference reach (RR-5) shows that nearly all COPC concentrations were higher in tissue samples at the Zwergle site than any other site sampled. Only RR-12 and RR-15 have concentrations significantly higher than Zwergle for cadmium. The concentration of zinc was also significantly higher for RR-11A1. The only risk-based concentration values to be exceeded were for arsenic (discussed below) and chromium at site RR-12, which had a concentration of 14 mg/kg.

For the tailing facility reference reach, metal concentrations were similar to upstream concentrations and none had the highest concentrations observed of all the sites. Concentrations of several metals in brown trout tissue along the tailing facility exposure reach were the highest of any sites samples, including cadmium, copper and zinc. Metals with concentrations significantly higher in the tailing facility exposure reach compared to the tailing facility reference reach were cobalt, iron, and selenium.

Concentrations of all metals in brown trout less than 8 inches were below risk-based concentration values. Mine exposure reach sites RR-7, RR-8, and RR-11A1 had significantly higher concentrations of copper than the Zwergle site and RR-12 had significantly higher concentrations of cadmium than the Zwergle site. Concentrations of mercury in fish tissue from RR-11A1 and RR-12 were significantly higher than sites in the upstream and downstream mine exposure reaches as well as mine reference reach. No other metal concentrations in brown trout less than 8 inches were significantly higher than other mine exposure reaches, the mine reference reach or Zwergle.

At the tailing facility exposure reach, concentrations of several metals in brown trout less than 8 inches were the highest of any sites sampled, including aluminum, iron, manganese, and zinc.

Only one young-of-the-year brown trout was collected along the mine exposure reach and therefore, no statistical comparison could be made with the reference reaches. There were no metal concentrations significantly greater than reference for the tailing facility exposure reach. Concentrations of all COPCs in young-of-the-year were below the risk-based concentration values.

Summaries of the brown trout tissue concentrations for key COPCs at the mine exposure area and mine reference reach are presented in Tables 5-34 and 5-35.

5.12.6.1.3 Arsenic in Fish Tissue

The risk-based concentration values in fish tissue were exceeded for arsenic. Arsenic was detected at a concentration of 0.17 mg/kg. This is above the concentration at which the EPA recommends against eating fish (0.13 mg/kg). These screening levels are associated with inorganic arsenic and the analysis did not discriminate between the organic (low toxicity) and inorganic (high toxicity) forms of arsenic.

Additional analysis was performed to evaluate the concentration of total and inorganic arsenic in rainbow trout samples. The results for total arsenic concentrations were consistent with the original analysis. Inorganic arsenic was not detected in any of the fish samples analyzed. The maximum concentration of inorganic arsenic which could potentially be present below the laboratory reporting limit would represent less than 14 percent of the detected total arsenic amount. The New Mexico Department of Game and Fish performed further testing of arsenic in rainbow trout at the Red River State Fish Hatchery and concluded that the source of the elevated levels of total arsenic in the hatchery trout was the fish feed, which included only a very small fraction of inorganic arsenic.

5.12.6.2 Benthic Invertebrates

5.12.6.2.1 Benthic Invertebrate Populations

Benthic macroinvertebrate populations demonstrated a similar trend as was seen in the fish populations. Most parameters decrease downstream of the town of Red River with the lowest values observed at site RR-15, downstream of Spring 13. Most parameters then show an increasing trend through site LR-16. These patterns were generally evident for both spring and fall data. Graphs of the mean numbers of taxa and EPT taxa are depicted on Figures 5-105 and 5-106.

The percent riffle embeddedness was highest in the mine reference reach (RR-4, -5 and -6), the area impacted by acidic flows and sediment from hydrothermal scar drainages, then decreases downstream. The average sediment parameters for each of the sample sites in the spring are depicted on Table 5-36, below.

TABLE 5-36
AVERAGE SEDIMENT PARAMETERS FOR SPRING 2002 – 2005

Site	% Riffle Embeddedness	% Embeddedness	% Fines (area)	% Fines (grid)
Zwergle	18.3	21.7	16.7	5.9
Mine Ref RR-4,5, 6	63.0	71.2	38.3	22.2
Mine RR-7,8	59.8	70.2	44.0	38.6
Mine RR-11A1	55.5	63.0	43.3	21.8
Mine RR-12	46.5	52.1	24.5	10.5
Mine RR-15	34.6	37.1	17.9	5.1
Tailing Ref RR-20, LR-1	32.0	33.2	13.0	8.9
Tailing LR-8A, -16	25.4	28.3	15.1	11.8

5.12.6.2.2 Benthic Invertebrate Tissue

Benthic macroinvertebrate tissue concentrations for the mine exposure reaches and/or tailing facility exposure reach were higher than the mine reference reach concentrations for aluminum (RR-11A1, RR-15), copper (RR-15), iron (RR-11A1), manganese (RR-11A1), molybdenum (LR-8A) and nickel (LR-16). Aluminum concentrations in the tissue at RR-15 and downstream sampling sites are more than twice the concentrations observed for the mine reference reach (RR-4, -5, and -6) and such increases correlate with the increase in aluminum concentrations in Red River surface water and sediment. It is noted that aluminum concentrations in benthic macroinvertebrate tissue at Eagle Rock Lake, which is located downstream of RR-15 and receives its water from the Red River, are higher than any Red River sites and nearly an order of magnitude higher than the reference lake (see Nature and Extent of Contamination at Eagle Rock Lake, Section 5.13).

For the tailing facility exposure area, only molybdenum in the benthic macroinvertebrate tissue had concentrations significantly higher than the reference reach. The molybdenum increase also correlates with the increase in molybdenum concentrations in Red River surface water downstream of Outfall 002. A summary of the tissue data for 2002 is presented in Table 5-37.

5.12.6.3 Periphyton and Aquatic Plants

Periphyton populations were dominated by diatoms in the upper Red River reaches (Zwergle through site RR-8), although blue green algae became more abundant and occasionally dominated the algal community in the lower Red River reaches. In terms of total number of taxa and total number of diatom taxa, all reaches were very similar, with the exception of the reach upstream of the town of Red River, which had fewer algal taxa. Algal population data did not demonstrate any indications of stress to this community.

Plant tissue analysis did not show any consistent trends longitudinally along the Red River. The highest concentrations of COPCs were often seen in the mine reference background reach, although a few metals did appear to increase in a downstream direction. At the mine exposure reach, site RR-12 (Spring 39 area) had the highest concentrations of COPCs in bryophyte tissue samples that were observed at any site. At site RR-15 (downstream from Spring 13), COPC concentrations in bryophyte tissue were lower that the mine reference reach (RR-4, RR-5, and RR-6), but higher than Zwergle.

At the tailing facility exposure area reach (LR-8A and LR-16) and reference reach (RR-20 and LR-1), concentrations of COPCs in bryophyte tissue samples were higher than all other sites, except RR-12. The concentrations of COPCs in the tailing facility exposure area reach were slightly higher than the tailing facility reference reach.

5.12.6.4 Toxicity Testing

5.12.6.4.1 Surface Water Bioassay

The three-brood screening-level chronic toxicity testing using *Ceriodaphnia dubia* (*C. dubia)* on water from base flow conditions showed no toxicity in either the survival or reproduction endpoints for any site.

The three-brood chronic toxicity testing using *C. dubia* on water at the initiation of snowmelt runoff and rising hydrograph showed significant reproduction effects at RR-15 and LR-16. For site RR-15, there was an inhibition (of growth) concentration at 25 percent (IC_{25}) of 83.1 percent and a no observed effects concentration (NOEC) of 75 percent river water. For site LR-16, there was an IC_{25} of 89.2 percent and a NOEC of 75 percent river water.

The acute 48-hour toxicity tests using *C. dubia* for three rainstorm events in August and September, 2003 showed significant effects for the September 5, 2003 storm event at the RR-8 site, with a lethal concentration at 50 percent (LC_{50}) of 36.3 percent river water.

5.12.6.4.2 Sediment Bioassay

The 10-day chronic sediment toxicity testing using *Hyalella azteca* and *Chironomus tentans* showed no toxicity for biomass (growth) for either test organism at any sample sites. However, toxicity was observed for survival at the Zwergle site (*H. azteca*) and the mine reference reach RR-5 site (*C. tentans*), as well as the mine exposure reach site RR-7 (*C. tentans*). Toxicity was also observed for survival of *H. azteca* at site LR-16 in the tailing facility exposure reach. Significantly lower survival (p less than 0.05) of the test organisms was observed in each case.

5.12.6.5 Habitat

Habitat parameter measurements show a diverse range of depths and residual pool depths to provide cover during low flow conditions at the Zwergle site. Fairly low accumulation of fine sediment and a primarily riffle habitat are also observed.

At the upstream mine reference reach (RR-4 through RR-6) and mine site exposure reaches, there are sufficient depths for fish populations, but limited residual pool depths during low-flow conditions. Sediment measures indicate high accumulations of fine sediment. These sites consisted primarily of riffle habitat, although site RR-11A1 had an abundance of pool habitat.

At the tailing facility exposure area and reference reaches, sufficient depths and residual pool depths were observed, as well as a low accumulation of sediment. The sites exhibited primarily a riffle habitat.

5.12.6.6 Focused Sampling

Focused sampling of the Red River was to evaluate potential impacts to the river and aquatic life due to migration of contaminated ground water from the mine to Red River at zones of ground water upwelling, particularly in the areas of Spring 13 and Spring 39. Since the distance between the Red River sampling sites may be too great to document small discrete zones of recovery between impacted zones, the focused sampling included transects spaced every 1,000 feet to provide better resolution of the extent of the impact and recovery zones. The focused sampling also included a serial dilution study to evaluate the range of acute and chronic toxicity effects to select aquatic receptors.

5.12.6.6.1 Transect Study

A total of 23 distinct EPT taxa were identified from all the transect samples, and all transects supported invertebrates, including sensitive species. Lowest abundances were identified at transects TR-1 to TR-4, TR-11, and TR-15 (Figure 5-107), which correlate to locations approximately 1,500 to 2,000 feet downstream of Spring 13, Spring 39, or Cabin Springs. On the figure, there appears to be a subtle trend for the north bank samples. The samples show a gentle repeating trend of slightly increasing abundance in a downstream direction to locations near and downstream of the springs, followed by a relatively sharp decrease in abundance before the trend repeats. Longitudinal trends for the middle and south bank samples are not apparent.

The number of EPT taxa ranged from 6 to 13, with no consistent longitudinal trends identified. Overall, major changes in the macroinvertebrate community were not observed downstream of the springs.

5.12.6.6.2 Serial Dilution Study

The 7-day subchronic toxicity tests on young (early life stage) rainbow trout indicate that spring water from Springs 13 and 39 is toxic. An IC_{50} for survival of 7.5 percent spring water and an IC_{25} for growth of 5.9 percent spring water were calculated for Spring 13, using either upstream Red River water or reconstituted laboratory water for dilution.

Water from Spring 39 is less toxic, with survival IC_{50} of 28.9 percent spring water using Red River dilution water and 32.4 percent spring water using reconstituted laboratory dilution water. Growth IC_{25} for Spring 39 ranged from 22.1 percent spring water using reconstituted laboratory dilution water to 22.6 percent spring water using upstream Red River dilution water.

The ground water flux from Spring 13 and Spring 39 was calculated into the average monthly stream flow to estimate the contribution of water from these springs for comparison to the concentrations shown to be toxic in laboratory tests. Water from Spring 13 is calculated to comprise less than 4.5 percent of the total stream flow. This is slightly less than the 5.9 percent growth IC_{25} and the 7.5 percent survival IC_{50}. Water from Spring 39 is calculated to comprise less than 16.5 percent of the total stream flow. This is also less than the 22.6 percent growth IC_{25} and the 28.9 percent survival IC_{50}.

5.12.6.7 Biotic and Abiotic Relationships

In order to identify factors that may be controlling biological parameters in the Red River, correlation analysis and regression analyses were used to determine if any of the measured habitat parameters, water quality, or sediment chemistry data were related to biological population parameters measured in 2002 and 2003. Of significance, from a biological perspective, is that the RI effort included not only the 2 years of specific RI sampling, but also incorporated the aquatic biological monitoring data collected from the Red River by Molycorp beginning in 1997. Thus, these data encompass seasonal and annual variability in river conditions over many years.

5.12.6.7.1 Fish

Correlation analysis and regression analyses showed the following relationships between abiotic parameters to resident trout populations (biomass)[53]:

- In 2002 and 2003, percent riffle embeddedness was the most significant habitat variable with an inverse relationship to resident trout biomass.
- In 2002, dissolved aluminum and copper were shown to have significant inverse relationships with resident trout biomass. In 2003, aluminum once again showed a similar relationship. Dissolved concentrations of copper and cadmium also showed inverse relationships with biomass, but they were not significant. In combining 2002 and 2003 data, significant inverse relationships were observed between resident trout biomass and aluminum, copper, and chromium concentrations.
- When 2002 and 2003 sediment chemistry data were analyzed together, no significant inverse relationships were observed between resident trout biomass and sediment metal concentrations.

There does not seem to be a single factor that determines the pattern of resident trout populations along the length of the Red River. Multiple physical and chemical factors appear to be influencing the distribution and number of resident trout in the river. Also, these factors appear to change in importance from year to year, and perhaps within a given year, which complicate the long-term evaluation of patterns in trout populations.

To determine how both habitat and water/sediment quality variables might be affecting resident trout populations on the Red River, an All Possible Regressions procedure was conducted. The regression modeling showed that the resident trout density and biomass were best described by parameters that included percent riffle embeddedness, percent pool

[53] Although resident trout density and biomass were similar, resident trout biomass was chosen over density because density is easily skewed by the presence of large numbers of young of the year fish, while biomass is a more stable descriptor of the fish population.

area, standard deviation of depth, dissolved aluminum, copper, and chromium concentrations and concentrations of arsenic in sediment. Additionally, previous investigations have shown negative correlations between spring runoff flow and trout population parameters. However, flow variables could not be used in the regression analyses to evaluate longitudinal differences.

5.12.6.7.2 Benthic Invertebrates

Correlation analysis and regression analyses showed the following relationships between abiotic parameters and benthic macroinvertebrate populations:

- Percent riffle embeddedness was the most significant overall habitat variable with correlation to benthic macroinvertebrate population parameters in 2002 and 2003. Percent riffle embeddedness was found to be significantly inversely correlated with density, total number of taxa, number of EPT taxa, and diversity.
- Dissolved concentrations of aluminum, manganese, and nickel had the most significant negative correlations with benthic macroinvertebrate parameters, while cadmium, chromium, and copper also showed significant negative correlations, but to a lesser extent.
- The number of EPT taxa, the total number of taxa, and diversity were the benthic macroinvertebrate parameters most often significantly correlated with dissolved metal concentrations.
- Significant negative relationships were observed between some benthic macroinvertebrate parameters and concentrations in sediment of lead, arsenic, barium, iron, molybdenum, and copper. Arsenic and lead most often showed the significant negative correlation.

The patterns in density and number of taxa for 1997 to 2005 are fairly consistent. Reductions in these parameters indicate several areas of impact along the Red River downstream of the town of Red River. Modeling results from the All Possible Regressions analysis show the following factors that best describe the seven major benthic macroinvertebrate population parameters:

- Number of EPT taxa: percent riffle embeddedness, manganese and nickel concentrations in surface water, and lead concentrations in sediment explain 84 percent of variation;
- Number of taxa: percent riffle embeddedness and manganese and nickel concentrations in surface water explain 68 percent of variation;
- Diversity: percent riffle embeddedness, nickel and copper concentrations in surface water, and arsenic and lead concentrations in sediment explain 60 percent of variation;
- Percent Ephemeroptera: aluminum and manganese concentrations in surface water explain 47 percent of variation;
- Density: percent riffle embeddedness, manganese concentration in surface water, and arsenic concentration in sediment explain 40 percent of variation;
- Percent EPT: percent riffle embeddedness, aluminum concentrations in surface water, and lead concentrations in sediment explain 32 percent of variation.

5.12.7 Summary of GSI Study

The ground water-to-surface water (GSI) study was conducted in 2003 and 2004. The 2003 study consisted of *in situ* (field) testing of the toxicity of surface water, sediment, and discharging ground water along a 16-mile reach in the Red River that spanned the mine site and tailing facility. The 2004 study consisted of similar testing, but focused specifically on discrete zones of ground water upwelling at Spring 13 and Spring 39 along the mine reach.

5.12.7.1 GSI Study Locations

The fall 2003 GSI study consisted of the following six sites distributed along the 16-mile reach of the river:

- Zwergle: Upstream reference and collection site for indigenous mayflies
- RR-5BB: Mine reference reach site near scar drainages
- RR-15: Mine reach site downstream of Spring 13
- LR-1: Tailing facility reference reach site
- LR-8A: Tailing facility reach site
- LR-16: Tailing facility reach site

The fall 2004 GSI study consisted of the following six sites distributed along Spring 13, Spring 39, and upstream reference reaches:

- Zwergle: Upstream reference and collection site for indigenous mayflies
- RR-5BB: Mine reference reach site near scar drainages
- RR-11B2: Spring 39 area
- RR-11B3: Spring 39 area
- RR-13A: Spring 13 area
- RR-13 B: Spring 13 area

Analytical test results are compared to EPA's SLC (acute and chronic for water samples), in addition to toxicity reference values used in the EPA BERA. Results of upwelling and downwelling conditions in river piezometers are provided, as are results of *in situ* toxicity testing (*i.e.,* mean survival of caged amphipods (*H. azteca*) and indigenous mayflies (*Drunella* spp.) in exposure chambers).

5.12.7.2 Water and Sediment Chemistry

In situ studies found that the following COPCs (metals) in aqueous samples were above the EPA SLC: aluminum, barium, beryllium, boron, cadmium, copper, lead, manganese, nickel and zinc. The following COPCs exceeded the sediment SLC: copper, iron, lead, manganese, nickel and zinc. The maximum concentrations of aluminum, barium, boron, and copper in water and copper, lead, manganese, nickel, and zinc in sediment exceeded toxicity reference values.

Overall, the pore water in piezometers at RR-5BB, RR-13A and -13B, and RR-15 was acidic and of poor quality, with RR-13A and -13B having the highest metals concentrations of the piezometers tested. The mean pH values for these sites ranged from the low 4's to mid 4's. The pore water at RR-11B2 and -11B3 was near neutral, with pH values ranging from 6.5 – 6.9.

5.12.7.3 Piezometer Upwelling and Downwelling

Some degree of ground water upwelling through sediment to the surface water (*i.e.,* discharge) was observed at each location. For major upwelling areas investigated, GSI study location RR-11B2 (Spring 39) had the strongest degree of upwelling. The next strongest upwelling zone was measured at RR-5BB (mine reference scar area). The two study locations in the Spring 13 area (RR-13A and -13B) and the second Spring 39 location (RR-11B3) did not exhibit as strong a degree of upwelling as RR-11B2 and RR-5BB. In fact, measurements actually showed fairly strong downwelling or neutral readings during the test. Figures 5-108 and 5-109 depict the piezometric hydraulic head differentials for some of these GSI test sites.

5.12.7.4 *In Situ* Toxicity

The 96-hour *in situ* exposures of caged amphipods (*H. azteca*) and indigenous mayflies (*Drunella* spp.) indicate that acute toxicity could not be attributed to the discharging ground water at the study locations in the vicinity of the mine and tailing facility during the testing periods of fall 2003 and fall 2004. The single observation of significant reduction in survival from an *in situ* acute exposure in a discharge zone was for *Drunella* spp. at the mine reference reach site RR-5BB. This site is located upstream of the mine, downstream of the town of Red River, and in a reach impacted by hydrothermal scar drainages. Figure 5-110 depicts the percent survival of *Drunella* spp. for the 2004 GSI study.

Although significant acute toxicity was not observed at the ground water upwelling zones adjacent to the mine site and tailing facility, when combining the *in situ* toxicity results with the water and sediment chemistry (primarily elevated metal concentrations and acidity), and the observed presence of upwelling ground water, there is the potential for such acute toxicity to benthic invertebrates, especially at Spring 13 and to a lesser extent at Spring 39. Additionally, chronic toxicity to benthic invertebrates at these zones of ground water upwelling remains a concern. This determination is also based on the sediment and 7-day rainbow trout toxicity tests (serial dilution tests) conducted for the Spring 13 and Spring 39 areas.

5.12.8 Hunt's Pond

Hunt's Pond was investigated as part of the Historic Tailing Spill Investigation in May 2004. Soil, pond sediment, and pond surface water were collected. Construction at the pond in 2000 and 2003 removed all the pond sediment, so a sediment sample could not be collected from the bottom of the pond. Rather, sediment samples were collected from the sides of the pond. In addition, a ground water well was installed downgradient of the pond to determine the quality of ground water flowing from the pond toward the Red River.

The soil samples excavated during augering contained no visible tailing at any of the sampling locations. Arsenic concentrations exceeded the human health screening level criterion. Ecological SLC were exceeded by concentrations of chromium, lead, manganese, molybdenum and vanadium. However, the SLC were also exceeded by the same metals in adjacent soil samples, as well as antimony, boron, cadmium, and mercury.

Concentration of metals (total and dissolved) in surface water samples from the pond did not exceed EPA Region 6 Freshwater Chronic Screening Level Criteria, with the exception of barium and boron. Concentrations in the sediment were below the EPA Region 6 Ecological Freshwater Sediment Screening Level Criteria. For ground water, concentrations were below the EPA Region 6 Human Health Tap Water Screening Level Criteria for all constituents.

The exposure scenario for human health was the recreational visitor/trespasser scenario. Based on the EPA HHRA and BERA, no human health or ecological COCs were identified in soil, pond surface water, or pond sediment that contributed appreciably to risk.

5.13 Nature and Extent of Contamination at Eagle Rock Lake

This section evaluates the nature and extent of contamination in the surface water and sediment investigated at Eagle Rock Lake and upper Fawn Lake (reference lake), as well as the aquatic ecology used for risk assessment.

Similar to the evaluation for other areas at the Site, the evaluation of nature and extent is performed with respect to the COPCs having concentrations exceeding the EPA SLC. To evaluate the nature of the COPCs, concentrations are compared to the concentrations in selected reference background areas. The comparison of data from Eagle Rock Lake to that from upper Fawn Lake, as the reference background lake, is a statistical comparison.

When forms of the term “significant” are used in context with this comparison, it implies “statistically significant”.

Also presented in this section are the COCs identified in the FS for Eagle Rock Lake which will be addressed by the Selected Remedy.

5.13.1 Surface Water

5.13.1.1 Sources and Pathways

As the source of the water in Eagle Rock Lake is the Red River, with an inlet and outlet structure, the water quality of the lake is similar to the river. Water near the inlet, middle, and outlet were sampled during four seasonal, low-flow events during the RI.

5.13.1.2 Chemistry and COPCs

The water is near neutral with pH values ranging from 6.5 to 7.7. Based on a comparison to human health and ecological SLC, there were no human health COPCs identified for Eagle Rock Lake. The ecological COPCs identified were:

- Aluminum
- Barium
- Boron
- Cadmium
- Iron

Aluminum exceeded both the chronic and acute ecological SLC. The COPCs exceeding chronic SLC are similar to those exceeded in Red River near the lake.

Of the ecological COPCs identified, only aluminum and cadmium had concentrations that were significantly greater than upper Fawn Lake.

5.13.1.3 Contaminants of Concern for Surface Water

In the EPA BERA, only aluminum and iron were identified with the potential to adversely affect trout. However, iron was not considered a COC because of the degree of uncertainty in the iron toxicity reference value and only a marginally-higher risk was estimated compared to upper Fawn Lake, suggesting that the risk was insignificant. The risk to trout from aluminum is low, but potentially significant. Therefore, aluminum is considered a COC for Eagle Rock Lake surface water. Table 5-38 presents a summary of the COC, concentration range, and acute and chronic ecological SLC for Eagle Rock Lake surface water.

TABLE 5-38
CONTAMINANT OF CONCERN, CONCENTRATION RANGE, AND SLC FOR EAGLE ROCK LAKE SURFACE WATER

COC	Concentration (mg/L)	Cleanup Level (mg/L)	
		Chronic	Acute
Aluminum	0.07 – 0.9	0.6 – 1.2	37.2 – 45.5

However, because the lake is managed as a put-in-take fishery for hatchery-reared rainbow trout, long-term (chronic) exposure is unlikely for stocked trout; brown trout are uncommon in the lake; and white suckers are generally less sensitive to metals exposure. Furthermore, the importance of aluminum in Eagle Rock Lake surface water is, however, likely overshadowed by the much more important issue of controlling aluminum in the Red River during and following rainstorm events. These observations suggest that controlling aluminum in Eagle Rock Lake under chronic conditions is probably unlikely to result in measureable improvements in conditions for trout in the lake unless acute (*i.e.*, storm-related) aluminum concentrations are also reduced.[54]

5.13.2 Sediment

Sediment near the inlet, middle and outlet was sampled four times during the RI. Based on a comparison with SLC, the following three human health COPCs were identified for sediment:

- Arsenic
- Iron
- Manganese

The following metals were identified as ecological COPCs:

[54] CDM Technical Memorandum – Ecological Chemicals of Concern (COCs) to be Addressed by Chevron Mining Inc. (CMI) Feasibility Study, Appendix A-3, FS Report.

- Aluminum
- Arsenic
- Cadmium
- Cobalt
- Copper
- Iron
- Lead
- Manganese
- Mercury
- Nickel
- Selenium
- Silver
- Zinc

Based on the statistical comparison to the reference area at upper Fawn Lake, arsenic is the only human health COPC with concentrations significantly greater than reference background. Ecological COPCs with concentrations significantly greater than those in upper Fawn Lake are aluminum, arsenic, nickel, selenium, and zinc. Aluminum concentrations were two to three times higher in Eagle Rock Lake than upper Fawn Lake and exceeded both chronic and acute ecological SLC. Beryllium concentrations in Eagle Rock Lake were also significantly greater than upper Fawn Lake concentrations, but did not exceed the ecological screening level criterion.

5.13.2.1 Sources and Pathways – USGS Lake Sediment Study

The USGS conducted geochemical studies of lake sediment from Eagle Rock Lake and upper Fawn Lake to evaluate the effect of CMI's mining operation on Eagle Rock Lake.[55] Two cores were taken, one from each lake near the outlet where sediment was thinnest. Samples from the cores were analyzed for primarily metals. The core from upper Fawn Lake, located upstream of the mine site, provided a record of the geochemical baseline in which to compare the Eagle Rock Lake core for the period from 1961 to 2002 (the time of the study).

[55] Questa Baseline and Pre-mining Ground water Quality Investigation 8: Lake-Sediment Geochemical Record from 1960 to 2002, Eagle Rock Lake and Fawn Lakes, Taos County, New Mexico

The USGS study found a pattern of increasing molybdenum concentrations in the Eagle Rock Lake sediment core from the early 1960s. The study also found an increase in cobalt, nickel, copper, and zinc. The USGS correlates this increase to the time period when open-pit preparation and mining commenced at the mine site.

The USGS study also showed that the sediment record of Eagle Rock Lake changed substantially in 1979 with large increases in concentration for many major elements and metals. The USGS correlates this abrupt change with the major flood-of-record recorded at the USGS Questa gage in 1979. The USGS states:

> *"The change in sediment geochemistry in Eagle Rock Lake in the post-1979 interval is dramatic and requires that a new source of sediment be identified that has substantially different geochemistry from that in the pre-1979 core interval."*

The USGS also concluded:

> *"Loss of mill tailings from pipeline breaks is most likely responsible for some of the spikes in trace-element concentrations in the Eagle Rock Lake core."*

The USGS further concluded that an enrichment of aluminum oxide (Al_2O_3), copper, and zinc in the sediment occurred as a result of chemical precipitation of these metals from ground water entering the Red River upstream of the lake. Additionally, a comparison of the geochemistry of the sediment core with both mine waste rock and pre-mining sediment chemical compositions indicate that both are possible sources of this sediment.

5.13.2.2 AVS/SEM Results

A method to assess toxicity and bioavailability using heavy-metal and total-sulfide measurements is called acid volatile sulfide/simultaneously extracted metals (AVS/SEM). The "AVS/SEM" hypothesis is that if the acid volatile sulfide present is greater than the molar sum of the SEM metals, the metals will be almost exclusively bound to sulfide, bioavailability will be extremely low, and toxicity is unlikely.

The AVS/SEM samples were analyzed on the Eagle Rock Lake and upper Fawn Lake sediments in fall 2002. The results showed that in all Eagle Rock Lake sediment samples and the upper Fawn Lake inlet sample, the metals are not bound up by the sulfides and could be available in a toxic form.

5.13.2.3 Contaminants of Concern for Sediment

Based on the EPA HHRA, there are no COCs identified in Eagle Rock Lake sediment that contribute appreciably to human health risk for this exposure area.

Based on the EPA BERA, there are at least five ecological COCs which present the greatest risks to benthic invertebrates in Eagle Rock Lake sediment. This list is based on comparison of data from the reference location (upper Fawn Lake) to Eagle Rock Lake sediment data and on relative toxicity. Further investigation post BERA resulted in refinement of this list, such that copper and aluminum (for floc formation) were added and selenium was eliminated from further evaluations at the ROD stage of the process. The final list of COCs for Eagle Rock Lake sediment are aluminum, cadmium, copper, manganese, nickel, and zinc. These COCs and their concentration ranges are presented in Table 5-39 below.

TABLE 5-39
CONTAMINANTS OF CONCERN AND CONCENTRATION RANGES
FOR EAGLE ROCK LAKE SEDIMENT

COC	Concentration (mg/kg)	Cleanup Level (mg/kg)
Aluminum	11,800 – 70,500	25,500
Cadmium	0.092 – 16.9	0.99
Copper	33.6 –612	31.6
Manganese	269 – 4,080	63
Nickel	9.7 – 378	22.7
Zinc	99 – 5,250	121

Notes;
ARCS = Assessment and Remediation of Contaminated Sediments Program (USEPA 1996)
TEL = Threshold Effects Level
CB = Consensus-based (CB TEC from MacDonald et al. 2000)
TEC = Threshold Effect Concentration
EPA R3 SL = EPA Region 3 Screening Level
Sources of cleanup levels are detailed in Table 12-17

Benthic invertebrate populations are important because the invertebrates are sensitive indicators of water and sediment quality. They also serve as a major food source for fish and, therefore, warrant protection by the Selected Remedy.

The estimated volume of contaminated sediment at Eagle Rock Lake to be addressed by the Selected Remedy is 15,000 yd^3, based on a three-foot depth extended over a three-acre area of the lake.

5.13.3 Aquatic Ecology

Aquatic biota was sampled from Eagle Rock Lake and the reference upper Fawn Lake to assess potential effects from exposure to Site-related contamination. The aquatic biota data were used by EPA in the baseline risk assessment.

5.13.3.1 Fish

Stocked rainbow trout and white suckers were collected from Eagle Rock Lake and upper Fawn Lake for tissue analysis. Brown trout were also collected from upper Fawn Lake, but not Eagle Rock Lake. Therefore, no statistical comparison between the two lakes was made for brown trout.

Several COPCs (metals) were detected in white suckers greater than 8 inches. All of the metals had concentrations below the risk-based concentration values. The COPCs with concentrations significantly higher than upper Fawn Lake fish tissue concentrations were cadmium, cobalt, and manganese.

For white suckers less than 8 inches, COPC concentrations were below the risk-based concentration values. The COPCs with concentrations significantly higher than upper Fawn Lake fish tissue concentrations were aluminum, cadmium, copper and lead. It is noted that the mean concentration of aluminum in white suckers from Eagle Rock Lake (177 mg/kg wet weight [ww]) was nearly nine times higher than the mean concentration for upper Fawn Lake (20.5 mg/kg ww).

The young-of-the-year samples were only collected from Eagle Rock Lake, so no statistical comparison could be made with upper Fawn Lake. Only arsenic was above the RBC value, but the analysis did not differentiate between inorganic and organic arsenic (see Section 5.12.6.1.3 for further discussion of arsenic speciation).

Overall, Eagle Rock Lake had a tendency for higher fish tissue metal concentrations than upper Fawn Lake.

Based on the EPA BERA, only copper and zinc presented elevated risk to white suckers. Risk for aluminum was not calculated as there was no aluminum toxicity reference value available at the time of the assessment. The BERA also concluded that the risk estimates for copper and zinc may be overestimated given the uncertainties with the selected toxicity reference values. Further, no significant differences were observed between the Eagle Rock Lake and the reference upper Fawn Lake.

5.13.3.2 Benthic Invertebrates

Overall, Eagle Rock Lake had significantly lower density, number of taxa, number of ETO, percent of taxa as ETO taxa, and number of Crustacea and Mollusca taxa for edge habitat compared to upper Fawn Lake in fall 2002 and fall 2003 sampling. In spring 2003 sampling, Eagle Rock Lake had significantly lower number and percent of Crustacea and Mollusca taxa than upper Fawn Lake.

5.13.3.3 Benthic Invertebrate Tissue

Benthic macroinvertebrate tissue concentrations were significantly higher in Eagle Rock Lake than upper Fawn Lake for aluminum, beryllium, cadmium, cobalt, iron, lead, manganese, nickel, and vanadium

5.13.3.4 Algae and Aquatic Plants

Due to a lack of bryophytes and rooted aquatic plants in upper Fawn Lake, algal tissue was collected in fall 2002 and aquatic macrophytes were collected in fall 2003. Eagle Rock Lake algae had higher concentrations of COPCs than upper Fawn Lake algae. However, macrophytes at Eagle Rock Lake had lower concentrations of COPCs than upper Fawn Lake algae. The difference may be due to the two different types of tissues sampled from the lakes.

5.13.3.5 Toxicity Testing

No toxicity in either survival or reproduction endpoints was observed for the three-brood screening-level toxicity testing using *C. dubia*.

No toxicity was observed for biomass (growth) or survival for either *Hyalella azteca* or *Chironomus tentans* in 10-day chronic sediment toxicity testing.

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6.0 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

6.1 Land Use

6.1.1 Mine Site Area

The mine is an operating facility. Mining activity occurs primarily underground, at the mill, and in the administration and maintenance and electrical areas. The waste rock piles and open pit are historic features remaining from open-pit mining conducted between 1965 and 1983.

6.1.1.1 Future Mining Operations Utilizing the Open Pit

The open pit is identified in the Selected Remedy as a potential repository for mine waste rock. The open pit is also being considered by CMI as part of its future mining plans. A repository at the mine site for placement of waste rock is a necessary component of the Selected Remedy, as potentially large volumes of waste rock may have to be removed from the rock piles in order to achieve the interbench slope angles required for long-term stability of the waste rock piles. The open pit is the most obvious location for such a repository. It has a capacity of approximately 270 million yd^3 of material.

CMI has informed EPA of planning activities that are continually ongoing which consider the utilization of the open pit in multiple and different future mining scenarios. Among these potential future mining scenarios is mining one or more of the following ore bodies: the Southwest Slice, the South Wall only, Sublevel Cave Mine, and the F-2 Ore Body.

CMI has indicated to EPA that as part of these planning activities, modification to and updates of methods of extraction are continually evaluated. Operating technologies may change and process options improved which could result in modifications to the mining and operating process. Existing technologies that may be used in the future, if they become economical, include paste tailing, tailing deposition to the open pit, process water use and milling.

To date, CMI has not informed EPA of any specific planned mining activities in the open pit or of any estimated timeframe for beginning such activity.

6.1.1.2 Other Future Operations

Future anticipated uses of parts of the mine site during operations include industrial and commercial uses.

6.1.1.3 Future Land Use After Mining

Based on the likely population growth in the mine vicinity and nearby communities and the existing popularity of the surrounding area for recreation and mountain resort development, future post-mining land uses of industrial, commercial, or residential are likely for the Mine Site Area. Residential use is more likely along the flatter lands adjacent to the Red River, rather than the mountainous terrain at the mine site. Population growth projections for Taos County indicate that the northern region, which includes the Village of Questa (population approximately 1,900) and the town of Red River (population approximately 500), will likely absorb the growth that is expected to occur in the Taos area due to the large amount of undeveloped land in this region. The recreational opportunities in the vicinity of the mine and the natural beauty of the Red River Valley make it an attractive and desirable area for residential development, for permanent residences, for temporary vacation homes, and for rental lodges or cabins.

Private residential cabins have been built adjacent to the mine site in the past. A few private cabins were once located along the river in the Columbine Park area. However, they were acquired by Molycorp and demolished. Several company cabins owned by

Molycorp were also once located along the river in the Columbine Park area. They have also been demolished.

The Mill Area of the mine site, where the mill structures and buildings are currently located, is likely to be put to industrial use in the future. It is the preliminary location for water treatment facilities to be constructed and operated as part of the Selected Remedy.

Future recreational uses are also very likely for the Mine Site Area. The mine site is surrounded by the Carson National Forest, and it is within a few miles of two national wilderness areas. Current and anticipated future uses are recreational skiing, hunting, kayaking, picnicking, camping, and fishing. Other uses include forestry management and oversight activities by U.S. Forest Service personnel.

The currently approved post-mining land use for the Mine Site Area under the New Mexico Mining Act is forestry and water management, as set forth in New Mexico Mining Act Permit TA001RE (MMD 2002; § 5, Part F), which requires closure and reclamation. The post mining land use under the Mining Act is not, however, a fixed land status. CMI can apply to change the post-mining land use designation at any time. Also, the post-mining land use can change after the site is no longer subject to New Mexico Mining Act requirements. State agencies report that as closure of a mine approaches, mine operators often find uses for their lands that were previously unanticipated. It is not unusual for mine operators to request a post-mining land use designation of industrial or commercial for portions of their facilities after mining operations cease. Some mine operators also request a post-mining land use designation of residential use after closure.

After cessation of mining operations, under the Closeout Plan for the mine, which is part of the New Mexico Mining Act permit, the Mine Site Area, including the Mill Area, must be reclaimed to a condition that allows for re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding area, and that does not conflict with the approved post-mining land use of forestry. A request by CMI to waive reclamation requirements for the open pit was approved by MMD in 2002 pursuant to Mining Act

Rules (§§ 19.10.5.506 and .507). The approval was based on an assessment by CMI that such reclamation would not be environmentally sound or economically feasible. Structures that are not designated for another post-closure use must be removed. However, it is anticipated that some buildings and structures in the Mill Area will be retained for long-term water management and treatment (MMD 2002; § 9, Parts D and E) (see Section 2.4.1.2). Under the closure plan for the mine, which is part of New Mexico discharge permit DP-1055, the Mine Site Area must be closed to protect ground water quality (see Section 2.4.2.1).

Both existing and planned institutional controls are required to be considered when evaluating future land use. EPA intends to seek temporary restrictions on drilling wells in areas of contaminated ground water from the New Mexico Office of the State Engineer. In addition, on May 21, 2009, CMI recorded the institutional controls with Taos County described below.

- **Deed of Conservation Easement**: The deed of conservation easement (Conservation Easement) is granted to the Village of Questa, with EPA, NMED, and EMNRD named as third-party beneficiaries. It applies to the mine site property, becomes effective when the permanent cessation of all mining activities, including mineral beneficiation at the entire mine, occurs, remains in effect in perpetuity and its provisions are intended to:
    - Prohibit residential land use;
    - Authorize the Village of Questa, at its option, to use the administrative and maintenance and electrical areas and a portion of the Mill Area for light industrial or other low ecological impact uses;
    - Prohibit excavation by more than ten feet;
    - Prohibit the withdrawal of ground water, except for the purposes of ground water remediation or monitoring;

- Prohibit the capture of any spring or other flowing water on or beneath the property, except for purposes of ground water remediation.

- **Declarations of Restrictive Covenants**: There are separate restrictive covenants for the tailing facility and the mine and mineral processing facility. The Village of Questa is named grantee in each and EPA, NMED, and EMNRD are designated as third party beneficiaries. The restrictive covenants became effective on May 21, 2009, when they were recorded in the Taos County deed records and run with the land. The tailing facility covenants are intended to prohibit all residential uses prior to the termination of mining activities and, thereafter, to allow only light industry and park, recreational or athletic field uses. The mine and minerals processing facility covenants prohibit recreational use before the termination of mining activities and, thereafter, allows uses which are consistent with the Conservation Easement. The restrictive covenants also prohibit:

  - Excavation to a depth of more than 10 feet below ground surface;
  - The collection, storage, or use of any present or future spring or other surface water with the exception of closure or reclamation;
  - The use of ground water for human consumption or installation of wells to obtain ground water for any purpose except closure or reclamation.

These proprietary controls should restrict residential land use and ground and surface water uses if they are effectively monitored and enforced. They allow light industrial development over part of the mine property and the Mill Area.

To comply with the conditions established by MMD for the pit waiver, CMI must restrict access to the pit through use of perimeter fencing and berms, signage, and institutional controls to ensure that the pit does not pose a current or future hazard to public health or safety.

Notwithstanding the current post-mining land use designation and the institutional controls that have been established or planned, EPA has developed alternatives for the Mine Site Area that address the potential hypothetical future resident and recreational visitor or trespasser.

6.1.2 Tailing Facility Area

The tailing facility is an operating facility. Wildlife currently uses the tailing facility for foraging and as a source of water (see discussion under Land Use Adjacent to Tailing Facility, Section 6.1.2.3 below).

6.1.2.1 Future Operations

Future anticipated use of parts of the tailing facility may be revised to incorporate light industrial, non-residential uses including renewable energy opportunities or other currently unknown opportunities.

As discussed in Section 2.2.2 above, CMI is constructing a 1-megawatt solar energy plant on a 20-acre inactive portion of the tailing impoundment as a 5-year demonstration pilot study. The solar energy plant will utilize concentrated photovoltaic technology and is scheduled to be completed and operational by the end of 2010.

6.1.2.2 Future Land Use After Tailing Disposal Operations

Future post-mining land uses of industrial, commercial, or residential are likely for the Tailing Facility Area. The tailing facility is bounded on the east, northeast, and southeast by the Village of Questa. Current and reasonably anticipated future land uses include residential, agricultural (irrigated pastures), livestock grazing, gardening, and wildlife habitat. There are multiple residences in the vicinity of the tailing facility in the Village of Questa. Some of these residences are located within ¼ mile of the tailing impoundments. Questa schools are located in close proximity to the northeast boundary of the tailing facility. Some commercial businesses are also in the area. The tailings facility itself is level and amenable to industrial development, as evidenced by the solar energy plant. Future industrial uses are likely at the tailing facility.

Future recreational use is also likely for the Tailing Facility Area. The tailing facility is bounded to the west and north by the Guadalupe Mountains, some of which is BLM-managed public land. The area is remote, but maintained by BLM via access roads. Current and reasonably anticipated future land uses are primarily wildlife and recreational (hiking, bicycling, horseback riding, camping, and picnicking). There are 29 lakes in and around Questa. The Wild Rivers Recreation Area includes most of these lakes and recreational opportunities around Questa. In 2010, a collaboration of parties consisting of BLM, the Village of Questa, CMI, the Rocky Mountain Youth Corps and supporting members of the public agreed to a new trailhead (Las Vistas de Questa trailhead) for hikers, bikers, and horseback riders. The trailhead will run from Questa to the Wild Rivers Recreation Area and cross over CMI property (through an easement granted by CMI). The trailhead will have picnic tables and restrooms.

A population trend study (NMED 2010) was conducted to project population trends for 2010 to 2050. The population in Taos County and the Village of Questa is projected to increase by 42 percent and 50 percent by 2050, respectively.

Local residents have observed a large resident herd of Rocky Mountain elk (150 – 200 head) in the Guadalupe Mountains. The elk have been observed to come down from the mountains during the late evening and night onto the tailing facility for water and to forage. Elk tracks at the tailing facility are numerous and have been observed by NMED and MMD personnel. Historically, livestock have been reported grazing on the tailing facility by state officials, but such use is believed to be infrequent. Although the facility is surrounded by a three-wire barbwire fence, it does not appear to be effective at keeping these animals off the tailing facility.

The currently approved post-mining land use under the New Mexico Mining Act and Mining Permit TA001RE is wildlife habitat. Upon closure, the area must be reclaimed to a condition that allows for re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding areas, consistent with the approved post-mining land use of wildlife habitat. However, that designation is subject to change, and a change in the designation is likely necessary to accommodate the solar energy plant.

Notwithstanding the current post-mining land use and the institutional controls established by CMI, alternatives have been developed for the Tailing Facility Area to address the potential hypothetical future resident, recreational visitor/trespasser, livestock grazing exposure, and non-residential light industrial scenarios.

6.1.3 Red River and Riparian and South of Tailing Facility Area

Within the riparian valley the current and anticipated future land uses are residential, commercial, recreational, agricultural (irrigated pastures), livestock grazing, gardening, and wildlife habitat. A limited number of cattle and sheep graze in the meadows south of the tailing facility during the warmer months and hay is harvested from the meadows for winter feeding. Of the cattle, few if any dairy cows have been observed. Copper salt blocks have been placed in the valley by CMI for cattle grazing in the area since 2006 because elevated molybdenum concentrations in the soil within this meadow present a risk of contracting molybdenosis disease, a molybdenum-induced form of copper deficiency.

Recreational activities include hunting, hiking, and camping. The U.S. Forest Service maintains the Questa Ranger Station and the inlet gate for Eagle Rock Lake about a mile downstream of the mine site. The rugged landscape of the Red River Gorge and canyon west of the riparian valley is within BLM-managed public lands. Although there is a vehicle access road, the Gorge area is isolated and remote. The Red River State Fish Hatchery is located within the Gorge. There are a number of buildings and structures located at the fish hatchery, including residential dwellings used by several permanent workers and their families. The fish hatchery is a popular location for visitors to tour during the summer months.

6.2 Ground Water and Surface Water Uses

6.2.1 Ground Water and Surface Water Protection in the State of New Mexico

The New Mexico Water Quality Control Commission (WQCC), under the authority of the New Mexico Water Quality Act, has established standards and regulations (Section 20.6.2 NMAC) for protecting all ground water of the state of New Mexico which has an existing concentration of 10,000 mg/L or less TDS, for present and potential future use as domestic and agricultural water supply and to protect those segments of surface water which are gaining because of ground water inflow for uses designated in the New Mexico Water Quality Standards. Under these regulations, ground water is protected at any place of withdrawal for present or reasonably foreseeable future use.

6.2.1.1 Place of Withdrawal

Section 74-6-5(E)(3) of the New Mexico Water Quality Act provides that "[d]etermination of a discharge's effect on ground water shall be measured at any place of withdrawal of water for present or reasonably foreseeable future use." The WQCC has held that to evaluate whether a site is a "place of withdrawal" requires the application of seven criteria. *In the Matter of: Appeal of Supplemental Discharge Permit for Closure (DP-1341) for Phelps Dodge Tyrone, Inc.*, (Feb. 4, 2009) (Nos. WQCC 03-12(A), WQCC 03-13(A)) (*Phelps Dodge Tyrone*). The seven criteria are (1) hydrology and geology, (2) ground water quality prior to *any* discharges from the facility, (3) past and current land use in the vicinity of the facility, (4) future land use in the vicinity of the facility, (5) past and current water use in the vicinity of the facility, (6) potential future water use and demand in the vicinity of the facility, and (7) population trends in the vicinity of the facility. In 2010, NMED conducted a preliminary evaluation of the place of withdrawal by applying these criteria to the Site. NMED concluded that the Questa Mine Site, including both the mine facility and the tailing facility, are places of withdrawal of water for present or reasonably foreseeable future use.[56] This conclusion could change as a result of a proceeding before the WQCC under § 74-6-5 of the New Mexico Water Quality Act in which CMI challenges a permit action taken by NMED relating to the Site.

6.2.2 Mine Site Area

6.2.2.1 Ground Water

The current and anticipated future use of ground water at the mine site (through the end of mining) is primarily process water in milling and tailing disposal operations and for pipeline maintenance and dust suppression at the tailing facility. Ground water is also withdrawn at the mine site for potable use by workers. Currently, ground water is pumped out of the underground mine workings as part of CMI's mine dewatering operations and transported to the mill for use in transporting tailing slurry to the tailing facility during milling periods and for pipeline maintenance and dust suppression at the tailing facility during non-milling periods. Ground water extracted or collected from mine production wells, as well as the NPDES water collection systems (ground water withdrawal well system and seepage interception systems), are also sent to the mill and used or disposed of in this manner. Additionally, diversion of Red River surface water provides a significant source of mill makeup water.

The Lab Well at the mill and the Columbine domestic well near the confluence of Columbine Creek and the Red River are used to supply the mill, the administration and maintenance and electrical areas with potable water and drinking water. Water from these wells is not used in milling operations.

[56] New Mexico Environment Department Preliminary Evaluation of Criteria for Place of Withdrawal of Water at the Chevron Mine Incorporated Questa Mine (Sept. 27, 2010).

After cessation of mining, ground water will continue to be withdrawn from the underground mine workings as part of the Selected Remedy and New Mexico's mining and ground water discharge permit requirements for reclamation. Additionally, ground water will be withdrawn along the roadside waste rock piles by the NPDES ground water withdrawal well system and along tributary drainages by the Selected Remedy. The collected ground water from these remedial systems will be treated and discharged to the Red River. The dewatering of the underground mine will be conducted for many years and possibly in perpetuity.

Other potential future uses of Mine Site Area ground water include drinking water and other domestic use associated with residential, commercial, or industrial land use. As stated above, CMI has established institutional controls over portions of the mine property which are intended to restrict withdrawal of ground water. If these institutional controls are effectively maintained, monitored and enforced, they should limit ground water use for drinking water and other domestic purposes.

The beneficial future use of ground water that flows from CMI's property to the Red River alluvial aquifer beyond the CMI property boundary is drinking water, other domestic water uses, and agriculture uses (livestock watering and irrigation).

The increasing population trends for the Questa area indicate that it is foreseeable that demands on area water supplies and the need for future sources of water to supply population demands will increase over time (NMED 2010).

6.2.2.2 Surface Water

The only surface water present at the mine site is seepage and storm water. Storm water at the mine site is currently managed by CMI in accordance with the NPDES MSGP and SWPPP and includes the collection and conveyance of storm water to the open pit, subsidence area, and various infiltration galleries on site, where it discharges to ground water. Storm water management is also currently regulated by New Mexico Ground Water

Discharge Permits DP-1539 and DP-1055. Under the NMED permits, CMI is required to develop a new method for the disposal of collected storm water for the protection of ground water. Consequently, storm water will be collected, treated and discharged to the Red River to protect ground water and surface water. Seeps and springs along the Red River are captured by the NPDES seepage interception systems and sent to the mill. Additionally, mine-related seepage will be collected and treated as part of the CERCLA response action. These surface water (and storm water) management activities will likely continue for many years after mining ceases.

6.2.3 Tailing Facility Area

6.2.3.1 Ground Water

Ground water beneath and south of the tailing facility is contaminated by tailing seepage. South of Dam No. 1, seepage-impacted ground water is collected by extraction wells and seepage barriers as part of NMED-directed ground water abatement actions and discharged to the Red River via NPDES-permitted Outfall 002 or pumped back to the facility in accordance with New Mexico Ground Water Discharge Permit DP-933.

Ground water is currently used by Questa residents in the vicinity of the tailing facility via private wells for drinking water, potable water, gardening, and livestock watering. In the area of ground water contamination south of Dam No. 1, owners of private wells are not legally prohibited from using the ground water. However, EPA is not aware of any resident using contaminated ground water for drinking or potable water use. Most, if not all, residences south of the tailing facility are known to be connected to the Questa municipal drinking water supply, although there are a number of private wells which are still used for irrigation and domestic purposes. Through discussions with local community members, EPA is aware that CMI bought the water rights from several residents that own property located in areas of ground water contamination. The ground water used in these areas is from the alluvial aquifer.

The source of the municipal drinking water supply is also the alluvial aquifer, with the water supply wells located upgradient to the east and northeast of the tailing facility.

The potential future use of ground water in the areas north, east and south of the tailing facility is as a source of drinking water for residents and future commercial and industrial workers.

Ground water in the basal bedrock (volcanic) aquifer is contaminated by tailing seepage south of Dam No. 4, in the area of the Red River Gorge. As discussed above, the rugged landscape of the Red River Gorge and canyon west of the riparian valley is within BLM-managed public lands and remains very isolated and remote. The current use of the ground water in the volcanic aquifer in this remote area is for domestic supply (including as drinking water) at the Red River State Fish Hatchery, the BLM facility well, and Chiflo Campground. Additionally, another BLM well is used for livestock and wildlife watering, and BLM has indicated their intentions of using other wells in the area.

Notwithstanding the remoteness of the Red River Gorge and canyon areas, the increasing population trends for the Questa area indicate that it is foreseeable that demands on area water supplies and the need for future sources of water to supply population demands will increase over time (NMED 2010).

6.2.3.1.1 Red River State Fish Hatchery

The Red River State Fish Hatchery, located along the Red River Gorge, uses ground water from the volcanic aquifer, as well as the alluvial aquifer, in fish-rearing operations. The ground water is collected from two spring areas: Spring 17, which is located south of Dam No. 1 and sourced by the alluvial aquifer; and Spring 18, which is sourced by the volcanic aquifer south of Dam No. 4. Both of these aquifers in the areas of the springs are impacted by tailing seepage. See Section 5.2.5 above.

The ground water from Spring 18 is also supplied to the buildings and structures, including residential dwellings, for potable water and drinking water use. Several permanent workers and their families reside at the hatchery. Other employees and the public (visitors) also use the water supplied to these facilities. A large number of tourists visit the facility in the summer months.

EPA, NMED, and New Mexico Department of Game and Fish officials, along with CMI representatives, met with hatchery personnel on May 26, 2010 to discuss the concern with drinking the tap water at the hatchery and the revised preliminary remediation goal developed by EPA Region 6. Based on the analytical results from monthly sampling by NMED since December 2009, the molybdenum concentrations were just below the revised preliminary remediation goal of 0.08 mg/L for molybdenum. However, the trend in concentrations was increasing over time. Although the quality of the water was not considered by EPA to pose a health concern at this time, CMI offered to provide bottled water to the hatchery to address concerns by hatchery personnel. The hatchery has received bottled water since June 2010 and monthly monitoring of the water quality at the hatchery continues to be performed by NMED and CMI.

The current use of ground water as a source of drinking water is anticipated to continue at the Red River State Fish Hatchery, the BLM facility and Chiflo Campground site for the foreseeable future, but is not expected to increase much beyond such use considering the remoteness of the area.

6.2.3.2 Surface Water

The tailing ponds are operating ponds that will be removed during closure and reclamation of the tailing facility following cessation of operations. Currently, these ponds do not support fish, but contain benthic invertebrate populations. The ponds are used by terrestrial wildlife, including mule deer, elk (as discussed above) and waterfowl.

6.2.4 Red River and Riparian and South of Tailing Facility Area

The Red River is a popular multiple-use watershed. Recreational activities include fishing and world class white-water kayaking in the lower reaches of the Red River. Stocking of the Red River with rainbow trout by hatchery personnel generally occurs during the summer, between May and September.

Designated uses of the Red River are coldwater aquatic life, fish culture, irrigation, livestock watering, wildlife habitat and primary contact. § 20.6.4.122 NMAC. These are current and potential future beneficial uses of the river.

6.2.5 Eagle Rock Lake

The current and potential future beneficial use of Eagle Rock Lake is recreational, as well as aquatic and aquatic-dependent life. The lake is a popular fishing site for the local community, as the lake is stocked regularly with rainbow trout in the summer months by hatchery personnel.

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7.0 SUMMARY OF SITE RISKS

This section of the ROD summarizes the Site's human health and environmental risks.

7.1 Summary of Human Health Risk Assessment

The Baseline Human Health Risk Assessment (HHRA) evaluated potential human health risks that may result from current and future exposure to mining-related contamination currently present at the Site. The HHRA was developed assuming that no further clean-up actions would be taken. Where health risk might remain high if no remediation or mitigation were undertaken, it provides the basis for taking remedial action and identifies contaminants and exposure pathways that need to be addressed during clean-up. This section of the ROD summarizes the results of the HHRA. The primary focus of this summary is on exposure pathways and chemicals found to pose actual or potential threats to human health.

The human health risk assessment process is comprised of four components: identification of chemicals of potential concern (COPCs), exposure assessment, toxicity assessment, and risk characterization. The completed risk assessment was used by EPA to identify areas and chemicals of concern (COCs) for remedial action. At this point remediation goals, based on the results of the risk assessment, were developed to help guide the selection of remedies. Each of these components of the HHRA is summarized in the following sections.

7.1.1 Identification of Chemicals of Concern

The HHRA used data collected for the RI (URS 2005a, 2005b) and from additional studies, including, for example, additional sampling in a small area south of tailing facility where seeps associated with the tailing impoundments were noted. All of these data were collected, in part, to identify contaminants present at the Site that could pose significant risk to human health. Such contaminants were identified as COPCs, as described below. Multi-media (*e.g.,* soil, air, ground water, surface water, sediment, home-grown produce, fish) sampling for the RI was performed from fall 2002 to summer 2004.

Mining-related contamination has been documented in soil, ground water, surface water and sediment at and in the vicinity of the mine site and tailing facility. As part of the human health risk assessment, the maximum concentration of each detected chemical in each medium (soil, ground water, surface water, etc.) was compared to a set of screening criteria that consisted of conservative federal and state numerical regulatory standards and criteria, calculated risk-based screening levels, or commonly accepted benchmarks approved by EPA for screening purposes. COPCs were then identified as the subset of chemicals detected in site media for which maximum detected concentrations exceeded these screening criteria. Selection of a chemical as a COPC does not indicate that the chemical poses a significant health threat; instead, it indicates that a more rigorous analysis of possible health threats is warranted. COPCs identified in this process were therefore examined more closely using risk assessment procedures provided in EPA guidance.

The HHRA found that soil and ground water are the primary media of concern. Unacceptable risk resulting from exposure to COCs in soil was identified only for the Mill Area at the mine site. Potential incidental ingestion of and dermal contact with polychlorinated biphenyls (PCBs) and molybdenum in soil at the Mill Area was found to pose a risk to future workers and residents. Inhalation of fugitive dusts generated by wind erosion did not contribute significantly to Site-related risks. PCBs were assessed as probable human carcinogens. Molybdenum is not known to be a carcinogen, and health risks are based on possible non-cancer impacts. The range of detected concentrations (minimum and maximum), frequency of detection, and a description of exposure point concentrations for these COCs are presented in Table 7-1.

An unacceptable risk was predicted for people who drink contaminated ground water drawn from rural domestic wells or industrial wells at the mine site and tailings facility. Non-cancer health hazards for several COCs were above acceptable levels. Table 7-2 presents a summary of COCs and medium-specific exposure point concentrations for ground water. Summary data for ground water are presented on a well-by-well basis for each ground water unit (*e.g.,* alluvial aquifer, colluvial, and bedrock). COCs for ground water are aluminum, antimony, arsenic, cadmium, iron, fluoride, manganese, molybdenum, vanadium and zinc.

7.1.2 Exposure Point Concentrations

Exposure areas (EAs) were identified for the HHRA to estimate potential risks to different human populations that might use the mine and tailing facility now and in the future. An EA is defined using both physical features of the Site and expected behavior of people that might use the Site. For example, in the future, people might use the Site for hunting. An EA for hunters can reasonably include large areas because this population would likely range widely over the Site. In contrast, future (post-mining) development of the Site for commercial, industrial or residential uses would likely be limited to flatter "buildable" areas and EAs for these populations would be much smaller.

EAs were selected for soil, ground water, surface water, and sediment. Soil EAs evaluated for the mine site were the administration area, Mill Area, waste rock piles, all other mine site areas, and the mine site riparian corridor (areas along the banks of the Red River). Soil EAs for the tailings facility included the tailing facility, south of tailing facility, and the tailing facility riparian area.

Ground water was evaluated on a well-by-well basis for the mine site and tailing facility. A well-by-well basis was used because it is difficult to predict how pumping from one location will affect contaminant concentrations. A well-by-well analysis provides a means of examining the range of possible human health impacts in different areas of the Site.

Surface water EAs were grouped according to surface water type and area (*e.g.,* Red River, lakes and ponds, springs and seeps, and catchments basins). Sediment EAs included the Red River, lakes, and ponds. These divisions among surface water and sediment areas reflect anticipated differences in how people might use the sites. For example, people might recreate in and along the Red River frequently, but are unlikely to frequently visit catchment basins that exist higher up in the drainages within the mine site boundary.

The selection of exposure point concentrations differed among EAs depending on factors such as data collection methods and expected land uses. For example, exposure point concentrations for mine site soil EAs were 95% upper confidence limits (UCLs) calculated after area-weighting to remove possible bias in non-random sampling locations. A UCL is an estimate of average concentrations within an EA and provides reasonable confidence that the true average will not be underestimated. Exposure point concentrations for COCs for soil at the Mill Area are presented on Table 7-1.

Exposure point concentrations for ground water were calculated on a well-by-well basis. This approach recognizes the differing hydrogeologic characteristic present and the differing potential for ground water use. Exposure point concentrations for ground water COPCs are estimated for each well as the 95% UCL, 95th percentile, or the maximum concentration depending on numbers of data points and variability within these data. Exposure point concentrations for ground water at the mine site and tailing facility are presented on Table 7-2.

Exposure point concentrations were calculated for several categories of surface water at the mine site and the tailing facility, including Red River surface water, springs, seeps, catchment basins, lakes, and ponds. For surface water and sediment, the HHRA used 95% UCLs or 95th percentiles as exposure point concentrations unless data were limited in quantity. In these cases, maximum COC concentrations were selected as exposure point concentrations. Exposure point concentrations for COCs in surface water (springs, seeps, and catchment basins) are presented in Table 7-3. Exposure point concentrations for COCs in sediment (tailing pond) are presented in Table 7-4.

Exposure point concentrations for air were calculated from soil exposure point concentrations using a generic particle emission factor. This factor is simply the ratio of soil concentrations and air concentrations based on national experience. No air concentrations data specific to the Site were used in exposure point concentration calculations. Existing air monitoring data from the tailing facility were, however, used as a means to check exposure point concentrations modeled from soil data.

7.1.3 Exposure Assessment

Exposure refers to potential contact of an individual (the receptor) with a contaminant. The exposure assessment evaluates the magnitude, frequency, duration, and route of potential exposure. A combination of Site visits, analysis of land use patterns, experience with mine sites, and information gathered in the community were used to identify how people may come into contact with Site-related contamination. Potential receptors were evaluated based on current and reasonably anticipated future use of land and ground water.

Site conceptual exposure models were developed for the mine site (Figure 5-1) and the tailing facility (Figure 5-2). Site conceptual exposure models graphically depict the movement of contaminants from sources (*e.g.,* waste rock and tailing), through Site media (*e.g.,* soil, air, ground water, surface water, and sediment) to locations where human exposure is possible. The Site conceptual exposure models illustrates known contaminant sources, affected media, possible routes of exposure (ingestion, dermal contact, and inhalation) and potential human receptors evaluated in the HHRA.

The primary sources of Site contaminants are mining, milling, and ore processing wastes, which include waste rock, tailing, and tailing spills. The primary ways these contaminants move in the environment are runoff, infiltration, percolation, and wind erosion. Contaminant movement can also occur from secondary sources: surface soils to surface water by runoff; transport to ground water through leaching, infiltration, and percolation; surface soil to garden vegetables through root uptake; and contaminated dust to other media (*e.g.,* leafy vegetables) through wind erosion. Exposure pathways that may pose to a risk to current or future receptors above EPA acceptable levels are highlighted in the Site conceptual exposure models. Potentially complete exposure pathways and the rationale for selection or elimination of these pathways are described in Table 1(mine site) and 2 (tailing facility) in Attachment 1.

EPA considers some areas of the mine site and the tailing facility to be suitable areas for potential future residential or commercial development. For the mine site, the administrative area, the Mill Area, and the Red River riparian area are suitable for residential land use. Redevelopment of the roadside waste rock piles and other rock piles for residential or commercial land use was evaluated in the risk assessment. All areas at and in the vicinity of the tailing facility were evaluated under the potential future residential land use scenario, including the tailing facility, tailing facility riparian area, and the area south of the tailing facility.

Potential receptors evaluated in the HHRA were:

- Current residents (near the tailing facility) and future residents (mine site and tailings facility)
- School children near the tailings facility
- Current and future recreational visitors, trespassers
- Current and future sport anglers
- Future commercial/industrial workers [potential exposure to current workers at the mine site are covered under Mine Safety Health Administration (MSHA) regulations (for an operating mine) and were not evaluated in the HHRA]
- Future construction workers (mine site and tailing facility)

As depicted in the Site conceptual exposure model for the mine site (Figure 5-1), results of the HHRA show that the following exposure pathways may present unacceptable risk:

- Future residents: Incidental ingestion associated with normal hand-to-mouth activity and absorption through the skin after dermal contact with contaminated soil at the Mill Area;
- Future residents: Ingestion of contaminated ground water drawn from rural domestic wells;
- On-Site commercial/industrial workers: Ingestion of contaminated ground water drawn from industrial wells; and
- Current and future recreational visitors: Incidental ingestion of seepage or seepage-contaminated surface water in mine site catchment basins, and in seeps/springs from waste rock piles and along the Red River.

Results of the HHRA show that the following exposure pathways are likely to present unacceptable risk for receptors at the tailing facility (Figure 5-2):

- Future residents: Ingestion of contaminated ground water drawn from rural domestic wells near the tailing facility;
- On-Site commercial/industrial workers: Ingestion of contaminated ground water drawn from industrial wells near the tailing facility; and
- Current and future recreational visitor: Incidental ingestion of and dermal contact with contaminated tailing pond sediment.

Health risks estimated for exposure by inhalation (breathing) of interior dust or particulates PM_{10} in ambient (outdoor) air by residents, school children, workers, and recreational visitors were below levels of concern. Similarly, risk estimates were below levels of concern for (1) current and future residents near the tailing facility via ingestion of home-grown produce or consumption of beef from livestock raised in contaminated areas near the tailing facility, (2) anglers (fishermen) via ingestion of brown trout, (3) current and future recreational visitors via ingestion of edible riparian plants, and (4) direct contact with soil for all receptors at all areas outside of the Mill Area at the mine site.

7.1.3.1 Exposure Assumptions

EPA guidance states that risk assessments for Superfund sites should include risk estimates based on reasonable maximum exposure as well as average exposure (central tendency exposure or CTE). Estimates based on reasonable maximum exposure generally form the basis for remedial decisions at a site. Reasonable maximum exposure is considered high-end exposure that is still within a possible range. According to EPA's Guidelines for Exposure Assessment (USEPA 1992), reasonable maximum exposure typically falls within the 90th to 99.9th percentile of possible exposures, and is among the highest exposures that are reasonably expected to occur at a site. Reasonable maximum exposure is estimated by combining average and upper range exposure assumptions.

For exposures involving direct contact with soil (incidental ingestion and dermal contact) assumptions were identified for number of days soil is typically frozen or snow covered, number of days per year exposure occurs (exposure frequency), number of years of exposure (exposure duration), amount of soil accidentally ingested each day (ingestion rate), amount of skin area exposed to soil each day (skin surface area), and body weights for adults and children. For exposure to COPC in fugitive dusts, additional assumptions were identified for amount of air breathed in each day (inhalation rate) and amount of contaminated soil typically suspended in air (particle emission factor). The particle emission factor used relates the contaminant concentration in soil with the concentration of respirable particles in air due to fugitive dust emissions from contaminated soils. The value assumes a vegetative cover of 50 percent and a mean annual wind speed of 4.69 miles per second (m/s).

Exposures to COPC in ground water also included assumptions for exposure frequency, exposure duration, skin surface area and body weight. In addition, these assumptions included estimates for the amount of water consumed each day from the household water supply (water ingestion rate).

Similar exposure assumptions were identified for other media, including surface water, sediment, homegrown produce, and edible parts of fish and game. However, human health risks associated with exposure to these media were not associated with risks above levels of concern.

Exposure assumptions for all exposure pathways evaluated in the HHRA are provided in Table 3 in Attachment 1.

7.1.4 Toxicity

The toxicity assessment considered: (1) the types of adverse health effects associated with individual and multiple chemical exposure, (2) the relationship between magnitude of exposures and adverse effects, and (3) related uncertainties such as the weight of evidence for a chemical's potential carcinogenicity in humans. The human health toxicity assessment quantified the relationship between estimated exposure (dose) to a COPC and the increased likelihood of adverse effects.

Toxicity values are used to evaluate the potential for each COPC to cause adverse effects in exposed individuals and are numerical expressions of the relationship between dose (exposure) and response (adverse health effects). Adverse effects include both carcinogenic and non-carcinogenic health effects in humans and these two types of effects are characterized differently. Risks of contracting cancer due to site exposures are evaluated using cancer slope factors developed by EPA. Quantification of non-cancer hazards relies on published reference doses (RfDs).

Cancer slope factors are used to estimate the probability that a person would develop cancer during his/her lifetime given exposure to site-specific contamination. This site-specific risk is in addition to the risk of developing cancer due to other causes.

Consequently, risk estimates generated in the risk assessment are frequently referred to as "excess lifetime" cancer risks.

RfDs are threshold values which represent a daily contaminant intake below which no adverse human health effects are expected to occur even for sensitive receptors (*e.g.,* children or the elderly) exposed over long periods of time. To evaluate non-carcinogenic health effects, a hazard quotient (HQ) is calculated. Hazard quotients are the ratio between site-specific human exposure doses and RfDs. HQs less than one are considered safe. HQs above one suggest that an adverse effect is possible, although HQs are not expressions of the probability that an effect will occur. Often, HQs for a single chemical and exposure pathway are added to reflect possible exposure of a receptor to several COPC and/or via more than one pathway. The addition of two or more HQs results in a hazard index (HI). HIs are evaluated in the risk characterization as described above for HQs.

The primary source of toxicological data used in the HHRA was the most current at the time of the HHRA of the following sources: (1) EPA's Integrated Risk Information System (IRIS), (2) EPA's Provisional Peer Reviewed Toxicity Values, (3) other sources of toxicity values (includes additional EPA and non-EPA sources of toxicity information). Oral and inhalation cancer slope factors are presented in Table 7-5. Non-cancer oral RfDs and inhalation reference concentrations are presented in Table 7-6.

7.1.5 Risk Characterization

Human health risks are based on conservative estimates of the potential carcinogenic risk or potential non-carcinogenic health effects. In this case, conservative means that risk estimates error on the side of protectiveness. Three factors considered for risks to human receptors were: (1) nature and extent of contamination at the site, (2) pathways through which human receptors are or may be exposed to those contaminants at the site, and (3) potential toxic effects of those contaminants. Toxicity values for COCs were used in conjunction with estimated intakes (doses) to evaluate potential carcinogenic and non-carcinogenic health effects.

EPA uses the 10^{-4} to 10^{-6} risk range as a "target range" to manage cancer risks as part of a Superfund Cleanup. This lifetime cancer risk range equates to one excess cancer in ten thousand individuals (10^{-4} = 10,000) to one excess cancer in one million individuals (10^{-6} = 1,000,000). "For sites where the cumulative site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, action generally is not warranted, but may be warranted if a chemical-specific standard that defines acceptable risk is violated or unless there are non-carcinogenic effects or an adverse environmental impact that warrants action" (USEPA 1991b). EPA also uses a target HI of 1 for defining unacceptable non-cancer hazards.

NMED applies a target excess lifetime cancer risk range of no greater than 10^{-5} and a HI threshold value of no greater than 1. Results of the HHRA were compared to these EPA and NMED target values to assist in determining whether response action is necessary at the Site.

EPA calculates risks using concentrations of contaminants measured at the site. For naturally occurring metals, these concentrations include a portion attributable to background. At many sites, background levels are low or do not contribute more than a small percentage to the overall risks at a site. However, for the Molycorp Site, background levels of certain metals contribute risks greater than EPA's target risk range. For this reason, the HHRA evaluated Site-related versus background risk. CERCLA response actions are intended to reduce risks at a site, but they do not generally address background conditions. To provide information to support risk management, this section presents total risk estimates (inclusive of background) but also presents information after adjusting for the incremental contribution of background risks. These risk estimates are referred to as "Site-related risks" in this ROD.

7.1.5.1 Carcinogenic Risk

Carcinogenic risk is defined as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. This "excess lifetime cancer risk" is calculated from the following equation:

Risk = CDI x CSF

Where:

Risk = the unitless probability of and individual developing cancer (*e.g.,* 3 x 10^{-5} or 3 excess lifetime cancers in 100,000 individuals) of an individual developing cancer

CDI = chronic daily chemical intake averaged over 70 years (milligrams per kilogram per day, mg/kg-day)

CSF = Cancer slope factor, expressed as $(mg/kg\text{-}day)^{-1}$

EPA guidance for the evaluation of carcinogenic risks associated with simultaneous exposure to multiple carcinogens assumes that incremental cancer risks are additive (USEPA 1989) or where a given receptor may be exposed to COCs via multiple pathways (*e.g.,* inhalation of particulates, soil ingestion, and dermal contact with soil), the risk from each pathway is also summed. If these assumptions are incorrect, over- or under-estimation of the actual risk could result (USEPA 1989).

7.1.5.2 Hazard Index for Non-Carcinogenic Effects

The potential for non-cancer health effects is evaluated by comparing an exposure level (dose) over a specified time period with the RfD. As stated above, an HQ less than or equal to one means the dose is less than or equal to the RfD and adverse health effects are unlikely to occur. Alternatively, an HQ of greater than 1 means the dose exceeds the RfD and the risk of adverse health effects is significant. The HQ is calculated as follows:

$HQ = CDI/RfD$

Where: CDI = Chronic Daily Intake (mg/kg-day)

RfD = Reference Dose (mg/kg-day)

As mentioned previously, to evaluate potential non-carcinogenic health hazards posed by simultaneous exposure to multiple chemicals, HQs for each COPC within a given exposure pathway (*e.g.,* inhalation of particles, soil ingestion, and dermal contact with soil) are summed. The resulting value is referred to as the HI. The summation of HQs to obtain hazard indexes assumes additivity of toxic effects and is appropriate only for chemicals with similar toxic endpoints (*e.g.,* liver toxicity, kidney toxicity). If the HI is less than one, the potential for adverse non-carcinogenic health effects is below levels of concern. If the sum is greater than one, a more detailed and critical evaluation of potential non-carcinogenic health effects may be warranted. Such additional evaluations may include the consideration of the specific target organ(s) and mechanism(s) of action for the more important COPCs or further consideration of exposure assumptions and expose concentrations used to estimate risk.

7.1.5.3 Summary of Cancer Risks and Non-Cancer Hazards

7.1.5.3.1 <u>Mine Site Soil</u>

For future residents, risks and hazards were evaluated for incidental ingestion of and dermal contact with surface soil (0 to 6 inches) and interior dust, and inhalation of particulates released from surface soil. For residents, cancer risk is based on an exposure duration of 30 years; age-adjusted exposure factors are used to integrate exposure from birth until age 30 by combining exposure assumptions for two age groups: young children (birth to six years in age) and adults. Cancer risks associated with exposure to soils at the mine site for future residents exceeded EPA's target risk range only for the Mill Area. Cancer risk in this area is two excess lifetime cancers in ten thousand individuals or $2x10^{-4}$

for reasonable maximum exposure. This risk is primarily attributable to exposure to PCBs in soil. Since background concentrations of PCBs are likely to be small, all of this risk is assumed to be "Site-related".

Children were evaluated for residential exposure for health hazards other than cancer. For the mine site, non-cancer health hazards are associated with exposure to contaminated soil at the Mill Area. The total HI based on reasonable maximum exposure is 8, due primarily to molybdenum exposure, which can cause toxic effects on joints, and perhaps also the liver, kidney, and the gastro-intestinal tract. Primary toxic effects include elevated uric acid that may cause gout-like symptoms, and effects associated with physiological copper deficiency.

For future commercial/industrial workers, future construction workers and recreational visitors for all exposure areas at the mine site, risks and hazards were evaluated for incidental ingestion of, dermal contact with, and inhalation of particulates released from surface soil. To be protective of future indoor and outdoor workers at the Site, the commercial/industrial scenario assumed that a worker would spend most of the day outdoors. Based on reasonable maximum exposure, cancer risks were within or below EPA's acceptable risk range for all receptors and for all EAs. Likewise, HIs were below the threshold of 1 for all receptors in all EAs.

A summary of the carcinogenic risks and non-carcinogenic hazards presented by the mine site soil is presented in Table 7-7.

7.1.5.3.2 Tailing Facility Soil

For future residents, risks and hazards were evaluated for incidental ingestion of and dermal contact with surface soil and interior dust, and inhalation of particulates released from surface soil. Cancer risks, based on reasonable maximum exposure associated with exposure to soil at the Tailing Facility Area are within EPA's acceptable risk range of 10^{-4} to 10^{-6} for current and future residents.

Similarly, HIs, based on reasonable maximum exposure, for current and future residents were at or below the threshold of 1.

For future commercial/industrial workers, future construction workers and recreational visitors, risks and hazards were also evaluated for incidental ingestion of, dermal contact with, and inhalation of particulates released from surface soil. Based on reasonable maximum exposure, cancer risks were within or below EPA's acceptable risk range and HIs were below the threshold of 1 for all receptors and all EAs.

7.1.5.3.3 Ground Water

Potential risks and hazards from exposure to contaminated ground water were estimated for two groups of human receptors. The first group was assumed to use ground water drawn from a private well or industrial/commercial well as a drinking water supply. This group included current and future residents and future commercial or industrial on-Site workers and assumed that ground water could be drawn from alluvial, colluvial, or bedrock aquifers or water-bearing units. The second group could be exposed to ground water if, during construction, excavation penetrated into the saturated zone. Shallow alluvial ground water may be present at sufficiently shallow depths for this scenario to occur, at least in portions of the Site. Therefore, this second group included future construction workers exposed via incidental ingestion and dermal contact to contaminated ground water in the upper alluvial aquifer or colluvium.

Risks and hazards were estimated for each aquifer on a well by well basis. Wells located on or near the mine site are screened in one of the following three ground water units: (1) the Red River alluvial aquifer, (2) colluvium in tributary drainages to the Red River and, in some cases, colluvial debris fans at the mouths of the tributary drainages, and (3) bedrock beneath the alluvium and colluvium. Wells located at or near the tailing facility produce water from one of the following two shallow water-bearing units: (1) alluvial aquifer (upper and basal portion), and (2) bedrock basal (volcanic) aquifer.

For future residents and future on-Site workers, background concentrations of several inorganic constituents may make important contributions to total risks and hazards due to exposure to contaminated ground water. However, several COPCs make important incremental contributions to background risk in many wells at the mine site.

Cancer risks from exposure of future residents and on-Site workers to contaminated ground water at the mine site are exclusively from possible exposure to arsenic. Non-cancer health hazards are from exposure to metals and other inorganic contaminants such as aluminum, antimony, arsenic, cadmium, fluoride, iron, manganese, molybdenum, vanadium, and zinc. A summary of carcinogenic risks and non-carcinogenic hazards associated with exposure to mine site ground water is presented in Table 7-7 and discussed below.

7.1.5.3.3.1 Mine Site Ground Water

Alluvial Aquifer: Cancer risk estimates from exposure to alluvial ground water range from 6×10^{-6} to 2×10^{-3} for future residents and 3×10^{-6} to 9×10^{-4} for workers. These risks exceed the EPA acceptable risk range of 1×10^{-4} to 1×10^{-6}, with 16 of 37 wells exceeding the range for future resident and 9 of 37 wells for the future workers. Cancer risks also exceeded the NMED target risk range of 1×10^{-5} to 1×10^{-6}. Elevated cancer risks associated with alluvial ground water occur sporadically along the Red River. These risks are similar to those estimated for reference background.

Health hazards, as estimated by HI, exceed the threshold of 1 for future residents in most alluvial wells (35 of 37 wells). HIs range from 0.003 to 204 depending on target organ. For the commercial or industrial workers, HIs range widely from 0.0005 to 45 depending on the target organ. HIs for several target organs (kidney, blood/blood forming tissues, teeth and bone, gastrointestinal tract, and central nervous system) exceed the target HI of 1 in many alluvial wells along the Red River by the roadside waste rock piles, between the confluence of the Red River and Columbine Creek and the upstream end of the Goathill colluvial debris fan and at the western boundary of the Site.

Mining-related sources of the metals and other inorganic chemicals in the alluvial ground water, such as the acid-generating waste rock piles within the tributary drainages to the Red River, appear to make substantial contributions to HI estimates in many wells. Acid rock drainage leaches these metals and other inorganic chemicals from waste rock to the underlying colluvial and bedrock ground waters, which subsequently flow to the alluvial aquifer at the mine site[57] (see Waste Rock Pile Characterization, Section 5.10.2, and Ground Water, Section 5.10.4, above).

<u>Colluvial Ground Water</u>: Total cancer risks among colluvial wells range from $2x10^{-5}$ to $4x10^{-3}$ for future residents and $1x10^{-5}$ to $2x10^{-3}$ for future workers. Cancer risks exceed both the EPA and NMED acceptable risk ranges. Eleven (11) of 14 wells exceeded the EPA risk range for future residents and 7 of 14 wells for future workers. The risks associated with arsenic concentrations in colluvial ground water at the mine site are above risks estimated for reference background and are likely mining related.

For health hazards, HIs for residents that might use colluvial ground water for drinking range from 0.01 to 1,474 depending on the target organ. Hazard Indices for commercial/industrial workers range widely from 0.002 to 324 depending on target organ. The central nervous system had an HI of 6 for construction workers, which is above the EPA threshold value. In some cases, background levels of some COCs make significant contributions to HIs; however, elevated non-cancer hazards occur in most areas along the southern boundary of the mine site, even when background is considered.

The highest concentrations of contaminants measured in colluvial ground water samples were taken from monitoring wells MMW-23A (toe of Capulin Waste Rock Pile) and MMW-38A (Middle Waste Rock Pile).

[57] Bedrock and colluvial ground waters also drain to the underground mine workings where it is collected and pumped to the mill as part of CMI's mine dewatering effort.

Bedrock Ground Water: Total cancer risks among bedrock wells range from $3x10^{-5}$ to $9x 10^{-4}$ for future residents and $1x10^{-5}$ to $4x10^{-4}$ for future workers. Arsenic concentrations in bedrock wells beneath colluvium at the toe of the western most waste rock pile of the roadside waste rock piles, beneath colluvium associated with the Goathill Gulch debris fan, and beneath colluvium near the mouth of Capulin Canyon are sufficiently high that cancer risks exceed EPA's and NMED's acceptable risk range. Eight (8) of 22 wells exceed the EPA risk range for the future resident and 6 of 22 wells exceed the range for the commercial/industrial worker. Such risks are greater than risks estimated for reference background wells, indicating that arsenic concentrations along this reach of the river may be influenced by mining-related activities.

Non-cancer health hazards from exposure to bedrock ground water are above EPA's target HI of 1 at many locations. Hazard Indices range from 0.003 to 239 for future residents and 0.0007 to 53 for commercial/industrial workers depending on the target organ. Elevated non-cancer hazards occur in bedrock wells.

The highest concentrations of contaminants measured in bedrock ground water samples were taken from monitoring wells MMW-36B (toe of Sugar Shack West Waste Rock Pile) and MMW-45B (near the mouth of Capulin Canyon at the southwestern edge of the mine site).

7.1.5.3.3.2 Tailing Facility Ground Water

Wells located at or near the tailing facility produce water from one of the following two shallow water-bearing units: (1) Alluvial Aquifer (upper and basal portion), and (2) Basal Bedrock Aquifer. A summary of carcinogenic risks and non-carcinogenic hazards presented by exposure to tailing facility ground water is presented in Table 7-8 and discussed below.

Alluvial Aquifer: Ground water contamination at the tailing facility is primarily located within the upper portion of the Alluvial Aquifer beneath the tailing facility, as well as south and southeast of the facility, near Dam No. 1 and the Change House. To a lesser extent, ground water contamination is present in the basal portion of the alluvial aquifer. Contamination is mostly confined to CMI property, but does extend beyond the property in certain areas of the valley south of the tailing facility (as far south as the Outfall 002 discharge point at the Red River and west of the discharge point). Many private wells that produce water from the alluvial aquifer are located in close proximity to the tailing facility. Substantial use of the aquifer as potable water indicates that the potential for such use exists. Anticipated future use of the ground water in the area south and southeast of the tailing facility is for drinking water and other domestic uses, as well as pasture and crop irrigation.

Cancer risks are due exclusively to exposure to arsenic and exceed both the EPA's and NMED's acceptable risk range. However, background and total risks are similar.

Health hazards, as estimated by HI, exceed EPA's target HI of 1 in numerous alluvial wells. The HI values range from 0.005 to 80 for current and future residents and from 0.001 to 18 for future on-Site commercial/industrial workers depending on the target organ. COPCs that affect target organs for which the HI is greater than 1 are molybdenum (GI tract, kidney, and liver), aluminum (GI tract and CNS), iron (GI tract and liver), manganese (CNS), and vanadium (metabolism). Total HI for molybdenum exposure significantly exceeds its HI associated with background, suggesting an impact from the tailing facility. HIs above 1 due to molybdenum exposure occur in wells located primarily along the south and southeastern perimeter of the tailing facility, as well as the area south of the facility (near Outfall 002 discharge point to Red River).

Non-cancer HIs for construction workers are all estimated to be less than the target HI of 1 for all alluvial wells.

<u>Basal Bedrock (volcanic) Aquifer</u>: Ground water contamination in the basal bedrock aquifer is observed primarily south of Dam No. 4 within and near the Red River Canyon, some of which is on BLM-managed public land. Currently, no users of this ground water

have been identified, with the exception of the Red River State Fish Hatchery, located about a mile downstream of the tailing facility. Some workers and their families live at the fish hatchery. The drinking water supplied to the residences and other buildings and structures at the hatchery is partly from nearby springs along the Red River Gorge (known as Spring 18), which are formed by the upwelling or flow of ground water from the bedrock aquifer. Although future use of ground water in the bedrock aquifer is likely to remain limited due to the remoteness of the area and rugged terrain, future installation of wells in the aquifer is possible.

Cancer risks due to potential exposure of current and future residents and future on-Site commercial/industrial workers that drink contaminated ground water are due exclusively to exposure to arsenic. Cancer risks fall within the EPA acceptable risk range of $1x\ 10^{-4}$ to $1x\ 10^{-6}$, but exceed NMED's target risk level ($1x\ 10^{-5}$). However, risks associated with arsenic are similar to background risk and are unlikely to be related to mining activities. Water in the bedrock aquifer is too deep to be reached by typical construction/excavation activities, and risks to construction workers were not addressed by the Selected Remedy.

Health hazards exceeded EPA's target HI threshold of 1 at some locations. HIs for exposure to COPCs in ground water range from 0.001 to 15 for future residents and 0.0002 to 3 for on-Site commercial/industrial workers, depending on the target organ. The HI estimates are due primarily to exposure to molybdenum (gastrointestinal tract, liver, and kidney). Molybdenum concentrations in some wells are statistically greater than background and the median exposure point concentration is greater than the preliminary remediation goal of 0.05 mg/L

7.1.5.3.4 <u>Fish</u>

The HHRA considered only resident brown trout, since they spend their entire life in the Red River. The risk assessment assumed that anglers would take a relatively large number of brown trout from the river during the course of each year. Since the river is small, the number of fish assumed to be caught and eaten could exceed the ability of the brown trout population to reproduce and grow. Thus, risk estimates for fishermen associated with fish consumption are likely to be conservative. Based on RME, cancer risks for anglers ingesting brown trout are below EPA's acceptable risk range and HIs are below the threshold of 1.

Stocked rainbow trout are typically in the river and Eagle Rock Lake a very short time before being caught by fishermen. These fish were not quantitatively assessed in the risk assessment. Nevertheless, stocked rainbow trout were collected and analyzed during the study to help address any health concerns the community might have with eating these fish. The results of analyses of rainbow trout showed that concentrations of all metals except arsenic were below levels that could present a health risk. Further analysis of arsenic in rainbow trout tissue indicated that it was present in organic forms that have low toxicity and, therefore, posed little or no human health threat. The source of the organic arsenic was determined to be the fish feed used at the state fish hatchery. The New Mexico Department of Game and Fish took immediate steps to ensure that feed used at its hatcheries has the lowest possible amount of arsenic to assure the public safety.

7.1.5.3.5 Tailing Pond Sediment

Recreational users were assumed to be exposed to contaminants in sediment via incidental ingestion and dermal contact while wading. Children 7 to 16 years of age were evaluated for these exposure pathways.

Cancer risks for recreational visitors, due entirely from possible exposure to arsenic, for both the mine site and tailing facility, are within or below EPA's acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$ for sediment. Non-cancer health hazards are above the EPA target threshold of 1 for sediment at the tailing ponds. The HI for exposure at the tailing ponds is 2, which is due mostly to exposure to molybdenum. A summary of carcinogenic risks and non-carcinogenic hazards for recreational visitors is presented in Table 7-9.

7.1.5.3.6 Surface Water in Mine Site Catchments and Seeps/Springs at Waste Rock Piles and along Red River

Recreational users were assumed to be exposed to contaminants in surface water via incidental ingestion and dermal contact while playing in surface water bodies at or near the Site. Children 7 to 16 years of age were evaluated for these exposure pathways.

Cancer risks, due entirely from possible exposure to arsenic and based on RME for a recreational user (child between 7-16 years of age), are within or below EPA's acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$ and NMED's target risk level of $1x10^{-5}$ for all surface water exposure areas. Total cancer risks are estimated for catchment basins ($8x10^{-7}$), catchment basin seepage ($1x10^{-5}$), seeps and springs associated with waste rock piles ($7x10^{-6}$), and seeps and springs adjacent to the Red River ($2x10^{-6}$).

Hazard Index estimates for mine site catchment basins, catchment basin seepage, and seeps and springs associated with waste rock piles and adjacent to the Red River are above the threshold of 1. An HI of 3 for the central nervous system was calculated for recurring visits to the catchment basins and is due to potential exposure to manganese. A higher HI for catchment basin seepage (48) was estimated for the central nervous system due to exposure to manganese, and high HIs were also estimated for the gastrointestinal system (3), and kidney (2) for exposure to cadmium and beryllium. A total HI for seeps and springs associated with rock piles was estimated to be 51. HI estimates by target organ were 45 for the central nervous system due mainly to exposure to manganese, 2 for the kidney (cadmium and beryllium) and 3 for the gastrointestinal system (cadmium and beryllium). Finally, a total HI for recurring exposure to seeps and springs adjacent to the Red River is 2; however, no HI based on individual target organs exceeded unity.

A summary of carcinogenic risks and non-carcinogenic hazards for recreational visitors is presented in Table 7-9.

7.1.6 Health-Based Protective Levels

Health-based protective levels were developed in the HHRA for COPCs and exposure scenarios found to pose actual or potential threats to human health. COPCs that pose possible health threats were carried into the FS as initial COCs. A list of all COCs and their associated protective levels for soil, sediment, surface water and ground water are presented on tables 7-10, 7-11, and 7-12. These health-based protective levels allow the information from the HHRA to be used in the FS to set quantitative targets (*i.e.,* preliminary remediation goals) for cleanup activities. Final remediation goals are discussed in Section 8, Remedial Action Objectives of this ROD.

A summary of risk for all COCs in soil, sediment, surface water and ground water are presented on tables 7-13, 7-14, and 7-15.

7.1.7 Uncertainties

As in any risk assessment, estimates of potential health threats (cancer risks and non-cancer health effects) have numerous associated uncertainties. Uncertainties are inherent in the risk assessment process because of the numerous assumptions that are made in estimating exposure, toxicity, and potential risk. Conservative assumptions are made at every step of the process in the HHRA so as not to underestimate potential risk. As a result, the risk assessment should not be construed as presenting absolute risks or hazards. Rather, it is a conservative analysis intended to support risk management and site clean-up that will ultimately protect human health.

In general, important areas of uncertainty include the following:

- Environmental data (*e.g.,* data usability, identification of COPCs, estimation of exposure point concentrations)

- Exposure assessment (*e.g.,* future land use, exposure pathways, exposure assumptions)
- Toxicological data
- Risk characterization

7.1.7.1 Environmental Data

Chemical concentrations in environmental media (soil, ground water, etc.) can never be known with absolute certainty. Confidence in characterization of site contamination is increased when appropriate numbers of samples were taken from appropriate locations. For the mine site, a large number of both random and biased soil samples were collected from all EAs. Biased samples were focused on areas where mine-related contamination was known and/or suspected. The combination of random and biased soil sampling increases confidence in site characterization since it provides coverage of the site as a whole and allows better resolution of possible “hot spots”. Available data are unlikely to have failed to locate large areas of the mine site or tailing facility with significantly elevated COPC concentrations.

Some areas of the Site were, however, not fully characterized, notably the open pit. The sides of these features are too steep and unstable to safely sample. Thus, data from the pit are insufficient to characterize COPC concentrations. Because of the steep, unstable slopes, people are very unlikely to frequent the pit slopes, and this lack of characterization is unlikely to have affected estimates for human health risk.

Ground water data used in the HHRA were collected over a relatively short period of time. These data represented current ground water quality for areas where wells are located, and reasonably represent the range of health risks along the Red River. However, prediction of future concentrations, especially over the long time periods that the mine may continue to operate (decades) is not possible. Health risks may thus be either under- or overestimated for the long term.

Air quality data collected at the tailing facility as part of the RI were not used in the HHRA. Rather, possible air concentrations were calculated from soil concentrations using a generic particle emission factor. Risk estimates based on these calculated air concentrations were uniformly low and below levels of regulatory concern. This approach is subject to considerable uncertainty - wind speeds and direction, dust sources other than the contaminated source, distance to receptors, seasonal variations in winds and temperatures, etc. will all affect possible air concentrations.

However, some data were collected outside of the remedial investigation by CMI as part of monitoring for dust releases from the tailing facility. These data also suggest that concentrations of COPCs in dust are typically low. For the tailing facility, the low exposure point concentrations for COPCs in air seem appropriate.

7.1.7.2 Exposure Assessment

Exposure assumptions (*e.g.,* ingestion rate, exposure frequency) are generally a large source of uncertainty. Exposure parameters are selected using a combination of available guidance and professional judgment. Both sources of information include considerable uncertainty. Exposure assumptions that are used in the HHRA are generally conservative and are chosen to assure that human health is adequately protected. For example, assumptions made for exposure time, frequency, and duration of potential chemical exposures, as well as for the quantity of material ingested, inhaled, or absorbed are all on the high end of those possible; their combination in calculations of exposure is expected to provide an estimate of exposure well above the average. In general, assumptions were made based on reasonable maximum exposure, and in most cases, values were based on general EPA guidance documents. Reasonable maximum exposure is expected to fall within the high range of possible exposure and exposures estimated in this risk assessment are expected to have met that goal.

7.1.7.3 Toxicity Assessment

A potentially large source of uncertainty is inherent in the derivation of toxicity criteria (*i.e.,* RfDs, and cancer slope factors). In many cases, data must be extrapolated from animals to sensitive humans by the application of uncertainty factors to an estimated no-observed-adverse-effect-level or lowest-observed adverse effects level for non-cancerous effects. Use of the EPA toxicity criteria could either overestimate or underestimate potential risks, but it is difficult to determine either the direction or magnitude of any errors. In general, however, it is likely that the criteria err on the side of protectiveness for most chemicals, including those chemicals identified as COPCs in the HHRA.

7.1.7.4 Risk Characterization

Cancer risks and non-cancer hazards were not estimated for some potentially exposed receptors. Instead these receptors were evaluated qualitatively by comparing risks and hazards with estimates for other receptors expected to receive equal or greater exposure. For example, the recreational scenario evaluation was used as a surrogate for a current trespasser scenario.

The risk assessment evaluates a hypothetical exposure scenario in which future residents are assumed to install private wells on and/or near the Site and to use ground water as a source of drinking water. Risks and hazards were evaluated on a well-by well-basis.

Cancer risks and non-cancer health hazards may exceed acceptable levels at the mine site and the tailing facility due to exposure to COCs, which are common constituents in soil and water. A background analysis was performed to determine if calculated risks and hazards were associated with releases from Molycorp operations at the mine site. This background analysis was used to help determine COCs for this ROD.

In summary, although uncertainties are associated with each step of the HHRA, conservative assumptions were made at every step of the process in the HHRA so as not to underestimate potential risk. An extensive database was available to support identification of exposure units and calculation of representative exposure point concentrations for media of concern. Current and future land uses were determined based on available data and exposure for potential receptors evaluated for potentially complete exposure pathways.

7.2 Summary of Ecological Risk Assessment

The first phase of the ecological risk assessment was to perform a screening-level ecological risk assessment to determine if further investigation was warranted. The screening-level ecological risk assessment was performed informally using an approach agreed upon by EPA, the State of New Mexico, CMI, and other key stakeholders and indicated a clear potential for ecological receptors (plants and animals) to be adversely affected by exposure to one or more environmental media (soil, water, sediment) at the Site. The screening-level ecological risk assessment also indicated the need to perform the baseline ecological risk assessment (BERA) to quantify the estimations of ecological risk and provide information to help EPA establish remedial priorities. The BERA was performed as the second phase of this risk assessment process and serves as a scientific basis for CERCLA response actions for the Site.

The Problem Formulation was conducted at the initial stage of the BERA and established the goals and described the scope and focus of the assessment. The Problem Formulation also considered Site-specific regulatory and policy issues and requirements, and identified potential stressors (*e.g.,* COPCs) and ecological resources potentially at risk. An important outcome of the Problem Formulation was the Site Conceptual Exposure Models (SCEMs) for the mine site and tailing facility (Figures 5-3 and 5-4). A refinement of the initial list of COPCs was performed using a three-tiered approach, with each successive tier refining the screening input parameters and reducing uncertainty in the screening process. A detailed discussion of this multiple-tiered screening process is presented in the Risk Assessment Memorandum: Selection of Chemicals of Potential Concern, Molycorp Mine, Questa, New Mexico, May 2005 (Appendix D-1 of the BERA).

The BERA focused on the potential ecological effects associated with chemical contamination, primarily Site-related contaminants evaluated in the BERA included those found in surface water, sediment, and surface soils at and adjacent to the mine site and tailing facility, and within the Red River and riparian corridor, including Eagle Rock Lake and Hunt's Pond. The BERA also assessed potential ecological effects from ground water to surface water interactions at zones of ground water upwelling to the Red River.

Extensive Site-specific data were collected and used, wherever practicable, to estimate risk and develop quantitative cleanup levels protective of ecological receptors. The Site-specific information included plant and animal tissue data; aquatic and terrestrial toxicity test data; bioaccumulation factors; population- or community-level studies for fish, benthic macroinvertebrates, terrestrial plants, and small mammals; and aquatic and riparian habitat quality evaluations.

The BERA also included extensive data collection in reference areas unaffected by Site contamination to ascertain local background conditions or concentrations for comparative purposes to Site data. This effort included the collection of chemistry and biological data from (1) the headwaters of the Red River near the town of Red River to just upstream of the mine site, and (2) Cabresto Creek. These data provided EPA with environmental data over areas unimpacted by mining activities. Media quality and biological data were also collected from upper Fawn Lake, as a reference area for Eagle Rock Lake and Hunt's Pond.

7.2.1 Identification of Chemicals of Concern

Ecological COCs are those chemical stressors identified in the BERA which may cause adverse effects to ecological receptors and, therefore, warrant response action under CERCLA. The ecological COCs are a subset of the COPCs evaluated in the BERA. They were identified after completion of the four major phases of the BERA: (1) identification of COPCs, (2) exposure assessment, (3) ecological effects assessment, and (4) ecological risk characterization. Following the completion of the BERA, those COPCs that were considered to pose a threat to ecological receptors were carried forward into the FS as initial COCs. During the FS, further screening of COCs was performed based on an assessment of ecological significance by EPA (see Section 3 of the FS Report) as well as additional Site-specific toxicity testing on molybdenum. Following completion of the FS, a re-evaluation of risk to wildlife at the tailing facility was also performed based on refined exposure assumptions. Based on this work, COCs associated with mining-related activity that may cause adverse effects to ecological receptors were identified. These COCs, and the COC concentrations expected to provide adequate protection to those ecological receptors at risk (*i.e.,* protective levels), are discussed at the end of this summary.

7.2.1.1 Chemicals of Potential Concern

The primary ecological COPCs identified for evaluation in the BERA were toxic metals potentially associated with plant uptake, direct contact, and ingestion exposures (*e.g.,* molybdenum) as well as metals with the potential to bioaccumulate and contribute to food web effects (cadmium, chromium, copper, lead, mercury, nickel, and zinc). Bioaccumulative metals were considered in the BERA for assessing risks to upper trophic level receptors. Other Site-related COPCs include a small number of organic chemicals. A list of all the ecological COPCs for the entire Site is presented on Table 7-16, below.

All the inorganic COPCs are quantitatively assessed in the BERA, while the organic COPCs are not subjected to quantitative analyses because (1) organic COPCs were infrequently detected in all media, especially surface water; and (2) organic COPCs detected in soil were detected primarily in very localized areas. Ecological receptors were considered extremely unlikely to be significantly exposed to organic COPCs at this Site. It is noted that the Mill Area, which contains Aroclor 1248 and Aroclor 1254 (PCBs) in soil, is not evaluated for ecological risk because it is an area of active milling operations and therefore has little or no suitable habitat for terrestrial receptors.

**TABLE 7-16:
SUMMARY OF ECOLOGICAL SITE-WIDE CHEMICALS
OF POTENTIAL CONCERN**

Inorganic COPCs	Organic COPCs
Aluminum	2,6-Dinitrotoluene *
Antimony	Aroclor 1248
Arsenic	Aroclor 1254
Barium	Carbazole
Beryllium	Diesel Fuel No.2
Boron	Gasoline
Cadmium	Phenanthrene
Chromium, total	
Chromium, hexavalent	
Cobalt	
Copper	
Iron	
Lead	
Manganese	
Mercury	
Molybdenum	
Nickel	
Selenium	
Silver	
Thallium	
Vanadium	
Zinc	

Notes:
COPCs – chemicals of potential concern
* – Retained even though frequency of detection was less than 5 percent.
pH is evaluated qualitatively for surface water and mine site soils

Tables 7-17 through 7-25 present the COPCs identified for each medium and exposure area (EA), along with the exposure point concentration, the toxicity reference value, and the calculated HQs for each COPC. The exposure point concentrations, toxicity reference values, and HQs are discussed in further detail in the following sections of this BERA summary. Those COPCs having HQs exceeding EPA’s threshold value of 1 and concentrations that are significantly higher that reference background concentrations are identified as initial COCs.

7.2.2 Exposure Assessment

In the exposure assessment phase of the BERA, the available exposure data, including the exposure media, EA, and exposure point concentration of each COPC, was assessed for selected representative ecological receptors. The selected ecological receptors were identified through an evaluation of the terrestrial and aquatic ecology at the Site. A site conceptual exposure model was developed to determine which exposure pathways are complete and significant and which key species are or could be exposed to Site-related contamination.

7.2.2.1 Terrestrial Ecology

7.2.2.1.1 Mine Site

The mine site, like most mountainous areas, exhibit changes in vegetation zones with elevation, in this case from low elevation grasses and shrub, through mid-elevation woodlands and forest, to high elevation conifer forests and alpine tundra.

7.2.2.1.1.1 Upland Vegetation

The natural upland vegetation of the mine site and its reference area consists largely of conifer woodlands and forest on moderate to steep mountain slopes. Habitats on the forested portions of the mine site range include pinyon-juniper woodlands, lower montane forests, and upper montane forests. All three of these vegetation types tend to have sparse herbaceous vegetation. Shrub cover varies from almost none to abundant. Tree canopy cover is mostly sparse (less than 30 percent) to moderate (30 to 60 percent) at subalpine and some upper montane sites, and pinyon-juniper woodlands.

7.2.2.1.1.2 Riparian Vegetation

Riparian habitat is extremely limited on the mine site and exists primarily along the banks of the Red River and in drainage bottoms. The riparian habitat occurs along the Red River in a strip ranging from less than 100 feet to about 600 feet wide, and along Cabresto Creek, where the riparian habitat has a similar range of widths. The riparian zone includes the river edge and lower alluvial terraces. Riparian habitat is highly variable in structure, and includes riparian forest (both deciduous woodland and conifer forest); montane riparian shrub mixed with meadows; dry, mesic, and wet meadows; gravel bars; and disturbed and other sparsely vegetated areas. Due to the variable habitat and range of moisture conditions, a large number of plant species occur.

7.2.2.1.1.3 Wildlife

Animals associated with mixed conifer forest ecosystems include mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), coyote (*Canis latrans*), cottontail rabbit (*Sylvilagus nuttallii*), red squirrel (*Tamiasciurus*), wood rat (*Neotomoa* sp.) , golden-mantled ground squirrel (*Spermophilus lateralis*), and various species of mice and voles. Also found are the mountain lion (*Felis concolor*), black bear (*Ursus americanus*), porcupine (*Erethizon dorsatum*), red fox (*Vulpes vulpes*), and numerous bats.

Some of the birds found in the mixed conifer forest include mountain chickadee (*Poecile gambeli*), western tanager (*Piranga ludoviciana*), and dark-eyed junco (*Junco hyemalis*). Major avian predators include red-tailed hawk (*Buteo jamaicensis*), owls, and eagles.

Based on sampling of terrestrial animals during the RI, the most widespread small mammal found in the area is the deer mouse (*Peromyscus maniculatus*). Reptiles that may be found in the area include collard lizard (*Crotaphytus collaris*), northern fence lizard (*Sceloporus undulatus*), bullsnake (*Pituophis catenifer sayi*), and prairie rattlesnake (*Crotalus viridis viridis*). Amphibians may be found in the riparian area along the mine site. They are discussed under Aquatic Ecology, Section 7.2.2.1, below.

7.2.2.1.2 Tailing Facility

The tailing facility and its reference areas are located within the Arizona/New Mexico Plateau eco-region (USEPA 2003) and are part of the Upper Rio Grande Valley. The Arizona/New Mexico Plateau eco-region consists primarily of dry shrublands and pinyon-juniper woodlands. According to Dick-Peddie (1993), the natural vegetation of the area from the Rio Grande Valley to the foothills of the Sangre de Cristo Mountains is desert grassland. This is a transitional type between Great Basin desert scrub and plains-mesa grassland. Sagebrush has expanded greatly in the past 125 years and now dominates much of the former desert grassland in this area.

7.2.2.1.2.1 Upland Vegetation

The natural vegetation includes desert grassland and sagebrush shrublands on areas of gentle topography and finer-textured soil, and pinyon-juniper woodland on steeper slopes and rocky coarse-textured soil.

The original vegetation of the tailing facility was destroyed or disturbed during construction and operation of the facility. The current vegetation is the result of several interim reclamation efforts using shallow alluvial soil cover, natural succession, and survival of original vegetation in some areas. It consists of primarily grassland and open shrubland dominated by species such as rubber rabbitbrush (*Ericameria nauseosa*) and perennial grasses.

CMI monitors vegetative cover performance on interim reclamation covers on an annual basis. Total perennial plant cover averaged 17.4 percent during drought conditions in fall 2002 and 29.8 percent during non-drought conditions in 2008. Some areas within the vegetated portions of the tailing facility have very sparse cover due to recent reclamation or other conditions.

7.2.2.1.2.2 Riparian Vegetation

Riparian habitats for the tailing facility are similar to riparian habitats for the mine site, but have some differences due to lower elevation and land use. Riparian habitats include montane riparian shrub/meadow mix, montane riparian forest, gravel bars, mesic and wet meadows used for agriculture, and dry meadows and foothills shrub in the Red River Canyon.

7.2.2.1.2.3 Wildlife

Mammals associated with the tailing facility sagebrush ecosystems include mule deer, Rocky Mountain elk, coyotes, and jackrabbits (*Lepus* spp.), as well as pocket gophers (*Geomys* spp.) and various other rodent species. Mammals associated with the pinyon-juniper woodlands include mule deer, coyote, bobcat (*Felis rufus*), and elk, as well as wood rats, chipmunks (*Tamius* spp.), jackrabbit, porcupine, and gray fox (*Urocyon cinereoargenteus*).

In 2003, the presence of mule deer, elk, and gopher along with those of horses and cattle were evident at the tailing facility. The area also did not appear to have been overused by wildlife. In the spring and fall of 2003, there was a small herd of cattle using the Cater Ranch area. The range of this area appeared to be in poor to fair range condition. Gopher signs were less apparent than at the tailing facility; however, abandoned prairie dog burrows were evident at some of the sites. A few live prairie dogs were also observed (URS 2004).

The most common birds in sagebrush/grassland habitat include Brewer's sparrow (*Spizella brewerii*), vesper sparrow (*Pooecetes gramineus*), and sage sparrow (*Amphispiza belli*). Birds most commonly found in the pinyon-juniper woodlands include the titmouse (*Baeolophus* sp.), black-throated gray warbler (*Dendroica nigrescens*), and mountain chickadee.

7.2.2.1.2.4 Cater Ranch – Reference Background Area

Cater Ranch, a property owned by CMI north of the tailing facility, is considered a reference background area for the Site. This area includes habitats containing sagebrush, rabbitbrush, meadow, and blue gramma plant species. The eastern portion of Cater Ranch is dominated by big sagebrush, which is thought to be the climax vegetation for the area. Cater Ranch, for the most part, consists of either rabbitbrush or a mixture of rabbitbrush and "barrens" that have minimal live vegetation in late May/early June. After summer rains, these barrens are covered in low-growing forbs and grasses, such as garden purslane, false buffalo grass, Russian thistle, and thyme-leaf spurge. Some of the middle areas of Cater Ranch contain blue gramma and sand dropseed. The western portion of Cater Ranch consists of rabbitbrush that appear to be in contact with ground water. Other common species include alkali sacation and Baltic rush in some areas, and western wheatgrass.

7.2.2.2 Aquatic Ecology

Habitat and aquatic and aquatic-dependent receptors were evaluated for the Red River, Eagle Rock Lake, upper Fawn Lake, and the tailing impoundments.

7.2.2.2.1 <u>Characteristics of Red River Reaches</u>

The aquatic biota characteristic of the Red River is discussed for the following four general reaches: (1) the upper reaches (above the town of Red River), (2) from the town of Red River to the upstream boundary of the mine site, (3) from the upstream mine site boundary to Cabresto Creek, and (4) downstream of Cabresto Creek to the Rio Grande.

The upper reaches of the Red River, from its headwaters to just upstream of the town of Red River, are in an area of residential development in the form of vacation homes and commercial lodges.

The reach from the town of Red River to the upstream (east) mine boundary includes town development and tributary drainages containing historical mining operations and natural hydrothermal scars. The scar-impacted drainages contribute acidic flows and sediment to the river during rainstorm events.

The reach from the upstream boundary of the mine site to Cabresto Creek includes the mine site reach. It is impacted by acidic, metals-laden ground water associated with mining-related activities, hydrothermal scars, and debris fans which have aggraded into the Red River. The contaminated ground water flows to the river at zones of upwelling. Another source of adverse impacts to ground water and, subsequently, surface water at zones of ground water upwelling, may include the highly mineralized zones associated with the molybdenum ore body.

The lower reach of the Red River changes from a wide river valley through Questa to a narrow canyon (Red River Gorge) from the Red River State Fish Hatchery to the Rio Grande. This reach flows past the tailing facility and is impacted by its operations.

7.2.2.2.2 Aquatic Habitat

The aquatic habitats of the Site are mostly those associated with the Red River. Aquatic habitat is dominated by riffle habitat throughout the river, with run habitat also present. Pool habitat is more abundant in the upper reaches of the river and downstream of the tailing facility in the canyon (Red River Gorge). Pool habitat is limited or lacking in the reach from the town of Red River to the upstream (east) mine boundary and in places along the mine site and in Questa.

In the upper reach of the river, the substrate exhibits little accumulation of sediment with low embeddedness. However, the amount of fine-grained sediment and degree of embeddedness increase to high levels through the area of scar-impacted tributary drainages between the town of Red River and the mine site. These characteristics decrease slightly along the mine site reach and further still going downstream. Along Questa and the tailing facility reach, embeddedness and sediment deposition are generally high, but then decrease toward the Rio Grande.

7.2.2.2.3 <u>Aquatic and Aquatic-Dependent Receptors</u>

Aquatic receptors for the Site are, for the most part, associated with the Red River. However, they also occur in and around Eagle Rock Lake, upper Fawn Lake, Cabresto Creek, Hunt’s Pond, and the tailing ponds. Aquatic or aquatic-dependent receptors occurring in or using these waters may include fish, aquatic benthic invertebrates, water column aquatic invertebrates, amphibians, fish-eating birds, fish-eating mammals, aquatic insect-eating birds, and aquatic insect-eating mammals.

7.2.2.2.3.1 Fish Assemblages

The fish community in the vicinity of the Site is not diverse. The most abundant resident species is the non-native brown trout (*Salmo trutta*). Second most abundant is the stocked, hatchery-raised rainbow trout (*Oncorhynchus mykiss*). Relatively few white suckers (*Catostomus commersoni*) are also found within the study area, primarily in upper Fawn Lake and Eagle Rock Lake. A few brook trout (*Salvelinus fontinalis*) have been found in Cabresto Creek and within the upper reaches of the Red River, and are dominant in the furthest upstream locations of tributaries to the Red River. Some Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*) have been identified upstream of the town of Red River. Cutthroat/rainbow hybrid trout have also been identified upstream of the town of Red River and are abundant in Cabresto Creek.

A summary of the fish assemblage in the Red River is as follows:

- **Brook trout** – Brook trout are present in the upper reaches from the headwaters to the upstream (east) boundary of the mine site. The brook trout have self-sustaining populations upstream of the town of Red River, but they are only occasionally collected along the scar-impacted drainages and do not appear to have self-sustaining populations in this reach. Along the mine site reach and further downstream they have not been observed.

- **Brown trout** – Brown trout are present throughout the Red River and maintain self-sustaining populations.

- **Rainbow trout** – Rainbow trout are present throughout the Red River, but they do not maintain self-sustaining populations. They are stocked by the New Mexico Department of Game and Fish. Long-term sampling indicates that stocked rainbow trout do not persist in the Red River as fish collected are recently stocked. These fish are either removed by angling, do not survive from one fall to the next, or move downstream out of the Red River.

- **Rio Grande cutthroat trout** – Rio Grande cutthroat trout are the only native salmonid in the Red River drainage. They have been collected occasionally in the upper reach of the river (headwaters) and rarely along the scar-impacted drainages and the mine site. They do not maintain self-sustaining populations in the mainstem of the Red River, but likely represent stray individuals that have moved out of small tributaries high in the drainage.

- **Rainbow trout – cutthroat trout hybrid** – Rainbow trout-cutthroat trout hybrids have been collected upstream of the mine site reach and rarely in the lower reach of the Red River. They have not been found along the mine site. They have self-sustaining populations in the upper reaches at the headwaters only. They do not maintain self-sustaining populations in the other reaches where they are present.

- **White sucker** – White suckers are found infrequently along the scar-impacted drainages and the mine site reach of the river, but they are uncommon.

Eagle Rock Lake and upper Fawn Lake fish assemblages both include stocked rainbow trout and white suckers. Brown trout are also found in upper Fawn Lake. No fish were collected from Hunt's Pond. The tailing ponds are operational ponds that were never intended for aquatic habit and there are no fish present.

7.2.2.2.3.2 Benthic Macroinvertebrate and Periphyton Assemblages

Benthic macroinvertebrates were collected in the fall from 1997 to 2004 and in the spring from 2000 to 2005 from a variety of sampling stations throughout the study area. These samples were used to determine benthic macroinvertebrate community structure using a specific set of abundance and diversity metrics. The composition of the benthic macroinvertebrate assemblage in the Red River includes insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Coleoptera (beetles), Trichoptera (caddisflies), and Diptera (flies, including mosquitoes).

Populations of benthic macroinvertebrates are also present in Eagle Rock Lake and upper Fawn Lake. Additionally, benthic macroinvertebrate species have populated the tailing ponds, some of which have been operationally inactive with standing water in place for many years.

The periphyton (attached benthic algae) population is dominated by diatoms and to some extent blue green algae.

7.2.2.2.3.3 Aquatic-Dependent Birds

Fish-eating birds such as herons and merganser occur in the Site area. Birds dependent on aquatic insects such as blackbirds, American dipper, and flycatchers also are present. The southwestern willow flycatcher (*Empidonax traillii extimus*), an endangered species, frequents riparian habitat where dense groves of willow, alder, and other species are present. This species has been documented in the Taos area. This bird requires surface water nearby for nesting and abundant aquatic insects for food. Surveys have not been conducted for the southwestern willow flycatcher along the Red River. However, there appears to be suitable habitat for this species between Eagle Rock Lake and the Red River State Fish Hatchery.

7.2.2.2.3.4 Other Aquatic-Dependent Receptors

Amphibians in the vicinity of the Site include the western spadefoot (*Spea hammondii*), northern leopard frog (*Rana pipiens* sp.), and tiger salamander (*Ambystoma tigrinum*). Other aquatic-dependent receptors include mink and insect-eating bats.

7.2.2.2.4 Federal and New Mexico State Endangered Species

For Taos County, New Mexico, there are three Federally-listed endangered species—southwestern willow flycatcher, whooping crane (*Grus Americana*), and black-footed ferret (*Mustela nigripes*). There are also three State-listed endangered species—southwestern willow flycatcher, whooping crane, and white-tailed ptarmigan (*Lagopus leucurus altipetens*). For the southwestern willow flycatcher, certain habitats have been listed as designated critical habitats. Most documented sightings of this flycatcher have occurred south of Taos. The Site is located approximately 30 miles north of Taos. None of these endangered species were observed during field activities.

7.2.2.2.5 Federal and New Mexico State Threatened Species

For Taos County, New Mexico, there are two Federally-listed threatened species (Mexican spotted owl [*Strix occidentalis lucida*] and bald eagle [*Haliaeetus leucocephalus alascanus*]). For the Mexican spotted owl, certain habitats have been listed as designated critical habitats. The Mexican spotted owl may also be present in the canyons surrounding the mine site. New Mexico provides habitat for bald eagle wintering and migration; no nesting has been identified in the vicinity of the Site. The nearest documented winter roost is nearly 25 miles from Questa, New Mexico. There are also nine State-listed threatened species—American peregrine falcon (*Falco peregrinus anatum*), Baird's sparrow

(*Ammodramus bairdii*), bald eagle, boreal owl (*Aegolius funereus*), gray vireo (Vireo vicinior), white-eared hummingbird (*Hylocharis leucotis borealis*), American marten (*Martes americana origenes*), New Mexican meadow jumping mouse (*Zapus hudsonius luteus*), and the Sangre de Cristo peaclam (*Pisidium sanquinichristi*). The peregrine falcon migrates seasonally through the area, and historically nested in the Upper Rio Grande area; however, no reported sightings have occurred in recent years. None of these threatened species were observed during field activities.

7.2.2.2.6 Federal and New Mexico State Species of Special Concern

For Taos County, New Mexico, there are 15 Federal Special Concern species, 1 Federal Candidate Species, 33 USFS Sensitive species, 23 New Mexico Sensitive, and 18 Bureau of Land Management Sensitive species.

7.2.2.2.7 Food Web Model Receptors

Food web modeling was used to assess risks to upper trophic level birds and mammals from exposure via ingestion of food items (*i.e.,* plants and animals). The aquatic receptors selected for food web modeling included American mink, belted kingfisher, marsh wren, northern raccoon, and osprey. The terrestrial receptors selected for food web modeling included the American robin, deermouse, eastern cottontail, northern short-tailed shrew, and red-tailed hawk.

7.2.2.3 Exposure Media

The exposure media included surface soil, sediment, surface water, and biota. Ecological receptors may be exposed to the abiotic media via direct contact or ingestion. Biota was considered an exposure medium for ecological receptors that consume contaminated food items (*e.g.,* vegetation and prey).

7.2.2.3.1 Surface Water

Several types and sources of surface water were assessed in the BERA. These include Red River surface water under low-flow conditions, high-flow conditions (storm events), and snowmelt conditions. Surface water was also assessed from specific water bodies, including Eagle Rock Lake, upper Fawn Lake, tailing ponds, Hunt's Pond, catchment basins that routinely hold storm water runoff or waste rock seepage at the mine site, and seeps and springs.

Some unique surface water samples were taken for specific purposes. Red River surface water samples were collected under storm and snowmelt conditions for toxicity testing with *C. dubia*. Spring 13 and Spring 39 water (undiluted) was taken for toxicity testing (serial dilution) with early life stage rainbow trout. Surface water was also collected from chambers (water column and against sediment chambers) as part of the GSI Study.

7.2.2.3.2 Sediment

Aquatic sediment from the Red River, Cabresto Creek, Eagle Rock Lake, upper Fawn Lake, Hunt's Pond, and the tailing ponds were assessed in the BERA. Sediment was also sampled from specific locations and used to conduct sediment toxicity tests with midge larvae and amphipods.

7.2.2.3.3 Surface Soil

Surface soil from the mine site, tailing facility, and riparian soil was assessed in the BERA. Soil samples collected at the mine site include surface soil from the waste rock piles, which commonly were acidic (low pH). Surface soils from the mine site (excluding the waste rock piles) were used for rye grass and earthworm bioassay toxicity testing. Surface soil samples collected from the tailing facility include a mixture of native soil, mine tailing, and alluvial soil used as interim cover for tailing. The amount of tailing in each soil sample was not quantified. Tailing samples were also collected from the tailing facility.

7.2.2.3.4 Biota

Biota assessed in the BERA include whole body fish (primarily resident brown trout), benthic macroinvertebrates (multiple taxa combined), terrestrial plants (above and below ground tissues, both washed and unwashed), terrestrial invertebrates, and small mammals (whole body individuals from multiple taxa).

7.2.2.4 Ecological Exposure Areas

The ecological EAs evaluated for the Site are provided in Table 7-26. The EAs are depicted on Figure 5-71 (soil and other areas) and Figure 100 (surface water and sediment). Table 7-27 specifically addresses the ecological exposure pathways for the mine site, while Table 7-28 specifically addresses the ecological exposure pathways for the tailing facility and the area south of the tailing facility. In addition, a number of reference background EAs were designated for surface water and sediment (*i.e.,* Zwergle to the Bitter Creek drainage [in the town of Red River; EA 1]), Bitter Creek to the mine Site (EA 2), Upper Cabresto Creek Reference, Lower Cabresto Creek Reference, Seeps and Springs, and upper Fawn Lake [UFL]) and soil (riparian and non-riparian soil for the mine site and riparian soil reference EA and tailing facility soil for the tailing facility-associated areas). COPC concentrations were quantitatively evaluated in each of the ecological EAs identified below.

7.2.2.5 Exposure Point Concentrations

Exposure point concentrations represent the concentrations to which receptors may be exposed. Exposure point concentrations serve as input into risk calculations, and are derived for all media-specific COPCs for the BERA. These include exposure point concentrations for both abiotic media (*e.g.,* surface water, sediment, soil) and biotic tissue (*e.g.,* fish tissue). With few exceptions, exposure point concentrations for abiotic and biotic media in each EA were calculated as the 95% UCL of the arithmetic mean concentration. The few exceptions include some locations (EAs) where specific surface water COPCs were not detected. In these cases, the full reporting limit, based on total recoverable data, is used to represent the surface water concentration for input into the food web models. Exposure point concentrations for each exposure area were statistically compared to reference background exposure point concentrations to assess whether such concentrations were associated with Site-related releases. Exposure point concentrations calculated for the COPC in each medium are presented in the HQ tables (Tables 7-17 through 7-25).

7.2.2.6 Exposure Analysis

To characterize exposure, available exposure data were analyzed to describe the source, the distribution of the stressor in the environment, and the contact or co-occurrence of the stressor with the ecological receptors. Exposures to plants, invertebrates, and fish were estimated from COPC concentrations in environmental media as well as through the measurement of COPC concentrations directly in Site invertebrates, plants, and fish and through the application of Site-specific bioaccumulation factors. Exposures to wildlife were estimated by modeling ingested doses of COPCs using oral dose methods developed by EPA (1993).

7.2.2.7 Site Conceptual Exposure Model

Two Site conceptual exposure models were developed for the BERA; one for the mine site, the other for the tailing facility. They visually present key components of ecological exposure pathways potentially resulting from the release and migration of Site-related chemical contamination. The Site conceptual exposure models summarized exposure scenarios and were used to help develop a series of testable null hypotheses for the Site. In addition, the models were used to support the selection of appropriate assessment and measurement endpoints.

The Site conceptual exposure models present the potential exposure pathways for representative ecological receptors exposed to Site-related contaminants. These potential pathways indicate how the ecological resources can co-occur or come in contact with contaminants, and include contaminant sources, fate and transport processes, and exposure routes. The Site conceptual exposure models are depicted on Figures 5-3 and 5-4. On these figures are symbols representing various assumptions about exposure pathways. Solid black dots represent complete and significant exposure pathways that were evaluated quantitatively. Dashed lines represent incomplete exposure pathways that were evaluated. Open circles represent exposure pathways that were considered in one of the following three ways:

- Insignificant and complete (subject to qualitative evaluation where data allow);
- Insignificant and complete (but not evaluated due to lack of data);
- Potentially complete but insignificant or highly unlikely in most cases.

Based on the completed and significant exposure pathways identified in the SCEM, quantitative risk estimation was reserved for the following ecological receptors:

- Birds and mammals (via food web modeling), and based on consumption of food items linked to soil or sediment exposures, with surface water (drinking) component and incidental soil or sediment ingestion included;
- Terrestrial plants and soil-dwelling invertebrates based on soil exposures (including tailing spills/soils);
- Fish based on surface water exposures;
- Fish based on whole body residues;
- Aquatic benthic invertebrates based on instream sediment exposures.

The Site conceptual exposure model also presents a simplified aquatic and terrestrial food web for the Site, showing the specific receptor groups linked to direct exposures. This food web is depicted on Figure 7-1. In addition, this figure shows (in bold type) the specific upper trophic level taxa selected as receptors for food web modeling as well as the major dietary items for selected upper trophic level receptors. The dietary items presented do not include all potential dietary components for each receptor, but instead consider available Site-specific biological data as well as certain assumptions related to food web modeling. For these reasons the diets of certain receptors, as shown in Figure 7-1, are limited to some degree by data availability. For example, it was assumed that mink consumed only fish, even though other prey items were likely to be consumed. The selection of key receptors and assumptions regarding prey items are discussed in further detail in the BERA.

7.2.3 Ecological Effects Assessment

In the ecological effects assessment phase of the BERA, effects data were analyzed to describe the relationship between the stressor and receptor response, and to evaluate the evidence that exposure to the stressor may cause the response.

7.2.3.1 Toxicity Reference Values

Chemical- and media-specific toxicity reference values were used to assess the potential for adverse effects to occur to each assessment endpoint based on comparison of the toxicity reference value to the estimated exposure (exposure point concentration or daily dose). The toxicity reference values are depicted for each COPC on Tables 7-17 through 7-25. For surface water, hardness-dependent or sulfate-dependent toxicity reference values are also depicted on the tables, as appropriate.

Abiotic media (surface water, sediment, and surface soil) toxicity reference values are based on the potential for adverse effects to occur in lower trophic level receptors (*e.g.,* plants and invertebrates for surface soil; benthic invertebrates for sediment; water column invertebrates and fish for surface water) because of exposure through direct contact and uptake/ingestion. These toxicity reference values do not consider bioaccumulation and food web exposures.

Whole body fish tissue toxicity reference values provided another line of evidence for assessing risks to fish due to exposure to bioaccumulative COPCs. Fish toxicity testing provided an additional line of evidence for assessing the potential for adverse effects to occur in fish.

Wildlife (bird and mammal) toxicity reference values are dietary dose thresholds developed at two effect levels for each chemical; toxicity reference values representing No Observed Adverse Effect Levels (NOAELs) and Lowest Observed Adverse Effect Levels (LOAELs). In instances where only a single toxicity reference value (NOAEL or LOAEL) was available for a chemical, the other toxicity reference value was estimated by applying an adjustment factor. The specific potential for molybdenosis to occur in deer and cattle through vegetation consumption was evaluated by selecting NOAELs and LOAELs based on plant concentrations.

7.2.3.2 Toxicity Testing

Toxicity to aquatic invertebrates was also evaluated using a second line of evidence: the direct measure of toxicity using water column invertebrates (daphnids, a type of crustacean) and sediment toxicity tests with two species, midge larvae and amphipods. Terrestrial toxicity tests using American Standard Test Methods for perennial rye grass and earthworms were also performed to evaluate the potential for adverse effects to plants and soil invertebrates, respectively.

7.2.3.3 Assessment Endpoints

The aquatic based and terrestrial based assessment endpoints for the Site are listed below.

Aquatic-Based (Surface Water and Sediment) Assessment Endpoints

- Protection of water-column and benthic invertebrate receptors from the toxic effects (on survival, growth, and reproduction) of Site-related chemicals present in sediment and surface water.
- Protection of fish from the toxic effects (on survival, growth, and reproduction) of Site-related chemicals present in surface water.
- Protection of insectivorous, piscivorous, and carnivorous avian receptors (*e.g.,* marsh wren, osprey, and belted kingfisher) from the toxic effects (on survival, growth, and reproduction) of Site-related chemicals present in prey, sediment, and surface water.
- Protection of omnivorous and piscivorous mammalian receptors (*e.g.,* raccoon and mink) from the toxic effects (on survival, growth, and reproduction) of Site-related chemicals present in prey, sediment, and surface water.

Terrestrial-Based (Soil) Assessment Endpoints

- Protection of terrestrial plants and invertebrate communities from the toxic effects (on survival, growth, or reproduction) of Site-related chemicals present in soil.
- Protection of amphibians and reptiles from the toxic effects (on survival, growth, or reproduction) of Site-related chemicals present in surface water, sediment, and soil.
- Protection of omnivorous and carnivorous avian receptors (*e.g.,* American robin and red-tailed hawk) from the toxic effects (on survival, growth, or reproduction) of Site-related chemicals present in prey and soil.
- Protection of herbivorous, omnivorous, and insectivorous mammalian receptors (*e.g.,* cottontail, mouse, and shrew) from the toxic effects (on survival, growth, or reproduction) of Site-related chemicals present in food items and soil.

7.2.4 Ecological Risk Characterization

Risk characterization is the final phase of the BERA in which the likelihood of adverse effects occurring to assessment endpoints as a result of exposure to a contaminant is evaluated by combining analyses of exposure and analyses of effects. Calculation of this ratio (exposure point concentration/toxicity reference value) results in a HQ (Tables 7-17 through 7-25). An HQ value of greater than 1 indicates that exposure to a Site COPC may result in toxic effects. HQs are calculated for COPCs in both Site and reference background EAs and a comparison of the two is made to determine whether the potential toxic effects from a contaminant is Site related. Other lines of evidence such as toxicity testing and community analysis are also used to characterize risk. Conclusions regarding the status of each assessment endpoint are summarized below.

7.2.4.1 Water-Column and Benthic Invertebrate Receptors

Levels of contaminants in whole sediments from the Site are present at levels that may result in toxic effects (survival, growth, and reproduction). Data supporting this conclusion include:

- Copper, lead, nickel, and/or molybdenum concentrations exceeded the sediment toxicity reference values in the Red River reaches from upstream of the mine site to the tailing facility (EA 1 through EA 8), Eagle Rock Lake, Upper Fawn Lake, and the tailing ponds. Molybdenum and zinc concentrations exceeded the sediment toxicity reference values in samples collected from Upper Cabresto Creek and Hunt's Pond, respectively.
- Amphipod toxicity test failure observed at sample stations on the lower Red River (LR-16), Cabresto Creek, Zwergle, and near the Hansen Creek scar drainage (RR-5BB). Midge toxicity test failure was observed at sample stations upstream of the mine site (RR-5) and at the Mill Area (RR-7). Daphnid toxicity test failure was

observed at sample stations upstream of the mine (RR-6), along the mine site reach (RR-8), between the mine site and tailing facility (RR-15), and along the tailing facility (LR-1, LR-8A), and downstream of the tailing facility (LR-16).

- Benthic invertebrate community metric values for Zwergle and Cabresto Creek, upstream of the mine were generally higher than other locations.
- Concentrations of several COPCs in Red River sediment along the Site obtained from mini-piezometer locations used in the GSI Study exceed sediment toxicity reference values for benthic invertebrates.

Data that does not support this conclusion is that benthic invertebrate survival in *in-situ* tests at ground water discharge areas along the mine site reach (GSI Study) was not impacted.

7.2.4.2 Fish

Levels of contaminants in surface water from the Site are at levels that may result in toxic effects (survival, growth, and reproduction). Data supporting this conclusion include:

- Exceedance of surface water toxicity reference values by the following COPC in the following areas: aluminum in areas upstream of the mine (EA 2), along the roadside waste rock piles (EA 3), along the middle reach of the mine site (EA 4), between the mine site and tailing facility (EA 6), along the tailing facility (EA 7), and downstream of the tailing facility (EA 8), and multiple COPCs in the seeps and springs adjacent to Red River and Eagle Rock Lake;
- Concentrations of several COPCs in Red River surface water along the Site from mini-piezometer locations exceed trout-based toxicity reference values for surface water;

- Fish biomass is generally highest at Cabresto Creek and Zwergle reference locations, with the lowest values generally found between the mine site and tailing facility (RR-15);
- HQs based on whole body fish toxicity reference values are elevated for copper (multiple riverine reference and non-reference locations), zinc (all riverine locations), and nickel (upper Fawn Lake and Eagle Rock Lake).

7.2.4.3 Terrestrial Plants

Levels of contaminants in soil from the Site are at levels that may result in toxic effects (survival, growth, and reproduction). Data supporting this conclusion include:

- Exceedance of soil toxicity reference values by multiple COPCs in the following areas: roadside waste rock piles (EA 3), central and western waste rock piles (EA 4), riparian corridor along the mine site (EA 5), riparian corridor along the tailing facility (EA 6), area south of the tailing facility (EA 7), and a hot spot area near Outfall 002 (EA 9), as well as Upper Cabresto Creek (EA 5 Reference), Lower Cabresto Creek (EA 6 Reference), and Cater Ranch (Tailing Facility Reference);
- Visual observations of disturbed soil within the waste rock pile areas of the mine site (EA 3 and EA 4).

Inconclusive data were the terrestrial plant community data for the tailing facility and Cater Ranch, where some differences are noted but none clearly attributable to toxicity. Other data which does not support this conclusion was that there were no rye grass toxicity test failures.

7.2.4.4 Terrestrial Invertebrate Communities

Levels of contaminants in soil from the Site are at levels that may result in toxic effects (survival, growth, and reproduction). Data supporting this conclusion include:

- Exceedance of soil toxicity reference values by multiple COPCs in the following areas: EA 3 and EA 4 (mine site waste rock piles), EA 5 and EA 6 (riparian corridor along min site and tailing facility), EA 7 and EA 9 (tailing facility and hot spot near Outfall 002), EA 5 Reference and EA 6 Reference (upper and lower Cabresto Creek riparian areas), and Cater Ranch (tailing facility reference).

The following data were inconclusive:

- There were no earthworm toxicity test failures;
- Most COPC concentrations measured in earthworm tissues are similar for worms exposed to reference and non-reference soil;
- Soil invertebrate community data, since an insufficient number of soil invertebrates were collected to allow confident comparisons between locations.

7.2.4.5 Avian Receptors (insectivorous, piscivorous, omnivorous, and carnivorous birds)

Levels of contaminants in prey, soil/sediment, and surface water from the Site are at levels that may result in toxic effects (survival, growth, and reproduction). Dietary NOAEL HQs calculated for many of the bird receptors supported this conclusion:

- Insectivorous bird HQs for lead and zinc exceed one at all EAs;
- Omnivorous bird HQs exceeded one (and LOAEL-based HQs in some cases) for cadmium (EA 3), chromium (EA 3, EA 4, EA 5, EA 6, EA 7, EA 9, Non-Riparian Reference, and EA 5 Reference), lead (all EAs), and zinc (all EAs);
- Dietary piscivorous bird HQs exceeded one for zinc (all EAs).

However, for carnivorous birds, this conclusion was not supported since none of the NOAEL HQs exceed one.

7.2.4.6 Mammalian Receptors (omnivorous, piscivorous, herbivorous, and insectivorous)

Levels of COPCs in prey/vegetation, soil/sediment, and surface water from the Site are not present at levels that may result in toxic effects (survival, growth, and reproduction). Dietary NOAEL HQs calculated for many of the mammal receptors support this conclusion since herbivorous, omnivorous, and piscivorous mammal HQs were below one. The only line of evidence that did not support this conclusion is that for insectivorous mammals the cadmium NOAEL HQ exceeded one; however, all other insectivorous mammal NOAEL HQs were below one.

7.2.4.7 Additional Information Post BERA – Molybdenum in Soil

The primary COC identified in the BERA for surface soil is molybdenum. Ecotoxicity data for molybdenum are sparse, and as a result additional investigations (Site-specific toxicity testing with rye grass and earthworm; bioavailability investigations with two different forms of molybdenum) have been performed since completion of the BERA to better understand the potential toxicity and bioavailability of molybdenum in soil. These investigations were performed as part of the further evaluation of preliminary remediation goals completed in the FS.

The soil toxicity reference value for molybdenum (initially set at 2.0 mg/kg in the BERA, based on a No Effect level for plant toxicity) has undergone several refinement steps as more information has become available. These refinement steps and associated implications are discussed below.

- Following additional literature review, a revised soil toxicity reference value for molybdenum was set at 54 mg/kg. This second toxicity reference value is based on toxicity studies for a representative avian receptor (western kingbird). As such, use of this toxicity reference value was assumed protective of other, non-tested terrestrial receptors, primarily birds and non-grazing mammals.

- Following the selection of the 54 mg/kg toxicity reference value for molybdenum in soil, Site-specific toxicity tests were conducted to assess the toxicity of mine site soils to more directly exposed organisms. These tests were based on laboratory exposures of rye grass (a representative terrestrial plant) and earthworm (a representative soil invertebrate). The results of these tests, along with an evaluation of uptake and bioavailability of different forms of molybdenum, were used to derive a final, Site-specific soil toxicity reference value of 300 mg/kg for molybdenum. Maintaining upland (*i.e.,* mine site) soil molybdenum concentrations below this threshold (300 mg/kg) is expected to be protective of plants and soil-associated animals. This threshold (300 mg/kg) is applicable only to upland, mine site soils, and not to riparian soils because it is based on Site-specific bioavailability and toxicity tests using mine site soils. The 54 mg/kg toxicity reference value for molybdenum applies to all other non-mine site soils.

- A soil toxicity reference value of 11 mg/kg has been established for soil areas where livestock grazing is likely. This toxicity reference value is derived to protect against molybdenosis in livestock and other sensitive wildlife (deer/elk), and is based on the Site-specific mean soil-to-plant bioaccumulation factor of about 1.0 and the forage-based dietary toxicity reference value of 11 mg/kg for cattle.

7.2.4.8 Revised Hazard Quotients for Molybdenum

- Soil and waste rock piles (eastern portion of the mine site) HQ = 2 (based on 300 mg/kg toxicity reference value);

- Soil and waste rock piles (western portion of the mine site) HQ = less than 1 (based on 300 mg/kg toxicity reference value);

- Riparian corridor along mine site HQ = less than 1 (based on the 54 mg/kg toxicity reference value);
- Riparian corridor along tailing facility HQ = less than 1 (based on the 54 mg/kg toxicity reference value);
- Tailing facility soil HQ = 2 (based on the 54 mg/kg toxicity reference value);
- Hot spot area south of the tailing facility HQ = 12 (based on the molybdenosis toxicity reference value of 11 mg/kg).

These revised HQs suggested that remediation of soils for molybdenum is warranted for the hot spot area south of the tailing facility, based on the substantially elevated HQ and evidence of localized cattle grazing. Remediation of soils in the riparian corridor is not warranted, however “hot spots” of elevated molybdenum in localized tailing spills are above the 54 mg/kg toxicity reference value and past removal of tailing spill material has been initiated by CMI under the direction and oversight of NMED. Remediation for protection of ecological receptors is not warranted for mine site soil and waste rock or the soil within the tailing facility based on revised HQs (described below) and likelihood of exposure considering limited suitable habitat. Further, waste rock piles across the Site would be capped (covered with cleaner material) for groundwater protection where molybdenum concentrations exceed the 300 mg/kg threshold.

7.2.4.9 Revised Ecological Risk Evaluation – Post Feasibility Study

Subsequent to the completion of the FS, CMI approached EPA and the State of New Mexico to propose alternate cover thicknesses of one foot and two feet be evaluated for the tailing facility, rather than the three-foot thickness specified in the New Mexico Mining Permit TA001RE and Ground Water Discharge Permit DP-933 as well as the FS. The proposed reduction in cover thickness to potentially one foot raised concerns of the validity of the underlying assumptions used in the risk assessment process for evaluating ecological receptors exposed to soil (consisting of a mixture of the alluvial soil placed as interim cover and tailing) at the tailing facility. Use of a one-foot thick soil cover as the final cover suggests that plants would be rooting into the underlying tailing material rather than primarily within the three-foot thick soil covers that is currently planned. As such, EPA decided that the risk evaluation parameters required modification. Instead of a mixture of cover and tailing, exposure point concentrations, HQs, and preliminary remediation goals need to be determined based on tailing-only samples. The revised analysis, which is documented in the Technical Memorandum for Re-evaluation of Risk Estimates for Tailing Facility Surface Sample, Addendum to the Baseline Ecological Risk Assessment – Molycorp, Inc. (CDM 2009c) is described below.

The revised exposure point concentration (184 mg molybdenum/kg soil) for molybdenum in surface material for the tailing facility (EA 7) is based on the geometric mean concentration of 15 tailing samples collected in 2002, 2003, and 2004. These samples consisted of 14 independent samples plus a fifteenth sample and its associated duplicate. The fifteenth value used for calculating the exposure point concentration is the average of that sample and its associated duplicate. The revised soil exposure point concentration increased from 115 mg/kg (CDM 2009c) to 184 mg/kg primarily because of the elimination of sample data for media not considered tailing material.

The soil-to-plant bioaccumulation factor used for the aforementioned revisions remained unchanged from that used in the BERA. This bioaccumulation factor was based on the average soil-to-plant bioaccumulation factor from 16 co-located and paired surface samples of soil or tailings and plant. Plant molybdenum concentrations were based on the above-ground portions of unwashed plants, and were the means of grasses, forbs, and shrubs.

The revised preliminary remediation goal and associated HQ calculation for protection of terrestrial receptors based on potential exposure to tailings and food items associated with tailings is based on a multi-step process. These steps are described below.

- Step 1 – Receptor Selection

  Target terrestrial receptors for assessing risks from exposure to tailing are mule deer and Rocky Mountain elk. These species are selected because of known occurrence onsite, likelihood of use of the tailing facility (EA 7) over varying frequencies and duration, diet, and potential sensitivity to dietary exposures of molybdenum based on sensitivity observed in cattle.

- Step 2 – Toxicity Reference Value Selection

  Toxicity data are lacking for elk. Limited data are available for mule deer. Studies by Nagy et al. (1975); Ward and Nagy (1976); Ward (1978); and Chappell et al. (1979) resulted in toxicity data for mule deer exposed to molybdenum (all in Eisler 1989) as presented below.

  The highest No Observed Adverse Effect Concentration (NOAEC) was 1,000 mg molybdenum/kg diet after 8-day exposure. The lowest reported Lowest Observed Adverse Effect Concentration (LOAEC) after 25-day exposure was 2,500 mg molybdenum/kg diet (Table 7-29). These are selected as the base toxicity values used to derive protective levels for molybdenum in tailing at EA 7. The NOAEC and LOAEC described are revised as follows:

  - <u>Converted from wet weight diet (plants) to dry weight soil concentration using the site-specific mean BAF of 1.3 (base dietary toxicity reference value / bioaccumulation factor = base soil toxicity reference value, in mg/kg dry weight)</u> – This conversion results in a soil-based molybdenum NOAEC of 770 mg/kg and a soil-based LOAEC of 1,923 mg/kg (Table 7-29).

  - <u>Ranked quintiles applied to NOAEC to LOAEC range (770 to 1,923 mg/kg)</u> – This step addressed the uncertainties associated with the difference between the highest NOAEC and the lowest LOAEC. EPA often recommends taking the geometric mean of the NOAEC and the LOAEC. Alternatively, a new approach recommended by EPA (M. Greenberg, Ph.D., personal communication, 2008) is based on the application of quintiles to the "gray zone" between the highest NOAEC and the lowest LOAEC (Table 7-29). Applying the latter approach to this effort resulted in the following quintiles (in percent) and associated protective levels for soil (before application of uncertainty factors):

- NOAEC = 770 mg Mo/kg soil
- 20% = 1,001 mg/kg
- 40% = 1,232 mg/kg
- 60% = 1,463 mg/kg
- 80% = 1,694 mg/kg
- LOAEC = 1,923 mg/kg (Table 7-29)

- Application of Uncertainty Factors – Uncertainty factors were applied to the quintile-associated protective levels as described below. An uncertainty factor of 10 was applied to account for the short duration exposures associated with the NOAEC (8 days) and the LOAEC (25 days). The uncertainty factor of 10 was used to approximate the preliminary remediation goal under longer term chronic exposures. A smaller uncertainty factor of 3 was also applied to account for the lack of data for elk and all other herbivorous mammals that may be exposed to tailings. Combining this smaller uncertainty factor with the uncertainty factor of 10 (acute to chronic) resulted in a total uncertainty factor of 30 (10 x 3 = 30). Application of the total uncertainty factor of 30 to the quintile-associated protective levels described above resulted in the following:

  - NOAEC = 26 mg/kg
  - 20% = 33 mg/kg
  - 40% = 41 mg/kg
  - 60% = 49 mg/kg
  - 80% = 56 mg/kg

        - LOAEC = 64 mg/kg (Table 7-23)

    - Selection of Final Protective Level – Selecting the most appropriate level of protection from those listed above was based on best professional judgment and degree of uncertainty with the NOAEC and LOAEC. The geomean of the LOAEC and NOAEC is 41 mg/kg. The arithmetic mean of the two values is 45 mg/kg. The reported unadjusted LOAEC of 2,500 mg/kg diet is associated with rather severe effects (reduced food intake and diarrhea). Therefore, the most appropriate preliminary remediation goal is one that is closer to the NOAEC rather than one nearer the LOAEC. Based on both professional judgment and the fact that the geomean is 41 mg/kg, the 40% quintile value of 41 mg/kg was selected as the final soil-based protective level for deer, elk, and other untested herbivorous mammals (not including domestic livestock).

- Step 3 – Calculation of Revised HQ

The revised protective level of 41 mg/kg of molybdenum in tailing was used to derive the revised HQ for soil-associated ecological receptors. The arithmetic mean molybdenum concentration in tailing, as described above, is 199 mg/kg, whereas the geometric mean molybdenum concentration in tailing is 184 mg/kg. The associated HQs are calculated as follows:

HQ = Exposure Point Concentration /Toxicity Reference Value

HQ = 199 mg/kg / 41 mg/kg = 5 (4.85 rounded up to nearest integer)

HQ = 184 mg/kg / 41 mg/kg = 4 (4.49 rounded down to nearest integer)

The final HQ for terrestrial mammals other than domestic livestock exposed to tailings material in EA7 ranges from HQ=4 to 5 (Table 7-29), and suggests that reduction in molybdenum concentrations or reduced exposure potential is warranted under current conditions.

7.2.5 Ecological Risk Conclusions

Results of the BERA show the greatest ecological risks at the Site were to (1) aquatic life (primarily resident brown trout) in the Red River by exposure to aluminum, and to a lesser degree, copper and zinc in surface water at and downstream of Spring 13 and other springs, (2) wildlife and/or livestock in the area south of the tailing facility by exposure to molybdenum in terrestrial plants that have taken up molybdenum from soil, (3) wildlife (deer/elk) on the tailing facility by exposure to molybdenum in tailing and plants (via dietary exposure), and (4) benthic macroinvertebrate populations (aquatic insects such as the larvae of mayflies and other invertebrates) exposed to degraded Eagle Rock Lake bottom sediments contaminated with several metals, including aluminum, zinc, nickel, and copper.

Species of special concern, including threatened and endangered species, do not appear to be at significant risk based on the media type, locations, and magnitude of COC concentrations associated with habitats for which exposure is likely. For example, some of the most significant risks are associated with Red River surface waters at locations where pH is low and dissolved metals and total aluminum concentrations are elevated. These locations (primarily at seeps) offer little suitable habitat for special status species, and such species have not been reported to reside in or near these areas.

A summary of these risks and the COC concentrations expected to provide adequate protection of these ecological receptors are presented below. These protective levels are identified as preliminary remediation goals.

7.2.5.1 Mine Site Area – Contaminants of Concern and Protective Levels

7.2.5.1.1 Molybdenum Levels in Borrow Material – Mine Site

Although there was no significant risk associated with surface soil at the mine site, surface soil preliminary remediation goals have been developed to ensure that CERCLA response actions are protective of terrestrial plants and animals from exposure to molybdenum in the cover materials proposed for source containment alternatives at the waste rock piles. The proposed use of Spring Gulch waste rock pile material as an on-Site borrow for cover material led to testing of the Spring Gulch waste rock for suitability. A significant portion of the Spring Gulch waste rock pile was estimated to be non-acid generating by CMI. Because of concerns with elevated molybdenum in the Spring Gulch waste rock above the molybdenum preliminary remediation goal (300 mg/kg) developed by EPA for protecting terrestrial plants and animals at the mine site, additional Site-specific testing was performed for molybdenum toxicity, bioaccessibility, and bioavailability. Based on the results of this testing, EPA developed a molybdenum suitability criterion of 600 mg/kg for screening the borrow material. The 600 mg/kg suitability criterion is higher than the 300 mg/kg molybdenum preliminary remediation goal because a significant portion of the molybdenum in Spring Gulch rock is of a form (molybdenite [MoS_2]) which is not readily bioavailable for ecological receptors (Table 7-30).

Additionally, EPA developed a successful plant growth performance-based preliminary remediation goal for the cover material to ensure that molybdenum uptake from borrow material to plants shall not be at a level that exceeds the risk-based concentrations considered protective of herbivorous native wildlife or inhibits attainment of revegetation success standards necessary for an effective evapotranspiration cover system to prevent acid rock drainage and the attainment of ground water cleanup levels.

7.2.5.1.2 Resident Brown Trout in the Red River

Long-term (chronic) exposure: Long-term (chronic) exposure to elevated concentrations of primarily aluminum, as well as copper and zinc, in surface water of the Red River at and downstream of Spring 13, and to a lesser degree at other seeps and springs along the river may cause severe adverse effects to exposed trout. These findings were based on surface water concentrations of contaminants (compared to aquatic toxicity data) and whole body fish concentrations, as well as other supplemental lines of evidence, including abundance and diversity data and laboratory toxicity test data in which trout were exposed to Spring 13 and Spring 39 water.

Risk estimates (expressed as HQs) calculated from comparison of surface water concentrations to trout-based toxicity reference values for chronic exposures were low, but considered significant, as HQs exceed EPA's threshold value of 1 for aluminum along several reaches of the Red River from upstream of the mine site to the tailing facility. The maximum HQ of 2 was calculated for the river reach downstream of the Cabresto Creek and Red River confluence (Table 7-18). HQs for chronic exposure to the springs and seeps in contact with the river range up to 31 for aluminum (Table 7-17).

Whole body residue-based HQs for large brown trout exceeded the threshold value of 1 for copper (2-5) and zinc (5-14) for areas of the Site and upstream of the Site (reference locations), with Site location HQs being greater than HQs for reference locations. The highest HQ for copper (5) was from near the Questa Ranger Station, located about a mile downstream of Spring 13 (Table 7-20).

Abundance and diversity data indicated a significant reduction in the numbers and pounds of brown trout beginning upstream of the mine site and continuing until downstream of Highway 522 (see Figures 5-104 and 5-105). The 7-day laboratory toxicity tests (serial dilution tests) using early life stage rainbow trout exposed to water from Springs 13 and 39 showed both springs were toxic at very low dilutions (5-10 percent).

These results revealed that even with substantial dilution by Red River water, Spring 13 and Spring 39 can cause severe adverse effects in exposed trout. Since the degree that spring water is diluted by river water undoubtedly varies over time, acutely toxic conditions to fish may occur when spring water discharges during low flow conditions in the Red River.

No conclusions were drawn on the potential for adverse effects to the stocked legal size rainbow trout based on the results of the early life stage rainbow trout in toxicity tests as the stocked trout are expected to reside in the river for only a short period of time prior to being taken by fishermen.

Based on the findings of the BERA, the recommended preliminary remediation goal for total aluminum in Red River surface water is 1 mg/L for Spring 13 and 0.8 mg/L for Spring 39 (Table 7-30). Remedial measures to reduce aluminum concentrations in surface water are also expected to reduce levels of copper and zinc.

Short-term (acute) exposure: Short-term (acute) exposure to elevated aluminum concentrations in surface water during or following storm events may result in adverse effects to trout both upstream and along the Site. However, trout are likely to avoid turbid water during storm events if possible, which would likely reduce the risks associated with acute exposures to aluminum. Protective levels for chronic and acute exposures are listed in Table 7-30.

7.2.5.2 Red River, Riparian, and South of Tailing Facility Area – Contaminants of Concern and Protective Levels

7.2.5.2.1 Wildlife and Livestock in Riparian Area South of Tailing Facility

Exposure to elevated molybdenum concentrations in surface soil, and in some cases terrestrial plants through uptake and accumulation, in the area south of the tailing facility may cause adverse affects (molybdenosis) to sensitive receptors such as livestock (cattle) and sensitive wildlife. This is an important issue because some large herbivorous mammals (including domestic cattle and sheep, as well as members of the deer family such as mule deer and elk) can exhibit molybdenosis if too much molybdenum is ingested. Molybdenosis is caused by copper deficiency due to molybdenum competing with copper, an essential nutrient, when molybdenum concentrations are increased (*i.e.*, molybdenum competes with copper absorption).

Ecotoxicity data for molybdenum in soil are sparse, and as a result additional investigations (Site-specific toxicity testing with rye grass and earthworms; bioavailability investigations with two different forms of molybdenum) have been performed since completion of the BERA to understand better the potential toxicity and bioavailability of molybdenum in Site soil.

Based on these tests and additional literature review, the toxicity reference values for the riparian area south of the tailing facility for molybdenum in surface soil are:

- 54 mg/kg toxicity reference value – protects terrestrial birds and non-grazing mammals (based on western kingbird) in the riparian corridor;
- 41 mg/kg toxicity reference value – protects wildlife (grazing mammals such as mule deer and Rocky Mountain elk).
- 11 mg/kg toxicity reference value – protects livestock (cattle, sheep) in areas that grazing is likely. This toxicity reference value is derived to protect against molybdenosis in livestock and sensitive wildlife;

The HQs calculated for molybdenum within the riparian area south of the tailing facility, based on these toxicity reference values, are 11 (livestock), 3 (deer/elk), and 2 (western kingbird). These HQs are above EPA's threshold value of 1 and warrant response action. The molybdenum concentration expected to provide adequate protection for both wildlife and livestock is 11 mg/kg (Table 7-31).

7.2.5.2.2 Trout in the Red River

The same rationale discussed for long-term (chronic) exposure by trout to Red River surface water at the Mine Site Area applies here as well. Based on the findings of the BERA, the concentration of total aluminum in Red River surface water expected to be protective of trout is 1.0 mg/L for Spring 13 and 0.8 mg/L for Spring 39 (Table 7-31). Remedial measures to reduce aluminum concentrations in surface water are also expected to reduce levels of copper and zinc.

Short-term (acute) exposure – The short-term exposure to elevated aluminum concentrations in surface water during or following storm events may result in adverse effects to trout both upstream and along the Site. However, trout are likely to avoid turbid water during storm events if possible, which would likely reduce the risks associated with acute exposures to aluminum. Protective levels for chronic and acute exposures are listed in Table 7-31.

Reducing exposure to these COCs in Red River surface water at concentrations above these protective levels will be addressed by the Selected Remedy for the Mine Site Area.

7.2.5.3 Tailing Facility Area – Contaminant of Concerns and Protective Levels

7.2.5.3.1 Wildlife (Deer/Elk) Exposed to Tailing Waste

Long-term (chronic) exposure to elevated molybdenum concentrations in tailing and plants (which take up molybdenum) may cause adverse affects (molybdenosis) to wildlife (deer/elk). The calculated HQ of 4 exceeds EPA's threshold value of 1, based on the Site-specific toxicity reference value of 41 mg/kg and exposure point concentration of 184 mg/kg (geometric mean) for tailing. The mule deer and Rocky Mountain elk are the receptors evaluated for risk because of their known year-round occurrence at the tailing facility, likelihood of use of the tailing facility over varying frequencies and durations, diet, and potential sensitivity to dietary exposures of molybdenum based on sensitivity observed in cattle.

A concentration of 41 mg/kg for molybdenum in soil is expected to provide adequate protection of deer and elk at the tailing facility (Table 7-29).

7.2.5.3.2 Aquatic Life and Benthic Macroinvertebrates in Tailing Pond Surface Water and Sediment

The highest sediment HQ considering all river and lake/pond locations was for molybdenum at the tailing ponds (HQ – 1,416). Elevated concentrations of copper in tailing pond sediments would also be of concern if tailing ponds are identified as suitable habitat for benthic macroinvertebrates. However, tailing ponds are currently not considered suitable aquatic habitats, primarily because they are part of the active tailing disposal facility.

Tailing pond surface water was found to be non-toxic or only minimally toxic (relative to the toxicity test controls) in tests exposing daphnids (water-column crustaceans) to the tailing pond water. As stated above, tailing ponds are currently not considered suitable aquatic habitats because they are part of the active tailing disposal facility.

Aquatic invertebrate community data suggest that aquatic invertebrates are neither abundant nor diverse, most likely due to the combination of poor water and sediment quality, low nutrient content, limited organic carbon content, low oxygen levels and operational activities (tailing ponds are often disturbed via filling and other activities).

Aquatic dependent birds (represented by osprey, marsh wren, and belted kingfisher) were evaluated via food web modeling. Estimated average daily doses from food web models compared to dietary low effect levels (*i.e.,* levels at which adverse effects may begin to be observed) showed negligible to no ecological risk to any of these species. Similar comparisons to no effect levels (*i.e.,* levels not associated with any observable adverse effects) showed limited risk to the marsh wren (for lead and zinc) and the belted kingfisher (for zinc). However, such risks would be reduced because these areas offer little suitable habitat and a limited food source, as described above. Overall, the results of the food web modeling indicate a low potential for adverse effects to birds from the tailing ponds.

7.2.5.4 Eagle Rock Lake – Contaminants of Concern and Protective Levels

7.2.5.4.1 Benthic Macroinvertebrates in Contaminated Sediment

Exposure to Eagle Rock Lake sediment may cause adverse effects to the benthic macroinvertebrate populations (aquatic insects and other invertebrates) due to exposure to elevated concentrations of several metals. HQs estimated for zinc (14; with an exposure point concentration of 1,742 mg/kg dry weight, is nearly six-fold higher than that of upper Fawn Lake [309 mg/kg]), copper (8), cadmium (6), nickel (6), lead (5), manganese (3), selenium (3), molybdenum (2), aluminum (1), arsenic (1), and silver (1) in sediment equal to or exceed EPA's threshold value of 1. Of these eleven metals, cadmium, copper, manganese, nickel, and zinc were retained as COCs in this ROD. Aluminum was also retained, primarily because elevated concentrations of aluminum appear to contribute to the physical degradation of benthic habitats by forming a semi-gelatinous floc that coats the bottom substrates. The other contaminants with HQs equal to or exceeding 1 were eliminated from further consideration (*i.e.,* arsenic, lead, molybdenum, selenium, and silver) because the HQs were not significantly higher than the HQs for sediment in upper Fawn Lake (the reference lake located east of the mine site). Sediment toxicity tests based on Eagle Rock Lake sediment did not show toxicity. However, analysis of benthic macroinvertebrate tissue showed concentrations of aluminum, copper, nickel and zinc above reference levels for tissue collected from upper Fawn Lake sediment. Finally, the surface of the sediments of Eagle Rock Lake is covered with the semi-gelatinous 'floc' (assumed to be comprised primarily of aluminum hydroxide) that degrades the microhabitat utilized by the benthic macroinvertebrates, and as stated above, this finding supports the retention of aluminum as a COC for Eagle Rock Lake sediments.

Benthic macroinvertebrates are considered important in the BERA because they are sensitive indicators of water and sediment quality. They also serve as a major food source for fish and, therefore, warrant protection by this proposed remedy. The protective levels for these COCs in sediment are listed in Table 7-31.

A summary of the ecological risk, COCs, and protective levels for all areas of the Site are presented on Table 7-32.

7.2.6 Summary of Ecological Risk, COCs, and Protective Levels

In summary, ecological risks are associated with the following areas and COCs:

- **Mine Site Area** – Spring Gulch Waste Rock as borrow material for cover poses risks to vegetation and wildlife from molybdenum uptake by plants;
- **Tailing Facility Area** – Tailing waste poses a risk to wildlife from molybdenum uptake by plants and metals contamination in tailing pond surface water and sediment poses a risk to aquatic life and benthic macroinvertebrates;
- **Red River and Riparian and South of Tailing Facility Area** – Red River surface water contamination (aluminum, cadmium, and copper) poses a risk to fish (trout) and soil contamination (molybdenum) south of the tailing facility poses a risk to wildlife and livestock;
- **Eagle Rock Lake** – Sediment contamination (metals) poses a risk to benthic macroinvertebrates.

A summary of the ecological risk, COCs, and protective levels are presented on Table 7-32.

7.2.7 Summary of Uncertainties

All risk assessments are associated with some degree of uncertainty, including uncertainties linked to data collection and analyses, data interpretation, assumptions associated with exposure or effects, and risk characterization. Important areas of potential uncertainty related to exposure assessment and effects assessment are discussed in Sections 3 and 4, respectively, of the BERA. Important components of these presentations are summarized here, along with uncertainties specifically related to risk characterization.

By definition, uncertainties in risk characterization are influenced by uncertainties in exposure assessment and effects assessment. The extensive sampling and analysis of surface water, sediment, surface soil, and biota minimize uncertainties in exposure assessment related to abiotic media. Descriptions of the magnitude and distribution of COPCs within the Site and the reference background areas are considered to be generally representative of current conditions within those areas. This is especially true for those media sampled multiple times over several years. In spite of the overall confidence in exposure data, some data are clearly biased towards times of the year when sampling is easiest or most desirable. For example, data collected during storm events are limited and may not represent the wide range of conditions that may be seen during such events.

Some environmental samples may be biased. These biases may, in various ways, affect the exposure point concentration calculations for all media. For example, Red River surface water and sediment exposure point concentrations may not be fully representative of long term average or "most likely" conditions because samples may have been taken at times when conditions were unique in some way. Specifically, recent flows, storm events, degree and location of upwelling of ground water, etc., can impact surface water and sediment metals concentrations and associated exposure point concentrations. Also contributing to uncertainty related to exposure data is the fact that in some cases both random and biased soil samples were included in the exposure point concentration calculations. Substantial differences between small-scale sampling (*e.g.,* multiple biased samples collected from a suspected "hot spot") and large-scale sampling (*e.g.,* multiple random samples collected from a large area) were generally not observed. This finding suggests that combining random and biased samples is unlikely to have had major impacts on soil exposure point concentration calculations.

Effects data can also contribute to overall uncertainty in risk characterization. Science and scientific investigations cannot prove any hypothesis beyond doubt. The scientific method is instead based on stating hypotheses, testing the hypotheses, and either accepting or rejecting the hypotheses based on one or more lines of evidence. Cause and effect relationships can be inferred, and evidence can support hypotheses, but cause and effect relationships can rarely be proven. Site-specific biological and chemical data are subject to concerns of representativeness and the sensitivity of sampled species used to derive such data. Toxicity data that are not Site-specific may not be totally applicable to the site being investigated.

There are also concerns about laboratory-to-field extrapolation of effects data and also concerns with taxa-to-taxa extrapolations. All effects data are, therefore, subject to some degree of uncertainty. Confidence in the ability of selected effects data for use as toxicity reference values to assess potential for ecological risks varies for each data value selected. While each and every effects data value used in this and every other BERA is associated with some degree of uncertainty, it is the general trend described by the comparisons between exposure concentrations and effects concentrations, and the overall confidence in such comparisons, that are most important. For the most part, there is higher confidence in effects data for the major surface water COPCs and for metals-related effects to upper trophic level mammals and birds. In decreasing order of confidence, these are followed by effects data for major COPCs in sediment, surface soil, and whole body fish tissue.

Another potential source of uncertainty is the biological data collected to support this BERA. For example, certain types of biota (*e.g.,* plants, worms, rodents, fish, and benthic macroinvertebrates) are used to represent key prey items in food web models. Each of these is assumed representative of much larger groups of organisms from which prey would actually be taken. For example, the rodent taxa collected are assumed to be adequately representative of small mammals regularly consumed by certain food web receptors (*e.g.,* raptors). Whether or not this assumption is sound cannot be determined using available data. In summary, sufficient numbers and types of biological data were collected in support of this BERA to serve as appropriate model input parameters. Bioaccumulation factors for most food web components are also based on project area information, which should decrease the uncertainties associated with model outputs.

Additional uncertainties related to biological data include those related to the selection or elimination of certain receptor groups. For example, it was decided early in the BERA planning process to recognize potential exposures for aquatic plants, amphibians, and reptiles. It was also recognized by all interested parties that data limitations precluded quantitative assessments of these specific receptor groups. Such limitations are based primarily on limited ecotoxicity data for members of the group (*e.g.,* reptiles and amphibians) or limited Site-specific data because of low abundance (aquatic plants). Not quantitatively assessing these receptor groups is not a major omission given the limited amount of aquatic vegetation in most Site-related surface waters and given the limited ecotoxicity database for reptiles and amphibians.

The risk characterization method itself can contribute to uncertainty. Careful calculation of exposure point concentrations, with special attention given to handling non-detect data and infrequently detected values, along with careful review of multiple sources of effects data minimizes this type of uncertainty. Incorporating general Site observations and several other lines of evidence (*e.g.,* community structure, toxicity testing) into risk characterization reduces the dependence on strict quantitative risk estimates that in some cases are more uncertain.

Risk estimates for upper trophic level receptors based on food web modeling may be overestimated for some COPCs for species with variable home or foraging ranges. This conclusion is based on the decision to select a mean value where a wide range exists. Whether the mean foraging range is relevant to this Site or not cannot be determined with existing data. In reality, some individuals may forage only within the Site boundaries, but others may forage over a wider area.

Finally, confidence in risk estimates varies among the COPCs. There is generally high confidence in the risk estimates for well-studied COPCs such as cadmium, copper, lead, zinc, and, where sufficient data exist, mercury. Risk estimates are probably less certain for chromium, nickel, selenium, manganese, thallium, and vanadium. Risk estimates are even more uncertain for molybdenum because little or no suitable ecotoxicity data are available for certain media types.

In summary, it is expected that the degree of uncertainty in exposure estimation, effects data, and risk characterization are minimized by the extensive data collection.

8.0 REMEDIAL ACTION OBJECTIVES

Remedial action objectives are developed for the five areas to be addressed by the Selected Remedy to protect human health and the environment. They provide general descriptions of the objectives of the cleanup. The remedial action objectives 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.

The remediation goals are media-specific, quantitative goals that define the extent of cleanup required to achieve the remedial action objectives. They are developed at a preliminary level during the RI/FS and are based primarily on health- or ecological-based criteria developed by EPA in risk assessment or federal/state numeric criteria or standards considered by EPA to be preliminary Applicable or Relevant and Appropriate Requirements (ARARs) for the Site. These goals serve as the design basis for the remedial alternatives presented in this ROD.

Current and reasonably anticipated future uses of the Site are considered in the development of the remedial action objectives. The anticipated future uses for the mining and tailing disposal facilities are based on past and current land uses, experience at other comparable sites, population trends, the NMED preliminary evaluation for place of withdrawal, the post-mining land use designation approved by MMD, government controls, and other factors. EPA recognizes that the post-mining land use may change in the future if CMI proposes an alternate post-mining land use and it is approved by MMD.

8.1 Remedial Action Objectives for the Mill Area

8.1.1 Remedial Action Objectives

For the Mill Area, the remedial action objective was developed to mitigate risks to human health estimated from potential exposure to PCBs and molybdenum contamination in soil. Ecological risk was not assessed for this area due to a lack of suitable habitat and ecological receptors. In developing the remedial action objective, it was assumed that following cessation of mining and milling operations, the reasonably anticipated future land uses were industrial, water management, residential and forestry.

The remedial action objective for the Mill Area is:

- Protect humans by preventing direct contact or ingestion of Mill Area soil that has a concentration of molybdenum or PCBs greater than federal ARARs and/or Site-specific health-based cleanup levels for soil.

8.1.2 Basis and Rationale for Remedial Action Objectives

The remedial action objective was originally to clean up Mill Area soil to residential standards, as EPA and NMED considered the future residential land use scenario to be a reasonable scenario after cessation of mining. This was based on observed residential developments occurring along the Red River Valley near the town of Red River. However, during and after performance of the FS, EPA considered several other factors that weigh in favor of industrial and commercial use as the most likely future land use at the Mill Area. These factors include (1) the past and current land use at the Mill Area, which has been the molybdenum milling facility and related buildings and infrastructure, (2) the NMED evaluation of place of withdrawal, which preliminarily concludes that the Mill Area is likely to be put to industrial use, (3) the post-mining land use designation approved by

MMD, which anticipates that a water treatment plant will be constructed and operated at the Mill Area, and (4) the institutional controls that restrict residential development at the Mill Area, but allow industrial operations. Therefore, the reasonably anticipated future land use for the Mill Area at this time is commercial/industrial. Nevertheless, because EPA continues to believe that future residential development in the Mill Area is a possibility and because remedial alternatives were developed in the FS for both residential and commercial/industrial land uses, EPA is presenting remedial alternatives for both land uses in this ROD.

8.1.3 Risk Addressed by the Remedial Action Objectives

The remedial action objectives addresses the cancer risk to future residents or commercial/industrial workers from exposure to PCBs in soil at levels exceeding the Toxic Substances Control Act (TSCA) numeric standards of 1 mg/kg for high occupancy (residential) use or 25 mg/kg for low occupancy (commercial/industrial) use. TSCA is identified as an ARAR for this decision. The remedial action objectives also address the non-cancer health hazards exceeding a hazard index (HI) of 1 from exposure to molybdenum concentrations in soil above the EPA health-based criterion of 503 mg/kg by future residents. For the commercial/industrial worker, risk associated with exposure to molybdenum in soil is does not exceed an HI of 1 and, therefore, does not warrant a response action under CERCLA. To achieve the remedial action objective, the response action will address these risks by preventing direct contact and incidental ingestion through either soil removal with off-Site disposal and/or treatment or capping options.

8.2 Remedial Action Objectives for the Mine Site Area

8.2.1 Remedial Action Objectives

EPA developed the remedial action objectives for the Mine Site Area with the assumption that the current land use of mining and milling at the operating facility will continue for some unknown period of time into the future. EPA does not speculate on the duration of that time period for purposes of this decision, and an estimate is not necessary. However, key features at the mine site such as the waste rock piles and open pit are remnants of the open pit mining period conducted from 1965 to 1983 and are not part of the current underground mining or milling operations (see Current and Potential Land and Future Resources Use, Section 6.0).

Following cessation of mining and after remediation, EPA assumes that land use at the mine site, other than the Mill Area, will be forestry and water management, the MMD-approved post-mining land use designation, as well as recreational use, and may also include residential, commercial, and industrial use. Additionally, EPA took into consideration the Deed of Conservation Easement and Declaration of Restrictive Covenants to restrict future residential uses and certain ground and surface water uses, as well as NMED's observation that institutional controls are not effective, and NMED's position that water use restrictions in proprietary controls must not be used as a substitute for ground water abatement in developing remedial action objectives.

The remedial action objectives for the Mine Site Area are:

- Prevent ingestion by humans of ground water containing mine-related inorganic COCs[58] exceeding state/federal ARARs[59] or Site-specific risk-based cleanup levels.
- Eliminate or reduce, to the maximum extent practicable, leaching and migration of inorganic COCs and acidity from waste rock (acid rock drainage) to ground water at concentrations and quantities that have the potential to cause exceedances of the numeric ground water ARARs or Site-specific risk-based cleanup levels.
- Restore contaminated ground water to meet state/federal ARARs or Site-specific risk-based cleanup levels for inorganic COCs.

[58] Inorganic COCs include metals.
[59] Numeric criteria or background concentrations, whichever is higher.

- Eliminate or reduce, to the maximum extent practicable, the migration of mine-related inorganic COCs in ground water to Red River surface water at concentrations that would result in surface water concentrations exceeding surface water ARARs or Site-specific risk-based cleanup levels.
- Protect Red River aquatic species from chronic exposure to inorganic COCs and acidity at Springs 13 and 39 by eliminating or reducing discharge, to the maximum extent practicable, of Springs 13 and 39 water to the Red River at levels that result in total aluminum concentrations below the Site-specific risk-based cleanup level of 1 mg/L in Red River surface water at Spring 13 and 0.8 mg/L in Red River surface water at Spring 39.[60]

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[60] The following provides a basis for this remedial action objective:
The EPCs for total aluminum in Red River surface water, based on four sampling events over two years (and not including any storm events or snowmelt conditions) are 0.91 mg/L upstream of Spring 39, 0.67 mg/L adjacent to Spring 39, and 1.41 mg/L adjacent to Spring 13. The corresponding chronic toxicity reference values for trout, based on trout-specific toxicity data and the mean hardness of each area, are 0.77 mg/L (upstream of Spring 39), 0.95 mg/L (Spring 39), and 0.97 mg/L (Spring 13).

The methodology for evaluating the achievement of the 1.0 mg/L (*i.e.,* 0.95 mg/L and 0.97 mg/L trout chronic toxicity reference values rounded to 1.0 mg/L for Spring 13) and 0.8 mg/L (*i.e.,* 0.77 rounded to 0.8 mg/L for Spring 39) risk-based cleanup levels for total aluminum will be based on monthly monitoring of total aluminum concentrations in the Red River. Sample collection will take place within a period of 2 hours or less of each other at an upstream and downstream location of each of these two springs in the Red River, approximately equidistant from the north bank and mid-channel, at approximately mid-depth. Sampling locations will be just upstream of all known Spring 13 and Spring 39 discharges to the Red River and approximately mid-way between the most downstream Spring 13 and Spring 39 discharges to the river and the next Red River sampling station.

Monitoring will not take place, nor will this remedial action objective and its requirements be applicable during precipitation events and for a period of a minimum of 2 days after stream flow returns to pre-precipitation flow rates. To verify a return to baseline water quality following a storm event, monitoring of select indicator parameter(s) (*e.g.,* turbidity or conductivity) will also be part of the monthly monitoring program, as well as monitoring baseline gauge height after the storm event.

The concentration limit for further action is the exceedance in the downstream sample of the cleanup level of 1.0 mg/L total aluminum for Spring 13 and 0.8 mg/L total aluminum for Spring 39. This limit does not apply when the upstream total aluminum concentration exceeds 1 mg/L for Spring 13 or 0.8 mg/L total aluminum for Spring 39. In cases where the upstream sample concentration exceeds the 1.0 mg/L limit for Spring 13 or 0.8 mg/L limit for Spring 39, the temporary limit for further action to be applied to the downstream sample is 1.3 times the total aluminum concentration measured in the upstream sample. The factor of 30% is designated to minimize false positives. The analytical variability was assessed through the analysis of field duplicate samples. The standard deviation due to sampling/analysis variability is about 16% for each of the two measurements at a spring. The uncertainty in measurement is estimated from this standard deviation for both the upstream and downstream concentrations as approximately 30%.

- Prevent future transport of mine site soil containing inorganic COCs to surface water entering the Red River to prevent future adverse impacts to habitat, physical toxicity, and exceedances of surface water quality ARARs.
- Protect recreational visitor/trespasser by reducing exposure (incidental ingestion) of surface water containing beryllium, cadmium, and manganese exceeding federal drinking water standards or Site-specific risk-based cleanup levels.
- Eliminate or reduce direct exposure and exposure via the food web, to mine site soil that contains molybdenum at concentrations that exceed the Site-specific risk-based cleanup level of 300 mg/kg for terrestrial ecological receptors.
- Maintain underground mine water elevations below those of the Red River, prevent ingestion by humans, and treat ground water from the underground mine workings containing mine-related inorganic COCs exceeding state/federal ARARs or Site-specific risk-based cleanup levels.

8.2.2 Basis and Rationale for Remedial Action Objectives

The basis for the remedial action objectives for the Mine Site Area is to protect future on-site industrial or commercial workers, recreational visitors and trespassers, and hypothetical future residents after cessation of mining. Based on population growth trends in the mine vicinity and nearby communities, residential use is an anticipated land use, especially along the Red River Valley and in the lower portion of the tributary drainages where the land is flatter. Although the proprietary controls recorded by CMI in 2009 should restrict residential use and ground water use if effectively enforced, alternatives have been developed to protect residential use and ground water use for domestic purposes. The federal or New Mexico MCLs, the New Mexico water quality standards, and EPA's health-based criteria for ground water drive the development of alternatives for addressing ground water contamination at the Mine Site Area through active remediation and source control.

Therefore, total aluminum concentrations below Spring 13 and Spring 39 are not allowed to increase beyond 1.3 times the concentration in water collected just upstream of Spring 13 and Spring 39.

The basis for the remedial action objectives is also to protect wildlife from exposure to molybdenum that is taken up and bioaccumulated by plants growing in waste rock since forestry is an MMD-approved post-mining land use. Protection of aquatic life (trout) in the Red River at and downgradient of seeps and springs also drives the development of alternatives which address sources of ground water contamination upwelling into the river along the mine reach. The current and anticipated future designated uses for the Red River include cold water aquatic life as well as wildlife habitat, irrigation, and livestock watering.

The mining-related sources of acidity and COCs are primarily the waste rock piles, which are comprised of acid generating or potentially acid generating rock. Additionally, based on the RI and previous hydrogeologic studies, there is a hydrologic connection between the bedrock and alluvial ground water aquifers and Red River surface water. During a mine shut down in the mid-1990s, the underground mine workings were allowed to fill back up with water. This caused acidic, metals-laden springs (Cabin Springs) along the mine reach of the Red River to flow as the bedrock water level was raised above the level (elevation) of the Red River. Preventing this hydrologic connection is an important consideration in the development of alternatives for the Mine Site Area.

In achieving the remedial action objectives at the Mine Site Area, the response action is expected to restore ground water and improve the quality of Red River surface water along and downstream of the mine. The effort for improving Red River surface water quality and protecting aquatic life is also part of the larger overall effort by multiple federal and state regulatory agencies, including ONRT and the federal trustee agencies, to clean up and protect the Red River Watershed.

8.2.3 Risk Addressed by the Remedial Action Objectives

Remedial action objectives will address the cancer risk from exposure to arsenic as well as the non-cancer health hazards from exposure to metals and other inorganic COCs by using ground water drawn from private water wells as drinking water. The response action will reduce COC concentrations to federal/state numeric standards or EPA health-based criteria. In achieving the remedial action objectives, the response action will reduce these risks primarily by ground water extraction and treatment technologies combined with source control options for containment of hazardous substances in the waste rock piles.

Such standards may not be attained, however, in those areas where natural background levels of certain metals and other inorganic COCs are above federal/state standards or EPA health-based criteria. The USGS Baseline Investigation estimated pre-mining baseline water quality for each of the tributary drainages at the mine site. The concentrations or ranges of concentrations estimated by the USGS are considered natural background levels for the Mine Site Area ground water. It is EPA's policy to generally clean up to background levels, if such levels exceed standards or health-based criteria.[61] Additionally, under the New Mexico Water Quality Act regulations, the numeric criterion for a specific constituent does not have to be achieved if that constituent is present in natural background at concentrations above the numeric criterion [§ 20.6.2.4101(B) NMAC].

The remedial action objectives will also address risk (direct toxicity) to resident brown trout from long-term chronic exposure to elevated concentrations of aluminum (total), as well as copper and zinc in Red River surface water at and downstream of Springs 13 and 39, and to a lesser degree at other seeps and springs. Risk estimates (HQs) from a comparison of surface water concentrations to trout-based toxicity reference values for chronic exposures were low (HQs exceeded EPA's threshold value of 1), but significant. HQs for chronic exposure to springs and seeps in contact with the river ranged up to 31 for aluminum and serial dilution tests with Springs 13 and 39 waters show acute toxicity at low levels of dilution. Additionally, whole body residue-based HQs for large brown trout exceeded the threshold value of 1 for copper (2-5) and zinc (5-14) for areas at the mine site and upstream of the mine site, but HQs at the mine site were greater than reference background. The highest HQ for copper was from near the Questa Ranger Station, located about a mile downstream of the mine reach. Abundance and diversity data also show significant reductions in the numbers and pounds of brown trout along the mine site, as

[61] Role of Background in the CERCLA Cleanup Program, OSWER 9285.6-07P

well as upstream and downstream of the mine site. In achieving the remedial action objectives, the response action will reduce risk by controlling point source ground water discharges along the mine reach of the river, as well as remediating ground water and controlling acid rock drainage and metals leaching of mine waste (source control) that contaminates ground water.

The remedial action objectives are not designed to reduce risk to stocked legal size rainbow trout, as no conclusions were drawn on the potential for adverse effects in the EPA BERA. Stocked rainbow trout are expected to reside in the river for only a short period of time prior to being taken by fishermen. Nevertheless, the remedial actions will likely have the effect of reducing risk to rainbow trout.

The remedial action objectives will address the non-cancer health hazards associated with exposure to beryllium, cadmium, and manganese in surface water at the mine site catchments and pumpback pond and the seeps and springs associated with the waste rock piles and along the Red River by recreational visitors or trespassers. The surface water in the catchments and pumpback pond consists of a mixture of waste rock seepage and impacted storm water. Hazard Index (HI) estimates for such exposures are above EPA's threshold of 1 and range as high as 51 for total HIs. In achieving the remedial action objectives, the response action will reduce these risks by preventing exposure using pipes to convey seepage to catchments and restricting access to the catchments.

8.3 Remedial Action Objectives for the Tailing Facility Area

8.3.1 Remedial Action Objectives

Since the tailing facility is an operating facility, EPA developed remedial action objectives with an understanding that some aspects of the remedial action will take place after tailing disposal operations have ceased.

In developing remedial action objectives, EPA assumed that wildlife currently using the tailing facility, such as elk herds that range within the Guadalupe Mountains, will continue to do so for the foreseeable future. EPA also assumed that the future land uses for the tailing facility will be wildlife habitat, the post-mining land use approved by MMD, as well as light industries (including renewable energy projects) and park, recreational, or athletic field uses.

For those areas adjacent to the tailing facility, EPA developed the remedial action objectives assuming current land uses of residential, agriculture (irrigated pastures), recreational, livestock grazing, gardening, and wildlife habit will continue for the foreseeable future. The remedial action objectives were also developed assuming the current use of ground water in the vicinity of the tailing facility for domestic and agricultural purposes (including drinking and livestock watering) will also continue for the foreseeable future. The alluvial aquifer is, and will likely continue to be, the most heavily used aquifer in the Questa area. The limited use of the basal bedrock aquifer for potable and drinking water at the Red River State Fish Hatchery is likely to continue for the foreseeable future. Although there is the potential for an increase in the use of the bedrock ground water south and west of the tailing facility, it is unlikely due to the remoteness of the area and that the contaminated ground water is mostly under BLM-controlled public lands.

The remedial action objectives for the Tailing Facility Area are:

- Eliminate or reduce ingestion by humans of ground water drawn from private wells containing mine-related inorganic COCs exceeding state/federal ARARs or Site-specific risk-based cleanup levels.
- Restore contaminated ground water at and off-site of the tailing facility to meet state/federal ARARs or Site-specific risk-based cleanup levels for inorganic COCs.
- Eliminate or reduce, to the maximum extent practicable, the seeping and migration of inorganic COCs from tailing to ground water at concentrations and quantities

that have the potential to cause exceedances of the numeric ground water ARARs[62] or Site-specific risk-based cleanup levels for ground water.

- Protect recreational visitor/trespasser or future commercial use scenario by reducing or eliminating exposure (dermal contact/investigation) to tailing in the ponded area that contains molybdenum at concentrations exceeding Site-specific health-based cleanup levels.

- Protect aquatic and aquatic-dependant life by reducing or eliminating exposure to tailing in the ponded areas that contains metals at concentrations exceeding Site-specific risk-based cleanup levels.

- Eliminate or reduce direct exposure and exposure via accumulation in plants to tailing that contain molybdenum at concentrations exceeding the Site-specific risk-based cleanup level for protection of wildlife (41 mg/kg for protection of deer and elk; 54 mg/kg for protection of birds and other terrestrial wildlife not including grazing mammals protected by the 41 mg/kg level).[63]

8.3.2 Basis and Rationale for Remedial Action Objectives

The basis for the remedial action objectives for the Tailing Facility Area is to protect current and future residents and future on-site commercial or industrial workers that may

[62] Numeric criteria or background concentrations, whichever are higher.

[63] The remedial action objective for protecting deer and elk was not developed during the FS as the risk to such receptors estimated in the EPA BERA (CDM 2009b) was below an HQ of 1 based on surface soil samples that consisted of variable amounts of natural soil, interim soil cover placed over tailing, and tailing, depending on the specific depth interval. The BERA did not evaluate risk from exposure to only tailing because the cover requirements established under the New Mexico Mining Permit TA001RE and Ground Water Discharge Permit DP-933 for reclamation specified three feet of soil. It was assumed that any disturbance and surface displacement of underlying tailing material by burrowing animals would be minimal with such cover thickness. However, in light of the approved 5-year pilot demonstration proposed by CMI in 2009 to evaluate alternate cover thicknesses of 1 and 2 feet at the tailing facility, concerns were raised about the validity of the underlying assumptions used in the risk assessment. The use of a one-foot thick cover suggests that plants growing at the tailing facility will be rooting into the tailing material underlying the cover and could take up molybdenum at levels that may be harmful to deer and elk. Therefore, a re-evaluation of risk estimates was performed for tailing facility surface samples based on exposure to tailing (CDM 2009c). Based on the new risk estimates, the remedial action objective was developed. Preliminary remediation goals to protect deer and elk from exposure to molybdenum in tailing at the tailing facility were included in the Proposed Plan.

use ground water drawn from private water wells, industrial wells, or spring collection systems for drinking water and for agricultural purposes, the current and reasonably foreseeable future use of ground water.

Although molybdenum concentrations are not above the New Mexico irrigation standard of 1 mg/L for molybdenum, it is above the EPA Region 6 health-based criterion of 0.08 mg/L in the area south of the tailing facility. Uranium concentrations also exceed the federal and New Mexico drinking water standard (MCL) for uranium and several metals and other inorganic contaminants exceed New Mexico ground water quality standards.

The protection of current and potential future users of ground water as drinking water and the cleanup standards and criteria were the primary drivers for development of the remedial alternatives for the Tailing Facility Area.

The protection of human health and wildlife that could be exposed to tailing or tailing pond sediment was also used to develop alternatives consisting of source containment and access restrictions.

8.3.3 Risk Addressed by the Remedial Action Objectives

The remedial action objectives will address the non-cancer health hazards associated with exposure to molybdenum by current and future residents and future on-site commercial/industrial workers that use ground water drawn from a private or commercial well for drinking water. HIs exceed the EPA threshold of 1 for molybdenum in certain areas of the alluvial and basal bedrock aquifers. Concentrations of molybdenum in both aquifers exceed the EPA Region 6 health-based criterion of 0.8 mg/L. In achieving the remedial action objectives, the response action will reduce the risk by cleaning up ground water to meet the EPA Region 6 health-based criterion through active ground water extraction and seepage interception technologies. Risk reduction will also be attained by the elimination or reduction of tailing seepage impacts to ground water through source control measures at the tailing facility following cessation of tailing disposal operations.

The remedial action objectives will also address risk to wildlife (deer and elk) from long-term (chronic) exposure to elevated molybdenum concentrations in tailing and plants that take up molybdenum from tailing. The calculated HQ of 4 for deer and elk exceeds the EPA threshold value of 1. The mule deer and Rocky Mountain elk are the receptors of concern because of their year-round occurrence at the tailing facility, likelihood of use of the tailing facility over varying frequencies and durations, diet, and potential sensitivity to dietary exposures of molybdenum based on sensitivity observed in cattle. The response action will reduce the risk to deer and elk by restricting access during the remaining operating life of tailing facility and by source containment following cessation of tailing disposal operations.

The remedial action objectives will similarly address the non-cancer health hazards to recreational visitors/trespassers and commercial/industrial workers from exposure to contaminated tailing pond sediment (tailing). The response action will reduce exposure by access restrictions during the operation of the facility and source containment following cessation of tailing disposal operations.

8.4 Remedial Action Objectives for the Red River and Riparian and South of Tailing Facility Area

8.4.1 Remedial Action Objectives

For the Red River and Riparian and South of Tailing Facility Area, EPA developed remedial action objectives assuming that current uses of the Red River by aquatic and aquatic dependent life and as a coldwater fishery will continue for the foreseeable future. EPA also assumed that the current land uses within the riparian area along the Red River for wildlife habitat (birds) and the area south of the tailing facility for wildlife habitat (deer, elk) and livestock grazing (cattle, sheep) will continue for the foreseeable future. Based on these assumptions, the remedial action objectives for the Red River, riparian, and south of tailing facility area are:

- Eliminate or reduce direct exposure and exposure via accumulation in plants to mining-affected soil and tailing spills that contain molybdenum at concentrations exceeding the Site-specific risk-based cleanup levels of 54 mg/kg for the protection of birds and other terrestrial wildlife not including grazing mammals protected by the 41 mg/kg level, 41 mg/kg for protection of wildlife (deer and elk) and 11 mg/kg for the protection of livestock (cattle and sheep).
- Eliminate or reduce direct exposure of fish to Red River surface water along the mine site and tailing facility that exceeds surface water ARARs or Site-specific risk-based cleanup levels for aluminum (direct toxicity).[64]

8.4.2 Basis and Rationale for Remedial Action Objectives

The basis for the remedial action objectives for the Red River is to protect aquatic life (trout) as a current and anticipated future use of the river by cleaning up the sources of contamination to the river. Findings of the RI have shown that aquatic life in the Red River is adversely impacted along the mine reach as well as upstream and downstream of mine reach. The protection of trout was a driver for developing the source control and seepage collection alternatives for the Mine Site Area.

The basis for the remedial action objectives for the area south of the tailing facility is to protective of wildlife (deer and elk) and livestock (cattle and sheep) that currently graze or forage in the area. These land uses are expected to continue into the reasonably foreseeable future. These receptors are or may be particularly sensitive to molybdenum toxicity and could contract molybdenosis from ingestion of contaminated soil and/or plants that take up molybdenum from the soil. The remedial action objectives are intended to prevent exposure and exposure via accumulation in plants to soil exceeding molybdenum

[64] Red River water quality is being addressed through response actions at the Mine Site Area to reduce COCs entering the river from ground water at Springs 13 and 39, including source control measures.

concentrations of 41 mg/kg to protect deer and elk and 11 mg/kg to protect cattle, sheep and other sensitive wildlife.

The basis for the remedial action objectives for the riparian areas along the Red River is to protect wildlife (primarily birds and non-grazing mammals) that may be exposed to hot spots of elevated molybdenum contamination in the tailing spills along the riparian corridor. The use of the riparian corridor by avian wildlife is a current and anticipated future land use.

8.4.3 Risk Addressed by the Remedial Action Objectives

The remedial action objectives will address the risk to resident brown trout from chronic exposure to aluminum, copper, and zinc in Red River surface water through response actions at the Mine Site Area (see Section 8.2.3, above). To achieve the remedial action objectives, the response action for the Mine Site Area will reduce the risk to resident brown trout by (1) controlling the discharges of contaminated ground water at springs (Springs 13 and 39) along the mine reach of the river, (2) reducing COC concentrations in ground water as well as preventing the migration of contaminated ground water to zone of upwelling, and (3) eliminating or reducing acid rock drainage and metals leaching from mine waste that impacts ground water and, ultimately, Red River surface water through the hydrologic connection between ground water and surface water at the mine site.

The remedial action objectives will also address the risk to wildlife (deer and elk) and livestock (cattle and sheep) that may contract molybdenosis from foraging or grazing in the meadow south of Dam No. 1 between Embargo Road and the river. The response action for the area south of the tailing facility will reduce the risk to these receptors by soil removal with on-site/off-site disposal or capping options.

The remedial action objectives do not address risk associated with the ingestion of milk from livestock (*i.e.,* non-cancer health hazards associated with molybdenum exposure) because the risk are likely overestimated due to very conservative assumptions in risk assessment (CDM 2009a) and few if any dairy cows have been observed in the area.

8.5 Remedial Action Objective for Eagle Rock Lake

8.5.1 Remedial Action Objectives

In developing the remedial action objectives for Eagle Rock Lake, EPA assumed the current use of the lake by the local community for fishing will continue for the foreseeable future, as the lake is routinely stocked with rainbow trout by hatchery personnel. The lake also supports aquatic and aquatic-dependant life, including fish and benthic macroinvertebrate populations.

The remedial action objectives for Eagle Rock Lake are:

- Eliminate or reduce direct exposure of benthic macroinvertebrates to mine site-affected sediment in Eagle Rock Lake that exceeds preliminary Site-specific risk-based cleanup levels for aluminum (with consideration of floc formation), cadmium, copper, manganese, nickel, and zinc.
- Eliminate or reduce the deposition of mine site-affected sediment in Eagle Rock Lake that exceeds preliminary Site-specific risk-based cleanup levels for the Red River sediment COCs (nickel and zinc) for benthic macroinvertebrates.

8.5.2 Basis and Rationale for Remedial Action Objectives

The basis of the remedial action objectives is to ensure that the current and anticipated future uses of Eagle Rock Lake by the local community for fishing and other recreational purposes as well as aquatic and aquatic-dependent life are protected. This will be done by cleaning up the lake-bottom sediment to protect the benthic macroinvertebrate population (aquatic insects) that comes into contact with the sediment. Benthic macroinvertebrate populations are considered important because the invertebrates are sensitive indicators of water and sediment quality. They also serve as a major food source for fish and, therefore, warrant protection by the Selected Remedy.

8.5.3 Risks Addressed by the Remedial Action Objectives

The remedial action objectives for Eagle Rock Lake will address risk to the benthic macroinvertebrate ecosystem from exposure to metals in lake sediment. Elevated concentrations of metals in sediment may cause adverse effects to the benthic macroinvertebrate populations. HQs estimated in the BERA exceed the EPA threshold value of 1 for zinc (14), copper (8) and nickel (6). The response action will reduce the risk to the benthic macroinvertebrate ecosystem through either sediment capping or dredging options while preventing future degradation of the sediment in the lake by controlling the inflow of mine-affected (as well as scar-affected) sediment from the Red River into the lake during storm events. Another option considered is the backfilling of Eagle Rock Lake and construction of a new lake.

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9.0 DESCRIPTION OF ALTERNATIVES

Twenty-seven alternatives and subalternative combinations were retained for detailed analysis in the FS at the five areas of the Site following screening. The alternatives that were analyzed are presented below for each individual area. The alternatives are numbered to correspond with the alternatives presented in the FS Report (URS 2009b).

Each of the five areas includes a No Action (or No Further Action) alternative which is required by the NCP as a baseline and includes continuation of current measures in place at the Site with no further actions taken.

9.1 General Elements

General elements used in the development of the remedial alternatives in the FS include cost elements, present worth analysis, period of analysis, discount rate, and general site monitoring and maintenance, including the performance of five-year reviews. The cost elements, present worth analysis, period of analysis and discount rate are summarized in this section and discussed in detail under Summary of Estimated Remedy Costs in Section 12.3.

Cost elements are associated with capital (construction), operation and maintenance (O&M) costs, and periodic costs. Water treatment includes construction of a water treatment plant and repository in Year 0, Year 10, Year 20, and Year 30 of the remedial action.

A present worth, or present value, analysis is a method used to evaluate expenditures that occur over different time periods. This standard methodology allows for a cost comparison of different remedial alternatives, which may have capital and O&M costs that are incurred in different time periods, on the basis of a single cost figure for each alternative.

Generally, a 30-year period of analysis was used to calculate a present value for each alternative, although several alternatives used a shorter period. The Mine Site Area period of analysis was extended to cover the duration of rock pile earthmoving activities (*e.g.,* 28 years) plus 30 years O&M, totaling 58 years. For water treatment, only a 30-year period of analysis is estimated for O&M.

A real discount rate was applied to expenditures that occur beyond the base year (2008) over the period of analysis. The real discount rate consists of the difference between the rate of inflation and the nominal discount rate. Based on the NCP and EPA Guidance (USEPA 2000), a real discount rate of 7 percent was used in developing the present worth (present value) cost estimates for the remedial alternatives.

9.1.1 General Site Monitoring and Maintenance

General monitoring and maintenance components are included in each alternative except for those areas not within the CMI property boundary, such as Eagle Rock Lake, private property south of the tailing facility, and the Red River and riparian areas. General maintenance activities may include maintenance of fences, signs, roads, drainage, or structures. Maintenance required to preserve a remedy and the associated components of an alternative (*e.g.,* long-term maintenance of an on-site disposal repository) has been included for all areas, where applicable. General monitoring activities may include sampling of surface water, ground water, or air. Site monitoring will, at a minimum, be the same as required under New Mexico Ground Water Discharge Permits DP-1055 and DP-933.

9.1.2 Five-Year Review

Under CERCLA § 121(c), five-year reviews will be required at the Site since the major sources of contamination (*e.g.,* waste rock and tailing) will remain on Site that would prohibit unlimited and unrestricted use. Five-year reviews will be conducted at the start of the remedial action on a Site-wide basis, and not per area of cleanup.

9.2 Mill Area Alternatives

The Mill Area includes the following five alternatives (and five subalternatives) for remediation of PCBs and molybdenum in soil:

- **Alternative 1** – No Further Action
- **Alternative 2** – Limited Action (Institutional Controls, Health and Safety Program and Hazard Communication; Cover at Mill Decommissioning)
- **Alternative 3** – Soil Removal (High Concentrations of PCBs>25 mg/kg) and Off-Site Treatment and Disposal (Low Occupancy/Commercial/Industrial)
- **Alternative 4** – Soil Removal (High Concentrations of PCBs >10 mg/kg) and Treatment and Disposal and Source Containment (High Occupancy/Residential)
    - Subalternative 4A: Soil Removal; Off-Site Treatment and Disposal of PCB Soil; Soil Cap
    - Subalternative 4B: Soil Removal; Off-Site Treatment and Disposal of PCB Soil; Asphalt Cap
- **Alternative 5** – Soil Removal and Treatment and Disposal (High Occupancy/Residential)

- Subalternative 5A: Soil Removal; Off-Site Treatment and Disposal of PCB Soil; Off-Site Disposal of Molybdenum Soil
- Subalternative 5B: Soil Removal; Off-Site Treatment and Disposal of PCB Soil; On-Site Disposal of Molybdenum Soil
- Subalternative 5C: Soil Removal; On-Site Treatment and Disposal of PCB Soil; On-Site Disposal of Molybdenum Soil

9.2.1 Common Elements of the Alternatives

There are common elements to many of the remedial alternatives for the Mill Area except the No Further Action alternative. They include land use controls, including access controls, general maintenance, water quality monitoring, storm water management, regrade, cover and revegetation as part of mill decommissioning, and institutional controls.

With the exception of the No Further Action and Limited Action alternatives, the remaining alternatives consist primarily of soil removal (excavation), with options for capping as well as on-Site and off-Site treatment and disposal.

9.2.1.1 Access Controls

The Mill Area is currently surrounded by a chain linked fence with restricted access through a central gate with a badge identification system. Signs are posted at the gate and on fences to control access. The existing fence, restricted access through the gate, and signage will be maintained as part of these alternatives.

9.2.1.2 Regrade, Cover and Vegetation as Part of Mill Decommissioning

The regrading, covering and vegetation elements are reclamation requirements established in New Mexico Mining Permit TA001RE, Permit Revision 96-2, and Ground Water Discharge Permit DP-1055. The cover shall be of a minimum 6-inch depth in areas of light industry use and consist of amended Spring Gulch waste rock which passes an 8-inch screen for grain size and is less than or equal to the 600 mg/kg molybdenum suitability criterion for screening borrow material. Vegetation will include grasses, forbs, shrubs and trees. In areas where the approved post-mining land use is forestry, the thickness of cover will be a minimum of 36 inches, consistent with conditions of Mining Permit TA001RE (Permit Revision 96-2) and Ground Water Discharge Permit DP-1055 for cover depth.

9.2.1.3 Institutional Controls

Government controls would be used to restrict access to contaminated ground water. Proprietary controls that have been recorded by CMI are intended to legally restrict land and resource use at the Mill Area to minimize the potential for human exposure. They are or would be used in the following manner for the Mill Area remedial alternatives:

- Temporary well drilling restrictions would be imposed by the New Mexico Office of State Engineer at the Mill Area; the prohibition will only apply to new requests for water well permits and cannot be enforced against existing water well permit holders;
- Restrictive covenants and the Conservation Easement recorded by CMI prohibit residential use of the mine site property (including the Mill Area) (see Current and Potential Future Land and Resources Use, Section 6.0, above). These proprietary controls also restrict the use of surface water and ground water, as well as certain construction activities to protect any remedial or reclamation measures required by EPA or New Mexico. CMI conveyed the Conservation Easement to the Village of Questa and identified EPA, NMED, and EMNRD as third party beneficiaries. The Declaration of Restrictive Covenants identifies CMI, the Village of Questa, EPA, NMED, and EMNRD as enforcing parties and the Village of Questa and the three government agencies as third party beneficiaries. The Conservation Easement and restrictive covenants run with the land in perpetuity and are binding on CMI and future owners, tenants, licensees, occupants and users of the property. They are to be maintained and enforced in perpetuity.

9.2.2 Key Applicable or Relevant and Appropriate Requirements

The following Applicable or Relevant and Appropriate Requirements (ARARs) are key requirements that provide a basis for developing the remedial alternatives for the Mill Area. A summary of the chemical-, action-, and location-specific ARARs that apply to each remedial alternative for the Site is presented in Tables 9-1 through 9-12.

9.2.2.1 Toxic Substances Control Act Requirements

In accordance with the Toxic Substances Control Act (TSCA) and 40 C.F.R. Part 761, the remedial alternatives include the following disposal requirements for PCBs for each land use category:

<u>Low Occupancy Area/Commercial/Industrial Land Use</u>: The cleanup level for bulk PCB remediation waste is less than or equal to 25 parts per million [or approximately milligrams per kilogram (mg/kg)] unless otherwise specified. For low occupancy areas, bulk PCB remediation waste at concentrations greater than 25 mg/kg and less than or equal to 50 mg/kg may remain on-site if secured by a fence and marked with a sign using the PCB mark having the Mark M_L format [40 C.F.R. § 761.61(a)(4)(i)(B)]. The PCB mark is a label with black striping around the border that contains certain information specified in the regulations that apply to PCB items. PCB Mark M_L is a 6-inch by 6-inch square with the text of the mark including the warning "Caution Contains PCBs." Low occupancy areas where bulk PCB remediation waste remain at concentrations greater than 25 mg/kg and less than or equal to 100 mg/kg must be covered with a cap meeting TSCA requirements.

<u>High Occupancy/Residential Land Use</u>: The cleanup level for bulk PCB remediation waste is less than or equal to 1 mg/kg without further conditions. High occupancy areas where bulk PCB remediation waste remain at concentrations greater than 1 mg/kg and less than or equal to 10 mg/kg must be covered with a cap meeting TSCA requirements.

9.2.2.2 New Mexico Mining Act and Subsequent Regulations

The New Mexico Mining Act regulations, § 19.10.5 NMAC, address non-coal mining of existing mining operations. Section 19.10.5.507 NMAC requires reclamation to a condition that allows the re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding areas following closure, unless it conflicts with the approved post-mining land use designation.

9.2.3 To-Be-Considered Items

To-be-considered (TBC) items identified for the Mill Area alternatives include the New Mexico Mining Permit TA001RE (Permit Revision 96-2) which provides conditions for reclamation and closure of the Mill Area and incorporates the closeout plan. TBC items also include the New Mexico Ground Water Discharge Permit DP-1055, which includes conditions for controlling discharges of contaminants from the site into ground water and surface water so as to protect ground and surface water for actual and potential future use as domestic and agricultural water supply and other uses; and to abate pollution of ground and surface water. Several of the conditions in these two permits are TBC items.

9.2.4 Distinguishing Features of Each Alternative

9.2.4.1 Alternative 1 – No Further Action

Estimated Construction Timeframe:	*Not Applicable*
Estimated Timeframe to Reach Remediation Goals:	*Not Applicable*
Estimated Capital Cost:	*$0*
Estimated Life Time O&M Costs:	*$802,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$327,000*
Number of Years Cost is Projected:	*30 years*

Alternative 1 would not require further actions at the Mill Area. Under current operations, public access is restricted and CMI provides a worker health and safety and hazard communication program that specifically addresses potential risks from exposure to PCBs. The access restriction and worker programs would continue. Oversight and enforcement of mining worker health and safety programs is a responsibility of the Mine Safety and Health Administration (MSHA) of the U.S. Department of Labor. In addition, Alternative 1 includes continued implementation of recorded institutional controls.

The major components of Alternative 1 include:

- Continue controlled access (fencing, signage, etc.) to the site;
- Continue current worker health and safety program and hazard communication;
- Institutional controls: Declaration of Restrictive Covenants, Conservation Easement, and temporary well drilling restrictions;
- General maintenance of Mill Area, including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Other maintenance and monitoring for the Mill Area is included in the alternative, which consists of grading of roads; maintenance of structures; water quality monitoring for all wells, seeps, and springs in and along the Mill Area and storm water management.

9.2.4.2 Alternative 2 – Limited Action (Institutional Controls, Health and Safety Program and Hazard Communication)

Estimated Construction Timeframe:	*1.5 years*
Estimated Timeframe to Reach Remediation Goals:	*1.5 years*
Estimated Capital Cost:	*$2,078,000*
Estimated Life Time O&M Costs:	*$923,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$2,451,000*

Number of Years Cost is Projected: *30 years*

Alternative 2 would include limited action to address risk from exposure to PCB-contaminated soil in the Mill Area.

The major components of Alternative 2 include:

- Continue controlled access (fencing, signage, etc.) to the site;
- Continue current worker health and safety program and hazard communication;
- BMP Plan development and implementation for in-place PCB management, including, but not limited to, signage and targeted excavation and gravel placement;
- Regrade, cover, and vegetate Mill Area as part of mill decommissioning;
- Visual horizontal indicator placed under the cover;
- Institutional controls: Declaration of Restrictive Covenants, Conservation Easement and temporary well drilling restrictions;
- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Current mine workers would continue to be protected from soil risks under CMI's health and safety and hazard communication program and MSHA requirements. In addition, Best Management Practices will be implemented to manage the PCBs currently in-place prior to placement of the cover, in order to prevent the highest concentration PCBs from being spread by grading, wind dispersion, and traffic (*i.e.,* pedestrian or vehicle traffic) throughout impacted areas of the Mill Area. Per the TSCA definition for low occupancy use areas, bulk PCB remediation wastes may remain at a cleanup site at concentrations greater than 25 ppm and less than or equal to 50 ppm if the site is secured by a fence and marked with a sign using the PCB mark having the Mark M_L format (see Section 9.2.2.1, above). Bulk PCB remediation waste includes, but is not limited to, the following nonliquid PCB remediation waste: soil, sediment, dredged materials, mud, PCB sewage sludge, and industrial sludge [40 C.F.R. § 761.61(a)(4)(i)]. Therefore, Best Management Practices for the Mill Area include installation of signs indicating the presence of PCBs above cleanup levels and the application of 4 inches of gravel over areas of soil containing concentrations of PCBs greater than 50 mg/kg. Gravel placement minimizes the potential for both on-site and off-site dispersal of soil containing elevated PCB concentrations under site maintenance activities and during high winds prior to implementation of a remedial action. These Best Management Practices are not all-inclusive and their details may be modified to provide additional protectiveness. In addition, an EPA-approved Best Management Practice Plan will be finalized, which contains specific measures based on the types of operations conducted in the Mill Area. This Best Management Practice Plan will include actions to be taken if construction activities are conducted in the Mill Area that involve the movement of soil containing molybdenum above the preliminary remediation goals and/or PCBs above the TSCA cleanup level (*e.g.,* during construction of a water treatment plant).

As part of this alternative, approximately 41 acres of the Mill Area will be regraded, a visual horizontal indicator put in place and covered with a minimum of 6 inches of amended Spring Gulch waste rock, and revegetated in areas designated for light industry use. A 36-inch thick revegetated and amended cover will be constructed for those areas with a designated forestry post-mining land use to allow for development of a self-sustaining forest ecosystem comparable to the surrounding region.[65] Screening of the Spring Gulch waste rock would be required to ensure that the material selected as fill meets the grain size requirement and does not exceed the molybdenum suitability criterion for screening borrow material.

[65] Based on cost estimates provided in the FS Report, the cost for increasing the cover depth from 6 inches to 36-inches across the 41-acre Mill Area would increase to between $4 and $5 million.

9.2.4.3 Alternative 3 – Soil Removal (High Concentrations of PCBs greater than 25 mg/kg) and Off-Site Treatment and Disposal (Low Occupancy – Commercial/Industrial)

Estimated Construction Timeframe:	*1.5 years*
Estimated Timeframe to Reach Remediation Goals:	*1.5 years*
Estimated Capital Cost:	*$2,176,000*
Estimated Life Time O&M Costs:	*$923,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$2,549,000*
Number of Years Cost is Projected:	*30 years*

The major components of Alternative 3 include:

- Continue controlled access (fencing, signage, etc.) to the site;
- Continue current worker health and safety program and hazard communication;
- Excavate soil greater than the TSCA cleanup level for total PCBs for low occupancy/commercial/industrial use areas (25 mg/kg);
- Confirmation sampling;
- Import clean fill and grade;
- Transport PCB soils and treat and/or dispose at appropriate EPA approved off-Site facilities;
- Regrade, cover, and vegetate Mill Area;
- Institutional controls: Declaration of Restrictive Covenants, Conservation Easement, and temporary well drilling restrictions;

- General maintenance of Mill Area, including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Approximately 2,400 yd^3 of soil with total PCB concentrations above the TSCA cleanup level of 25 mg/kg for low occupancy/commercial/industrial use would be excavated from an area covering about 0.6 acres. Affected soil will be removed initially to a depth of 2.5 feet. Confirmation soil sampling will be conducted to determine if cleanup levels have been attained. If not, additional soil will be excavated until cleanup levels are met or an EPA-acceptable depth has been reached.

The excavated soil will be separated into soils containing PCBs greater than 50 mg/kg and those with PCBs less than or equal to 50 mg/kg. The greater than 50 mg/kg PCB-soils will be transported to the nearest off-Site treatment, storage, and disposal facility that accepts and treats PCB-affected soil. An appropriate facility may be located approximately 400 miles away, one way. This facility treats (*i.e.,* incinerates) the PCB-affected soil prior to disposal.

The excavated soil with PCBs less than or equal to 50 mg/kg will be transported to the nearest off-Site facility that accepts but does not treat the PCB-affected soil. An appropriate facility may be located approximately 300 miles away, one way. Soil samples will be collected and analyzed to identify contaminant concentrations prior to transport.

The excavation would be backfilled with approximately 2,400 yd^3 of clean fill material and regraded. The Spring Gulch Waste Rock Pile, which has been identified as the borrow material for fill, may require screening to achieve a suitable gradation for the backfill.

Similar to Alternative 2, Alternative 3 includes worker health and safety and hazard communication programs.

9.2.4.4 Subalternative 4A – Soil Removal (High Concentrations of PCBs greater than 10 mg/kg) and Off-Site Treatment and Disposal of PCB Soil; Source Containment (Concentrations of PCBs between 1 and 10 mg/kg and Molybdenum greater than 503 mg/kg) with Soil Cap (High Occupancy/Residential)

Estimated Construction Timeframe:	*3 years*
Estimated Timeframe to Reach Remediation Goals:	*3 years*
Estimated Capital Cost:	*$13,064,000*
Estimated Life Time O&M Costs:	*$946,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$13,446,000*
Number of Years Cost is Projected:	*30 years*

Approximately 3,300 yd^3 of soil with concentrations of total PCBs above the TSCA cleanup level of 10 mg/kg for high occupancy/residential use would be excavated from an area covering 0.8 acre. The remaining soil having concentrations that exceed either the TSCA cleanup level for total PCBs in high occupancy/residential use areas (1 mg/kg) or the residential remediation goal for molybdenum (503 mg/kg) would be covered with a soil cap. This area covers approximately 28 acres. Soil material needed to meet the requirements of 40 C.F.R. § 761.61(a)(7) would be obtained from an off-Site borrow source which may be located several hundred miles away (100 to 250 miles). The depth of excavation would be determined in a manner consistent with that described in Alternative 3. The PCB-affected soil would be separated and disposed off Site also in a manner consistent with that described in Alternative 3. The layered institutional controls would prohibit activities that may compromise the integrity of the cap placed over PCB- and molybdenum-contaminated soil.

The major components of Subalternative 4A include:

- Continue controlled access (fencing, signage, etc.) to the site;
- Continue current worker health and safety program and hazard communication;
- Excavate soil greater than the TSCA cleanup level for total PCBs for high occupancy/residential use with a cap (10 mg/kg);
- Confirmation sampling;
- Import clean fill and grade;
- Transport PCB soils and treat and/or dispose at appropriate EPA approved off-Site facilities;
- Apply a soil cap over soil areas exceeding the TSCA cleanup level for PCBs for high occupancy/residential use (1 mg/kg) and/or the residential PRG for molybdenum (503 mg/kg);
- Regrade, cover, and vegetate appropriate portions of the Mill Area;
- Institutional controls: Declaration of Restrictive Covenants, Conservation Easement, and temporary well drilling restrictions;
- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Subalternative 4A includes targeted removal of PCB-affected soils, off-Site disposal, and installation of a cap. Delineation of the area for targeted soil removal was estimated based on total PCB concentrations collected at depths of 0 to 6 and 0 to 24 inches during the RI. In order for the cap to be compliant with PCB cleanup provisions in 40 C.F.R. § 271.61 (a)(4)(i)(a) for high occupancy areas, total PCB concentrations must be below 10 mg/kg if PCBs remain in place with no plans for removal or treatment of the soil. Review of the distribution of PCBs in the Mill Area reveals that the highest concentrations are found in focused samples collected outside of doorways at the Packaging/Drying building and near the thickener. The total area includes approximately 0.8 acre. Assuming a 2.5-foot depth of excavation, the estimated volume of PCB-affected soil requiring removal is approximately 3,300 yd^3. Depth of excavation will be determined in a manner consistent with that described in Alternative 3. After the removal of PCB-contaminated soil, clean fill material will be placed into the excavation and graded. The fill will be blended to match the original land surface and drainage.

The PCB-affected soil will be separated into soils containing PCBs greater than 50 mg/kg and those with PCBs less than or equal to 50 mg/kg. The greater than 50 mg/kg PCB-soils will be transported to an appropriate off-Site treatment, storage and disposal facility that accepts and treats PCB-affected soil. An appropriate facility may be located approximately 400 miles away, one way. This facility treats (*i.e.,* incinerates) the PCB-affected soil prior to disposal. The excavated soil with PCBs less than or equal to 50 mg/kg will be transported to the nearest off-Site facility that accepts but does not treat the PCB-affected soil. An appropriate facility may be located approximately 300 miles away, one way. Soil samples will be collected and analyzed to identify constituent concentrations prior to transport.

Areas not excavated (approximately 28 acres) that contain soil with concentrations exceeding either the TSCA cleanup level for high occupancy/residential use areas for total PCBs (1 mg/kg) or the residential remediation goal for molybdenum (503 mg/kg) will be capped. This cap material will meet the requirements of 40 C.F.R. § 761.61 (a)(7) and will be obtained from an off-Site borrow source, which may be several hundred miles away (100 to 250 miles). A soil cap over 28 acres requires approximately 45,000 yd^3 of off-Site clay material, assuming a 1-foot-thick cap. A 6-inch thick cover placed on top of the compacted clay cap requires approximately 23,000 yd^3 of Spring Gulch waste rock material. A 36-inch cover requires approximately 138,000 yd^3 of waste rock material.

Confirmation soil sampling will be required as part of remediation activities. Limited sampling of the perimeter of the excavation will be conducted to identify excavation limits and cap limits. Storm water currently drains to and is detained in a catchment near the Lab. Upon decommissioning, areas of the mill outside the remediated footprint area will be regraded, covered with 36 inches of amended Spring Gulch material, and revegetated.

Remediated areas will only be excluded from the additional regrade and cover at decommissioning if they satisfy the cover requirements (36 inches) at the time of mill decommissioning. However, the approved post-mining land use for the Mill Area allows for water management (*i.e.*, water treatment). Areas required for water management would be excluded from the area to be covered with 36 inches of Spring Gulch material until no longer used for this purpose.

9.2.4.5 Subalternative 4B - Soil Removal (High Concentrations of PCBs greater than 10 mg/kg) and Off-Site Treatment and Disposal of PCB Soil; Source Containment (Concentrations of PCBs between 1 and 10 mg/kg and Molybdenum greater than 503 mg/kg) with Asphalt Cap (High Occupancy/Residential)

Estimated Construction Timeframe:	*3 years*
Estimated Timeframe to Reach Remediation Goals:	*3 years*
Estimated Capital Cost:	*$10,444,000*
Estimated Life Time O&M Costs:	*$2,847,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$11,502,000*
Number of Years Cost is Projected:	*30 years*

Removal activities will be similar to those described for Subalternative 4A with the exception of the cap. An asphalt cap would be constructed as opposed to a soil cap over soil areas exceeding the TSCA cleanup level for PCBs for high occupancy/residential use (1 mg/kg) or the residential remediation goals for molybdenum (503 mg/kg).

The major components of Subalternative 4B include:

- Continue controlled access (fencing, signage, etc.) to the site;
- Continue current worker health and safety program and hazard communication;

- Excavate soil greater than the TSCA cleanup level for total PCBs for high occupancy/residential use with a cap (10 mg/kg);
- Confirmation sampling;
- Import clean fill and grade;
- Transport PCB soils and treat and/or dispose at appropriate EPA-approved off-Site facilities;
- Apply an asphalt cap over soil areas exceeding the TSCA cleanup level for PCBs for high occupancy/residential use (1 mg/kg) and/or the residential PRG for molybdenum (503 mg/kg);
- Regrade, cover, and vegetate appropriate portions of the Mill Area;
- Institutional controls: Declaration of Restrictive Covenants, Conservation Easement, and temporary well drilling restrictions;
- General maintenance of Mill Area including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

The area to be capped is approximately 28 acres. Asphalt will be obtained from an off-Site contractor approximately 30 miles away. The asphalt will be placed over the affected soil areas and compacted. Approximately 23,000 yd^3 of asphalt will be required for a 6-inch thick layer of asphalt to cap the 28 acres. Confirmation sampling described for Subalternative 4A would also be included.

9.2.4.6 Subalternative 5A – Soil Removal (High Concentrations of PCBs greater than 1 mg/kg, Molybdenum greater than 503 mg/kg); Off-Site Treatment and Disposal of PCB Soil; Off-Site Disposal of Molybdenum Soil (High Occupancy/Residential)

Estimated Construction Timeframe:	*5 years*
Estimated Timeframe to Reach Remediation Goals:	*5 years*

Estimated Capital Cost:	*$47,269,000*
Estimated Life Time O&M Costs:	*$1,206,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$47,746,000*
Number of Years Cost is Projected:	*30 years*

Subalternative 5A includes soil removal, off-Site treatment and disposal of soil. The major components of Subalternative 5A include:

- Continue controlled access (fencing, signage, etc.) to the site;
- Continue current worker health and safety program and hazard communication;
- Excavate soil where concentrations are greater than the residential remediation goal for molybdenum (503 mg/kg) and/or the TSCA cleanup level for total PCBs for high occupancy/residential use (1 mg/kg);
- Transport molybdenum-affected soil and dispose at an appropriate off-Site facility;
- Transport PCB-affected soils and treat and/or dispose at appropriate EPA approved off-Site facilities;
- Confirmation sampling;
- Import clean fill and grade;
- Regrade, cover, and vegetate Mill Area;
- Institutional controls: Declaration of Restrictive Covenants, Conservation Easement, and temporary well drilling restrictions;
- General maintenance of Mill Area, including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Subalternative 5A adds removal of soil with concentrations of molybdenum and PCBs greater than the residential remediation goal for molybdenum (503 mg/kg) and total PCBs greater than the TSCA cleanup level for PCBs in high occupancy/residential use areas (1 mg/kg). Areas with soil concentrations greater than these cleanup levels will be excavated to eliminate direct exposure to soil. The area with concentrations in soil exceeding the high occupancy/ residential cleanup level for total PCBs is approximately 28 acres. It overlaps with a portion of the area with concentrations exceeding the molybdenum remediation goal. An additional area with concentrations in soil exceeding only the molybdenum remediation goal is approximately 12 acres, for a total of 40 acres. Assuming a 2.5-foot depth, approximately 113,000 yd^3 of PCB-affected soil and 49,000 yd^3 of molybdenum-affected soil will be excavated over the full 40 acres. Depth of excavation will be determined in a manner consistent with that described in Alternative 3.

The excavated soil will be separated into soils containing PCBs greater than 50 mg/kg and those with PCBs less than or equal to 50 mg/kg. The greater than 50 mg/kg PCB-soils will be transported by truck-mounted roll-offs to the nearest off-Site treatment, storage and disposal facility that accepts and treats PCB-affected soil. An appropriate facility may be located approximately 400 miles away, one way. This facility treats (*i.e.,* incinerates) the PCB-affected soil prior to disposal. The excavated soil with PCBs less than or equal to 50 mg/kg will be transported to the nearest off-Site facility that accepts but does not treat the PCB-affected soil. An appropriate facility may be located approximately 300 miles away, one way. Soil samples will be collected and analyzed to identify constituent concentrations prior to transport.

The molybdenum-contaminated soil will be disposed of off Site. Off-Site disposal includes transportation to a solid waste landfill, which may be located approximately 30 miles away, one way. The excavation will be backfilled with approximately 162,000 yd^3 of clean fill material. The clean fill will be obtained from the Spring Gulch Waste Rock Pile and may require amending prior to placement and revegetation. The fill will be blended to match the original land surface and drainage.

Confirmation soil sampling will be required as part of remediation activities. Limited sampling of the perimeter of the excavation will be conducted to identify excavation limits.

Upon decommissioning, areas of the mill outside the remediated footprint area will be regraded, covered with amended Spring Gulch waste rock material, and revegetated. Remediated areas will be excluded from the regrade and cover at mill decommissioning only if they satisfy the cover requirements (36 inches) at the time of decommissioning. However, the approved post-mining land use for the Mill Area allows for water management (*i.e.*, water treatment). Areas required for water management would be excluded from the regrade and cover activities until no longer used for this purpose.

9.2.4.7 Subalternative 5B – Soil Removal (High Concentrations of PCBs greater than 1 mg/kg, Molybdenum greater than 503 mg/kg); Off-Site Treatment and Disposal of PCB Soil; On-Site Disposal of Molybdenum Soil (High Occupancy/Residential)

Estimated Construction Timeframe:	*5 years*
Estimated Timeframe to Reach Remediation Goals:	*5 years*
Estimated Capital Cost:	*$43,190,000*
Estimated Life Time O&M Costs:	*$1,206,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$43,667,000*
Number of Years Cost is Projected:	*30 years*

Subalternative 5B is identical to 5A except that the excavated molybdenum-contaminated soil is disposed of on Site. The PCB-contaminated soil is excavated and disposed off Site as described for Subalternative 5A.

The major components of Subalternative 5B include:

- Continue controlled access (fencing, signage, etc.) to the site;
- Continue current worker health and safety program and hazard communication;

- Excavate soil where concentrations are greater than the residential remediation goal for molybdenum (503 mg/kg) and/or the TSCA cleanup level for total PCBs for high occupancy/residential use (1 mg/kg);
- Transport molybdenum-affected soil and dispose at an appropriate on-Site location;
- Transport PCB-affected soils and treat and/or dispose at appropriate EPA approved off-Site facilities;
- Confirmation sampling;
- Import clean fill and grade;
- Regrade, cover, and vegetate Mill Area;
- Institutional controls: Declaration of Restrictive Covenants, Conservation Easement, and temporary well drilling restrictions;
- General maintenance of Mill Area, including water quality monitoring for all wells, seeps, and springs along the Mill Area and storm water management.

Removal activities will be similar to those described for Subalternative 5A.

The molybdenum-affected soil (approximately 49,000 yd^3) will be excavated and disposed on Site. On-Site disposal includes either placement in an impoundment at the tailing facility or at an appropriate location on Site, possibly the open pit. If the open pit is not available, new cells may be constructed at the mine site. The cells will be lined and of similar construction to the cells designed to contain the sludge or filter cake from the water treatment plant and otherwise comply with applicable disposal regulations.

9.2.4.8 Subalternative 5C - Soil Removal (High Concentrations of PCBs greater than 1 mg/kg, Molybdenum greater than 503 mg/kg); On-Site Treatment and Disposal of PCB Soil; On-Site Disposal of Molybdenum Soil (High Occupancy/Residential)

Estimated Construction Timeframe:	*4.8 years*
Estimated Timeframe to Reach Remediation Goals:	*4.8 years*
Estimated Capital Cost:	*$43,337,000*
Estimated Life Time O&M Costs:	*$1,206,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$43,814,000*
Number of Years Cost is Projected:	*30 years*

Subalternative 5C includes removal of molybdenum- and PCB-contaminated soil with on-Site treatment and disposal of the soil containing PCBs and on-Site disposal of soil containing molybdenum. Subalternative 5C is identical to Subalternatives 5A and 5B, except that the excavated molybdenum- and treated PCB-contaminated soil is disposed on Site.

The major components of Subalternative 5C include:

- Continue controlled access (fencing, signage, etc.) to the site;
- Continue current worker health and safety program and hazard communication;
- Excavate soil where concentrations are greater than the residential remediation goal for molybdenum (503 mg/kg) and/or the TSCA cleanup level for total PCBs for high occupancy/residential use (1 mg/kg);
- Transport molybdenum-affected soil and dispose at an appropriate on-Site location;

- On-Site treatment (*i.e.,* thermal desorption) of PCB-affected soil and on-Site disposal of treated soil and molybdenum-affected soil;
- Manage on-Site air emissions from thermal desorption process;
- Confirmation sampling;
- Import clean fill and grade;
- Regrade, cover, and vegetate Mill Area;
- Institutional controls: Declaration of Restrictive Covenants, Conservation Easement, and temporary well drilling restrictions;
- General maintenance of Mill Area, including water quality monitoring for all wells, seeps and springs along the Mill Area and storm water management

Removal activities will be similar to those described for Subalternatives 5A and 5B. However, all PCB-contaminated soil will be treated on Site.

On-Site treatment consists of the use of a thermal desorption unit. On-Site treatment would include the transportation of a direct-fired thermal desorption unit on Site and operation by a contractor. The direct-fired system ultimately heats the soil to temperatures ranging from 1,200°F to 2,000°F, thereby destroying organics to levels below cleanup standards. The treated soil exits the thermal desorber, is rehydrated, and conveyed for stockpiling. The thermal desorption unit requires collection and treatment of air emissions generated from the thermal desorption process.

Although the soil will be treated for PCBs, molybdenum still remains in the soil at concentrations greater than the residential cleanup level for molybdenum (503 mg/kg). Therefore, the PCB-treated soil containing molybdenum above cleanup standards would require disposal and would be combined with the molybdenum-only soil initially separated out prior to treatment. Testing of soil and other residuals will be performed to characterize constituent concentrations prior to treatment and/or disposal. As in Subalternative 5B, on-

Site disposal includes placement of soil either in an impoundment at the tailing facility or at another appropriate location on Site.

9.2.5 Long-Term Reliability of Each Alternative

For the “No Further Action” and “Limited Action” alternatives (Alternatives 1 and 2), PCB and molybdenum contamination in soil remains in place for an indefinite length of time. As PCBs have low mobility in soil, they will persist in soil for the long term. The access restrictions and worker health and safety and communication hazard programs that are currently in place are only reliable if consistently conducted in accordance with the requirements of those programs, adequately monitored by mining personnel, and adequately overseen and enforced by MSHA.

The proprietary controls recorded by CMI provide legal restrictions to minimize exposure to contamination by limiting land and resource use (*e.g.,* restricting future residential use). These proprietary controls have weaknesses in terms of long-term reliability as they are dependent to a large degree on the Village of Questa being primarily responsible for maintaining, monitoring, and enforcing the controls. Concerns with such responsibilities include the political and fiscal constraints which may affect the Village of Questa’s ability to enforce the controls. Property law can be complicated because a property owner has many individual rights with respect to real property. Proprietary controls are not always enforceable, particularly if the person seeking to enforce the restriction is not an adjacent property owner or if the owner against whom the restriction would be enforced is a subsequent purchaser of the property. In a 2005 report to Congress the U.S. General Accountability Office determined that institutional controls were often not adequately implemented, monitored, or enforced at CERCLA sites.[66] Additionally, the New Mexico

[66] In a January 2005 Report to Congress entitled: “Hazardous Waste Sites, Improved Effectiveness of Controls at Sites Could Better Protect the Public,” the U.S. General Accountability Office determined that institutional controls were often not adequately implemented, monitored, or enforced at CERCLA sites. To ensure the long-term effectiveness of institutional controls, the General Accountability Office recommended a number of measures, including ensuring that the frequency and scope of monitoring efforts are sufficient to maintain the effectiveness of controls and that the information on controls reported in EPA’s new tracking systems accurately reflects actual conditions.

Water Quality Control Commission (WQCC) held in *Phelps Dodge Tyrone* that the "use or application of institutional controls is not an appropriate criterion for determining place of withdrawal of water for present or reasonably foreseeable future use under section 74-6-5(E)(3)" of the Water Quality Act. *Phelps Dodge Tyrone* at ¶ 23, page 79.

The soil excavation alternatives with off-Site treatment and/or disposal (Alternatives 3, 4, and 5) are the most reliable options that provide permanence. The capping component of Alternatives 4A and 4B and the on-Site disposal component of Subalternatives 5B and 5C are not as reliable as excavation and off-Site disposal because residual contamination remains at the Site and the integrity of the engineered caps and containment systems must be maintained to ensure protectiveness for the long term.

Covering the Mill Area with 3 feet of amended Spring Gulch waste rock and revegetation at mill decommissioning for all alternatives add to their reliability in protecting human health in the long-term.

9.2.6 Expected Outcomes of Each Alternative

The expected outcome for any one of the remedial alternatives will not change the current use of the Mill Area as an active milling facility. For the remaining life of the facility, the current activities for access restriction (fencing, signage, etc.) and the health and safety and risk communication programs will continue to protect mine workers and the public. Following decommissioning and closure of the mill, the anticipated future land use is industrial or commercial. Institutional controls recorded by CMI are intended to prohibit future residential use, as well as certain surface water and ground water uses, and restrict certain construction activities. These institutional controls are restrictions that apply only to CMI property: they do not extend beyond CMI's property boundaries. Mining-related ground water contamination was not identified in the Mill Area during the RI. If temporary well drilling restrictions are imposed by the New Mexico Office of the State Engineer to restrict ground water use in the area, those restrictions will only be for the period of time while the remedy is being implemented and cleanup levels are being attained. For the "No

Further Action" alternative (Alternative 1), the risk remains for the potential off-Site transport of soil containing molybdenum and PCBs tracked on the undercarriage of vehicles.

Implementation of any of the remedial alternatives, other than the "No Further Action" alternative, is expected to reduce human health risks by removal/capping of PCB and/or molybdenum contamination in soil to levels that allow for future residential or commercial/industrial land uses. The timeframe in which such uses are achievable are relatively short, ranging from 1.5 to 5 years.

9.3 Mine Site Area Alternatives

The Mine Site Area includes the following three alternatives and two subalternatives for mitigating inorganic compounds (primarily metals) and acidity in soil and ground water:

- **Alternative 1** – No Further Action
- **Alternative 2** – Limited Action (Institutional Controls; Storm Water, Surface Water, and Ground Water Management and Treatment)
- **Alternative 3** – Source Containment; Storm Water, Surface Water, and Ground Water Management; Ground Water Extraction and Treatment
    - Subalternative 3A – 3H:1V: Balanced-Cut-Fill, Partial/Complete Removal, Regrade, and Cover for 3H:1V Slopes; Storm Water, Surface Water, and Ground Water Management; Ground Water Extraction and Treatment
    - Subalternative 3B – 2H:1V: Balanced-Cut-Fill, Regrade, and Cover for 2H:1V Slopes; Storm Water, Surface Water, and Ground Water Management; Ground Water Extraction and Treatment.

A significant consideration in developing remedial alternatives for the Mine Site Area is addressing the waste rock piles and the resulting ground and surface water contamination within the existing drainage basins at the mine site. The waste rock piles consist of Sulphur Gulch South, Sulphur Gulch North/Blind Gulch, and Spring Gulch waste rock piles within the Sulphur Gulch drainage; Middle and Sugar Shack South waste rock piles within the unnamed drainages; Goathill North, Goathill South, and Sugar Shack West waste rock piles within the Goathill Gulch and Slick Line Gulch drainages; and Capulin Waste Rock Pile within Capulin Canyon drainage. In addition, the open pit and subsidence area are included in the Mine Site Area because they are current components of CMI's water management and are features created by past and current mining activities which allow contaminated surface water and seepage to enter the underground mine workings.

9.3.1 Common Elements of the Alternatives

There are common elements to the remedial alternatives for the Mine Site Area except the No Further Action alternative. They are land use controls, including access controls and institutional controls, general maintenance and monitoring, and storm water, surface water, and ground water management.

9.3.1.1 Access Controls

As the mine site covers approximately three square miles of mountainous land, the alternatives will include access controls only in specific areas of the mine site that are easily accessible. Current access restrictions are in place for those areas with operating facilities (buildings, structures, etc.) and include fencing, placement of signage and guarded entry points. These land use controls will continue during the operational life of the mine. The fencing and signage will be maintained after closure.

9.3.1.2 Continue Storm Water, Surface Water, and Ground Water Collection and Management

CMI has constructed storm water run-on and run-off diversions at the waste rock piles and the diversions are either maintained or modified in all of the alternatives. Storm water that is collected will continue to be diverted to the open pit or subsidence area where it flows to the underground mine. The physical features at the mine site (open pit, subsidence area, old underground workings, and decline) would continue to capture and drain colluvial and bedrock ground water to the underground mine, where it would be withdrawn and treated as part of mine dewatering operations. Dewatering would maintain the water level in the mine at an elevation below the Red River. The operation of the seepage interception systems at Spring 13 and 39 as Best Management Practices (BMPs) under EPA NPDES Permit NM0022306 (USEPA 2006) would continue.

9.3.1.3 General Maintenance and Monitoring

General maintenance of storm water diversions (with appropriate sizing to meet the 100-year, 24-hour storm event, or an alternate approved design) will continue. Water quality monitoring of alluvial, colluvial, and bedrock ground water and geotechnical monitoring will also continue.

9.3.1.4 Institutional Controls

EPA would request that the New Mexico Office of the State Engineer temporarily prohibit issuance of new water well permits for well drilling while the mine site ground water is being remediated. Such prohibition shall cease once ground water cleanup levels are achieved. In addition to the government controls, CMI has recorded proprietary controls intended to legally restrict land and resource uses, including all future residential land uses. These institutional controls are discussed in more detail under the Mill Area Alternatives, Section 9.2.1.2, and Current and Potential Future Land and Resources Use, Section 6.0, above.

The above controls would reduce or eliminate future human health exposure to soil. The recorded proprietary controls identify specific requirements and how they have been implemented, the length of time they are to be maintained and monitored, and the entities that are responsible for their enforcement.

9.3.2 Key Applicable or Relevant and Appropriate Requirements

The following ARARs are key requirements that provide a basis for developing the remedial alternatives for the Mine Site Area. A summary of the chemical-, action-, and location-specific ARARs that apply to each remedial alternative for the Site is presented in Tables 9-1 through 9-12.

9.3.2.1 Safe Drinking Water Act Regulations

Safe Drinking Water Act regulations, 40 C.F.R. Part 141, have been adopted by New Mexico (§ 20.7.10.100 NMAC). See below. 40 C.F.R. Part 141 specifies maximum contaminant levels (MCLs) and MCL goals (MCLGs) for select chemicals in drinking water at the tap. The MCLs and MCLGs are relevant and appropriate for ground water if the ground water is a current or potential source of drinking water.

9.3.2.2 Clean Water Act Regulations

Standards for the use or disposal of sewage sludge set forth in 40 C.F.R. § 503.10 are applicable if biosolids are used as amendments for cover material to be placed atop waste rock or tailing.

9.3.2.3 New Mexico Water Quality Act Regulations

The New Mexico Water Quality Act regulations at § 20.6 NMAC are applicable chemical-specific and location-specific requirements for protection of ground water and surface water.

New Mexico WQCC regulations at §§ 20.6.2.3101, 3103 NMAC provide protection of ground water with 10,000 mg/L TDS or less at any place of withdrawal for present or reasonably foreseeable future use and ground water abatement standards. Abatement standards are also established in § 20.6.2.4103 NMAC for ground water and surface water and requirement for abatement of subsurface water and surface water are established in § 20.6.2.4101 NMAC.

Standards for Interstate and Intrastate Surface Waters at § 20.6.4.12 NMAC establish water quality designated uses and criteria for a specified stream segment and § 20.6.4.900 NMAC provides surface water standards applicable to designated uses.

9.3.2.4 New Mexico Regulations for Public Drinking Water Systems

As stated above, New Mexico regulations for public drinking water systems in § 20.7.10.100 NMAC that establish health-based standards for public drinking water systems (MCLs and MCLGs) are relevant and appropriate requirements for ground water that may be used for drinking water. The New Mexico standards adopt by reference federal MCLs in 40 C.F.R. Part 141.

9.3.2.5 New Mexico Rules and Regulations Governing the Use of Public Underground Waters for Household or Other Domestic Use – Office of the State Engineer

The New Mexico Office of the State Engineer rules and regulations established in § 19.27.4 NMAC are for new domestic well permits and the plugging of wells and boreholes.

9.3.2.6 New Mexico Mining Act Regulations

The New Mexico coal mining regulations for reclamation and closure, §§ 19.8.20.2001-2066 NMAC, are identified by New Mexico as relevant and appropriate to the mine site. Under the federal Surface Mining Control and Reclamation Act (SMCRA), New Mexico is authorized to implement the coal mining program. The New Mexico coal mining regulations are approved by the Office of Surface Mining and, therefore, implemented in lieu of SMCRA. Relevant and appropriate requirements of the New Mexico coal mining regulations include Topsoil Substitutes and Supplements (§ 19.8.20.2005 E NMAC), Topdressing: Nutrients and Amendments (§ 19.8.20.2008 NMAC), Hydrologic Balance: Discharge of Water into an Underground Mine (§ 19.8.20.2023 NMAC), Backfilling and Grading: Covering Coal and Acid and Toxic-Forming Material (§ 19.8.20.2056 NMAC), Regrading or Stabilizing Rills and Gullies (§ 19.8.20.59 NMAC), and revegetation requirements (§§ 19.8.20.2060–2066 NMAC).

Sections 19.10.5 - .6 NMAC address non-coal mining. Section 19.10.5.507 NMAC requires reclamation to a condition that allows the re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding areas following closure, unless it conflicts with the approved post-mining land use.

9.3.3 To-Be-Considered Items

TBC items identified for the Mine Site Area alternatives include the New Mexico Mining Permit TA001RE (Permit Revision 96-2) which provides conditions for reclamation and closure of the mine and mill and incorporates the Closeout Plan. TBC items also include the New Mexico Ground Water Discharge Permit DP-1055, which includes conditions for controlling discharges of contaminants from the site into ground water and surface water. In DP-1055, Conditions 30-32 require CMI to implement the components of an approved Closure Plan, including:

- *Waste Rock Pile Regrade* – All waste rock piles shall be regraded to slopes of no steeper than 3 horizontal to 1 vertical (3H:1V). In the event underlying slopes exceed 3H:1V, the waste rock may instead be regraded to slopes of no steeper than 2H:1V, to the maximum extent practicable. Regrading shall include the construction of surface water diversion ditches every 100 to 200 vertical feet on the waste rock piles faces. Relocation in combination with regrading may be necessary to meet slope requirements.
- *Waste Rock Pile Cover and Revegetation* – All waste rock piles determined to have potential for generating acid leachate shall be covered with a minimum of three feet of non-acid generating growth medium, to the maximum extent practicable. All covered piles shall be revegetated to ensure long-term stability of the cover and reduce infiltration to the maximum extent practicable.

9.3.4 Distinguishing Features of Each Alternative

9.3.4.1 Alternative 1 – No Further Action

Estimated Construction Timeframe:	*Not Applicable*
Estimated Timeframe to Reach Remediation Goals:	*Not Applicable*

Estimated Capital Cost:	*$0*
Estimated Life Time O&M Costs:	*$20,198,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$8,265,000*
Number of Years Cost is Projected:	*30 years*

This alternative continues the current actions that are in place within the Mine Site Area with no further actions.

The major components of this alternative include:

- Continue controlled access (fencing, gate, and signage);
- Continue operating 3 existing withdrawal wells, water collection at Spring 39 and Spring 13, and pumping from the underground; pH adjustment using lime and placement at the tailing facility (for tailing slurry/pipeline maintenance);
- Continue current storm water controls and conveyance of storm water to the open pit;
- Continue to maintain existing 8,720- and 8,920-foot storm water diversions at the roadside waste rock piles that convey run-off to the open pit;
- Continue collection and conveyance of Capulin and Goathill North rock pile seepage to the subsidence area;
- Continue capture and management of colluvial and bedrock water in the underground mine via the open pit, subsidence area, old underground workings, and decline;
- Water in the underground mine will be maintained at an elevation below the Red River, and water withdrawn from the underground mine will be pH adjusted with lime;

- Continue ground water and geotechnical monitoring and general site maintenance of storm water diversions;
- Institutional controls: Declaration of Restrictive Covenants (Administration Area), Conservation Easement, and temporary well drilling restrictions.

Continuation of water management for use in operations is a component of Alternative 1. The three existing alluvial ground water withdrawal wells in front of the roadside waste rock piles, seepage interception systems at Springs 13 and 39, and pumping from the underground mine would continue. The total amount of water collected by these systems is approximately 770 gpm. This contaminated water is pumped to the mill sump (Sump 5000) and mixed with tailing, then transport to the tailing facility for disposal during milling period. During non-milling periods, the contaminated (acidic) water is pumped to Sump 5000, pH adjusted using hydrated lime, mixed with unimpacted water and conveyed through the tailing pipeline for maintenance purposes and for partial dust control at the tailing facility. All water transported to the tailing facility is maintained at a pH of between 6.0 and 9.0 as required by DP-933.

The volume of unimpacted water which is mixed with the contaminated water varies, but can be over 1,000 gpm (see Water Usage/Disposal at Mill, Section 2.3.1.4 and Table 1-1, above). The mixing of these two waters results in all of the water being contaminated as it is transported to the tailing facility. NMED has sampled the water at the end of the pipeline at the tailing facility and found it exceeds New Mexico water quality standards for manganese and other contaminants. The contaminated water conveyed to the tailing facility is discharged into an unlined impoundment where the majority of the water seeps through the tailing (as tailing seepage) to ground water. This contributes to the ground water contamination at the tailing facility.

The operation of the seepage interception system at Springs 13 and 39 is performed as Best Management Practices under NPDES Permit NM0022306. The current storm water controls and conveyance of storm water to the open pit would continue, as well as the collection and conveyance of Capulin and Goathill North waste rock pile seepage to the subsidence area. The 8,720- and 8,920-foot storm water diversions at the roadside waste rock piles would be maintained to continue conveyance of runoff to the open pit.

9.3.4.2 Alternative 2 – Limited Action (Institutional Controls; Storm Water, Surface Water, and Ground Water Management and Treatment)

Estimated Construction Timeframe:	*1 year*
Estimated Timeframe to Reach Remediation Goals:	*Not Achieved*
Estimated Capital Cost:	*$150,000*
Estimated Life Time O&M Costs:	*$20,455,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$8,524,000*
Number of Years Cost is Projected:	*30 years*

Alternative 2 is identical to Alternative 1 except that Alternative 2 includes limited additional action for controlling access associated with the Capulin Leachate Collection System and water treatment.

The major components of this alternative include:

- Continue controlled access (fencing, gate, signage);
- Continue operating 3 existing withdrawal wells, water collection at Spring 39 and Spring 13, and pumping from the underground; pH adjust water until the water treatment plant is available to treat all of this water;
- Pipe seepage to and install a fence around the Capulin seepage collection and pumpback ponds to prevent exposure by a visitor/trespasser to the seepage;
- Continue current storm water controls and conveyance of storm water to the open pit;

- Continue to maintain existing 8,720- and 8,920-foot storm water diversions at the roadside rock piles that convey run-off to the open pit;
- Continue collection and conveyance of Capulin and Goathill North rock pile seepage to the subsidence area;
- Continue capture and management of colluvial and bedrock water in the underground mine via the open pit, subsidence area, old underground workings, and decline;
- Water in the underground mine will be maintained at an elevation below the Red River and water withdrawn from the underground mine will be pH adjusted with lime;
- Continue ground water and geotechnical monitoring and general site maintenance of storm water diversions (with appropriate sizing to meet the 100-year, 24-hour storm event or an alternative approved design);
- Institutional controls: Declaration of Restrictive Covenants, Conservation Easement, and temporary well drilling restriction.

Alternative 2 includes the installation of a pipe at the toe of Capulin Waste Rock Pile to direct seepage to the upper Capulin catchment and subsequent fencing of the catchment and pumpback pond system to address potential exposure to the seepage by a visitor/trespasser. Seepage will also be piped from the toe of Goathill North Waste Rock Pile to the subsidence area. Alternative 2 also includes water treatment six months prior to mill decommissioning.

A new water treatment plant will be constructed and online approximately 6 months prior to mill decommissioning. Other options under the CERCLA process for timing of the new water treatment plant include implementation at years 0, 10, 20, and 30 of the remedial action. It is also noted that implementation may also be required under state permitting requirements. A description of the water treatment system and associated costs are provided as part of Subalternative 3A.

9.3.4.3 Subalternative 3A – Source Containment [3H:1V: Balanced-Cut-Fill, Partial/Complete Removal, Regrade, and Cover for 3H:1V Slopes]; Storm Water, Surface Water, and Ground Water Management; Ground Water Extraction and Treatment

Estimated Construction Timeframe:	*25 years*
Estimated Timeframe to Reach Remediation Goals:	*10 years – alluvial ground water* *Remediation goals may not be met for colluvial/bedrock ground water*
Estimated Capital Cost:	*$600,351,000*
Estimated Life Time O&M Costs:	*$68,772,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$309,982,000*
Number of Years Cost is Projected:	*55 years*

TABLE 9-13
MINE SITE WATER TREATMENT

Water Treatment Cost Analysis	
Estimated Capital Cost	$20,263,000
Estimated O&M Cost	$41,063,000
Year 0 Construction; 30-Year Period of Analysis	
Estimated Present Value Cost	$34,541,000
Year 10 Construction; 40-Year Period of Analysis	
Estimated Present Value Cost	$17,559,000
Year 20 Construction; 50-Year Period of Analysis	
Estimated Present Value Cost	$8,926,000
Year 30 Construction; 60-Year Period of Analysis	
Estimated Present Value Cost	$4,538,000

Subalternative 3A is identical to Alternative 2 except that Subalternative 3A adds containment of the environmental impacts from waste rock piles, including grading, removal, cover (store and release/evapo-transpiration), revegetation, long-term slope maintenance, and additional storm water, surface water, and ground water management controls.

The major components of this subalternative include:

- Balanced-cut-fill, partial/complete removal, and regrade of the rock piles using minimum 3H:1V interbench slopes; amended cover; and revegetation;
- Construct and utilize an on-site repository(ies) for waste rock; locations are to be determined during the remedial design phase for each rock pile;
- Continue controlled access (fencing, gate, signage);
- Continue operating three existing alluvial ground water extraction wells, water collection at Spring 39 and Spring 13, and pumping from the underground; pH adjust water until the water treatment plant is available to treat all of this water;
- Continue collection and conveyance of Capulin and Goathill North waste rock pile seepage to the subsidence area, on an interim basis until remedial construction has been completed, at which time water will be piped to the Mill Area for treatment;
- Upgrade/install a seepage collection system near the base of Capulin Waste Rock Pile to enhance seepage capture; pipe seepage to the Mill Area for treatment;
- Operate a new ground water extraction well system in lower Capulin Canyon and pipe the water to the Mill Area for treatment;
- Operate a new seepage collection system near the base of Goathill North Waste Rock Pile to enhance seepage capture; pipe water to the Mill Area for treatment; operate a new ground water extraction well system in lower Goathill Gulch near the head of the debris fan; pipe water to the Mill Area for treatment;

- Install a ground water extraction well system in lower Slick Line Gulch between wells MMW-21 and MMW-48A; pipe water to the Mill Area for treatment.
- Operate a new ground water extraction well system in colluvium at the base of the roadside waste rock pile drainages; phase out operation of three existing alluvial ground water extraction wells as alluvial ground water cleanup levels are achieved.
- Decommission the Capulin pumpback system to prevent exposure by a visitor/trespasser to the seepage;
- Continue or modify current storm water controls and conveyance of storm water to the open pit;
- Continue capture and management of colluvial and bedrock water in the underground mine via the open pit, subsidence area, old underground workings, and decline;
- Water in the underground mine will be maintained at an elevation below the Red River and water withdrawn from the underground mine will be pH adjusted with lime;
- Continue ground water and geotechnical monitoring and general site maintenance of storm water diversions (with appropriate sizing to meet the 100-year, 24-hour storm event or an alternative approved design);
- Institutional controls: Declaration of Restrictive Covenants, Conservation Easement and temporary well drilling restriction.

As part of Subalternative 3A, the waste rock piles were evaluated to identify possible and practical balanced-cut-fill, partial or complete removals, and regrade. The waste rock pile with a balanced-cut-fill within the in-place regraded rock pile is Goathill South. The rock piles that were selected for partial or complete removal because the interbench 3H:1V grades are not achievable with an in-place regrade include: Capulin, Goathill North, Sugar Shack West, Sugar Shack South, Middle, Sulphur Gulch South, and Sulphur Gulch North/Blind Gulch.

Each of these waste rock piles is unique and the challenges for remediating such massive piles that have been deposited onto steep bedrock terrain present complexities as well as uncertainties. To achieve the interbench 3H:1V slope angles, varying amounts of waste rock would have to be removed from each pile as well as varying the footprint of the pile. Consequently, during the remedial design, each waste rock pile would be evaluated independently to balance the relative value of a number of factors including, but not limited to: slope stability and factor of safety requirements (ARARs), underlying bedrock slopes, design parameters for an effective store and release/evapo-transpiration cover system (including vegetative success) on steep slopes, long-term slope maintenance, water management, TBCs, minimizing construction-related environmental impacts such as exposure of hydrothermal scars and safety – both worker and public. This evaluation may include further study or pilot studies before a final design can be fully developed for an individual waste rock pile. The information obtained from such studies and pilots will be used in the detailed evaluation and design of individual waste rock piles.

During remedial design, treatability or pilot scale testing of cover design parameters, physical properties of borrow such as grain size, would be performed to determine optimal cover design specifications for reducing infiltration to the maximum extent practicable and ensuring that performance criteria are met.

9.3.4.3.1 Waste Rock Pile Regrade and Cover

In Subalternative 3A, each of the waste rock piles would be graded to a minimum interbench slope of 3H:1V to the underlying slope to the maximum extent practicable. Based on preliminary conceptual designs, a final interbench slope of 3H:1V is targeted with slope break lengths provided approximately every 200 feet. However, the slopes may vary depending on the final detailed design. Each waste rock pile would be regraded to achieve a stable slope for the placement of the cover, utilizing amended Spring Gulch waste rock and revegetated. Regrading activities would include partial/complete removal of the waste rock pile with placement of waste rock in an on-site repository(ies). The total volume of waste rock to be removed and placed in the repository(ies) is approximately 119 million yd^3. The volume of waste rock to be removed from individual waste rock piles is as follows:

▪ Capulin	1.5 million yd^3
▪ Goathill North	2.8 million yd^3
▪ Goathill South	0 million yd^3
▪ Sugar Shack West	3.9 million yd^3
▪ Sugar Shack South	25.7 million yd^3
▪ Middle	34.7 million yd^3
▪ Sulphur Gulch South	34.7 million yd^3
▪ Sulphur Gulch North/Blind Gulch	12.7 million yd^3
▪ Spring Gulch	2.6 million yd^3

Water management diversion features would be incorporated into the final design and may include terraces, swales, ditches, and other features, as necessary. Both run-off and run-on water would be managed via these features to divert unimpacted water around the waste rock pile, or off of the rock pile to a natural drainage to avoid becoming contaminated.

Following regrade, each waste rock pile would be covered with 36 inches of cover material. The cover would be excavated from Spring Gulch Waste Rock Pile identified as non-acid generating black andesite and aplite screened to a maximum grain size of 8 inches and less than or equal to the molybdenum screening level criterion of 600 mg/kg for borrow material and amended. Following cover placement, each waste rock pile would be revegetated. Vegetation would include native grasses, shrubs, forbs, and trees.

Once sufficient borrow material has been removed from the Spring Gulch Waste Rock Pile for covering other waste rock piles, the remaining waste rock pile would be graded to a minimum slope of 3H:1V (similar to the other rock piles), covered with appropriate non-acid generating and amended cover materials from Spring Gulch Waste Rock Pile and revegetated.

The total surface area for grading and revegetation is approximately 420 acres. The total volume of material to cover the waste rock piles is estimated to be approximately 2.4 million yd^3 based on a 36-inch cover thickness.

9.3.4.3.2 On-Site Waste Rock Repository

In Subalternative 3A, the construction of the on-site repository(ies) for waste rock would include: (1) placement and compaction of waste rock material, (2) grading of waste rock to a stable slope for the construction of the cover, and (3) covering the graded surface with materials obtained from Spring Gulch Waste Rock Pile. For costing purposes, the open pit is used as the on-site repository location. However, the actual location of an on-site repository would be determined during remedial design. Placement of waste rock material in an on-site repository would provide achievable in-place regrade for the waste rock piles that have waste rock material removed. It would also achieve stable slopes for construction of a cover.

9.3.4.3.3 Ground Water Management, Extraction and Treatment

Subalternative 3A includes the same ground water management components as Alternative 2 except with the addition of the following extraction and treatment components:

- Two seepage interceptor drains near the toe of Capulin Rock Pile;
- Interceptor drain near the toe of Goathill North Rock Pile;

- Ground water extraction well system at the base of the roadside waste rock pile drainages;
- Ground water extraction well system in lower Goathill Gulch near the head of the debris fan;
- Ground water extraction well system in lower Slick Line Gulch between existing monitoring wells MMW-21 and MMW-48A;
- Ground water extraction well system in lower Capulin Canyon;
- Water collected from these components would be piped to a water treatment plant for treatment.

The two seepage interceptor drains would be installed in drainages below the toe of the Capulin Waste Rock Pile during the rock pile regrade, and one seepage interceptor drain would be installed approximately 100 feet downstream of the existing toe drain at Goathill North Waste Rock Pile. The purpose of the new drains would be to collect additional seepage from waste rock piles. The drains would be designed to collect subsurface flow. The collected seepage would drain by gravity through a high-density polyethylene (HDPE) pipe 8,000 feet in length routed down Capulin Canyon to the Spring 13 collection vault, then pumped to the water treatment facility. Seepage from the Goathill North Waste Rock Pile would be drained by gravity through an HDPE pipe 12,000 feet in length and routed down Goathill Gulch to the Columbine pump station and then pumped to the water treatment facility. Storm water runoff would be directed over or around the systems. The existing Capulin Leachate Collection System would be decommissioned, including catchments, sediment traps, and the pumpback pond.

A ground water extraction well system would be installed at the base of the roadside waste rock piles in pre-mine drainages to capture seepage from the waste rock piles before it enters the Red River alluvial aquifer. When contaminant concentrations in the alluvial aquifer are reduced to cleanup levels, authorization to phase out operation of the three existing GWW extraction wells would be sought from EPA’s NPDES program.

A ground water extraction well system would be installed in lower Goathill/Slick Line Gulch, located in lower Goathill Gulch near the head of the debris fan and in Slick Line Gulch between monitoring wells MMW-21 and MMW-48A.

The additional amount of water to be collected and managed by these additional extraction and collection systems in Subalternative 3A, compared to Alternative 2, would be approximately 200 gpm. The total amount of water to be collected and managed under Subalternative 3A is estimated to be 970 gpm. The extracted water would be pumped to an on-site water treatment facility.

9.3.4.3.4 Water Treatment

As with Alternative 2, a new water treatment plant will be constructed and on-line approximately 6 months prior to mill decommissioning for Subalternative 3A. Other options for timing of the new water treatment plant include implementation at years 0, 10, 20, and 30 construction of the remedial action. It is also noted that other timeframes for implementation may also be required under New Mexico permitting requirements. Estimated costs for mine site water treatment are summarized in Table 9-13, above.

The new water treatment plant will be constructed at the mine site to treat all impacted water collected during remedial action (*e.g.,* seeps. springs, alluvial and colluvial ground water, and underground mine water). The primary treatment technology consists of lime neutralization/chemical precipitation/HDS with secondary treatment (*i.e.,* reverse osmosis/ultrafiltration or other membrane/filtration technology) to achieve more stringent discharge limits, if required. Conveyance of water (*i.e.,* pipelines, ditches, pumps, etc.) would be included with the water treatment and would use existing infrastructure where possible. If the existing infrastructure is inadequate at the time water treatment would begin, new or additional infrastructure would be required. A discharge point for the treated water has not been determined and would be evaluated during the remedial design. The preliminary location for the treatment plant is at the mill.

The filter cake is expected to be nonhazardous and would be analyzed to ensure proper disposal. An engineered repository would be constructed at the mine site for placement of water treatment residuals (sludge/filter cake). Approximately 10 to 15 cells of approximately 7,500 yd^3 capacities would be needed. The cells would be lined with a geosynthetic liner overlain by a low density polyethylene geomembrane. Storm water collection and diversion systems would be constructed to manage storm water run-on and run-off.

9.3.4.4 Subalternative 3B – Source Containment [2H:1V: Balanced-Cut-Fill, Regrade, and Cover for 2H:1V Slopes]; Storm Water, Surface Water, and Ground Water Management; Ground Water Extraction and Treatment

Estimated Construction Timeframe:	*28 years*
Estimated Timeframe to Reach Remediation Goals:	*10 years – alluvial ground water* *Remediation goals may not be met for colluvial/bedrock ground water*
Estimated Capital Cost:	*$231,488,000*
Estimated Life Time O&M Costs:	*$71,720,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$114,421,000*
Number of Years Cost is Projected:	*58 years*

Subalternative 3B includes the same general components as Subalternative 3A except only a balanced-cut-fill within and between the waste rock piles is used to achieve a minimum interbench slope of 2H:1V. Material removed from waste rock piles would be placed at either Spring Gulch or Sulphur Gulch North/Blind Gulch waste rock piles. The remaining general components include cover (store and release/evapo-transpiration), revegetation, long-term slope maintenance, and storm water, surface water, and ground water management.

The major components of this subalternative include:

- Balanced-cut-fill and regrade of the waste rock piles to minimum 2H:1V interbench slopes, amended cover, and revegetation;
- Construct and utilize an on-site repository(ies) for waste rock if necessary; locations are to be determined during the remedial design phase for each waste rock pile;
- Continue controlled access (fencing, gate, signage);
- Continue operating three existing alluvial ground water extraction wells, water collection at Spring 39 and Spring 13, and pumping from the underground; pH adjust water until the water treatment plant is available to treat all of this water;
- Continue collection and conveyance of Capulin and Goathill North waste rock pile seepage to the subsidence area on an interim basis until remedial construction has been completed, at which time water will be piped to the Mill Area for treatment;
- Upgrade/install a seepage collection system near the base of Capulin Waste Rock Pile to enhance seepage capture; pipe seepage to the Mill Area for treatment;
- Operate a new ground water extraction well system in lower Capulin Canyon and pipe the water to the Mill Area for treatment;
- Operate a new seepage collection system near the base of Goathill North Waste Rock Pile to enhance seepage capture; pipe water to the Mill Area for treatment;
- Operate a new ground water extraction system in lower Goathill Gulch near the head of the debris fan; pipe water to the Mill Area for treatment;
- Install a ground water extraction system in lower Slick Line Gulch between wells MMW-21 and MMW-48A; pipe water to the Mill Area for treatment;

- Operate a new ground water extraction well system in the colluvium at the base of the roadside rock pile drainages; phase out operation of three existing alluvial ground water extraction wells as alluvial ground water cleanup levels are achieved;
- Decommission the Capulin pumpback system to prevent exposure by a visitor/trespasser to the seepage;
- Continue current storm water controls and conveyance of storm water to the open pit;
- Continue capture and management of colluvial and bedrock water in the underground mine via the open pit, subsidence zone, old underground workings, and decline;
- Water in the underground mine will be maintained at an elevation below the Red River and water withdrawn from the underground mine will be pH adjusted with lime;
- Continue ground water and geotechnical monitoring and general site maintenance of storm water diversions (with appropriate sizing to meet the 100-year, 24-hour storm event, or an alternative design approved by the EPA during the remedial design phase);
- Institutional controls: Declaration of Restrictive Covenants , Conservation Easement, temporary well drilling restriction;

As part of this subalternative, the waste rock piles were evaluated to achieve a minimum interbench slope of 2H:1V to the underlying slope, to the maximum extent practicable.

Regrading activities would include a balanced-cut-fill within or between rock piles. The waste rock piles that have an in-place regrade are Capulin, Goathill North, and Sugar Shack West. The waste rock piles with a balanced-cut-fill achieved by moving waste rock material to other rock piles include: Goathill South, Sugar Shack South, Middle, and

Sulphur Gulch South. The waste rock piles that would receive additional waste rock material include Sulphur Gulch North/Blind Gulch and Spring Gulch.

Like Subalternative 3A, each waste rock pile would be evaluated independently and further study or pilot studies may be performed before a final design can be fully developed for an individual waste rock pile. Also like Subalternative 3A, treatability or pilot scale testing of cover design parameters, physical properties of borrow such as grain size, would be necessary to determine optimal cover design specifications for reducing infiltration to the maximum extent practicable and ensuring that performance criteria are met.

9.3.4.4.1 Waste Rock Pile Regrade and Cover

Each waste rock pile would be graded to a minimum interbench slope of 2H:1V to the maximum extent practicable with slope break lengths provided approximately every 200 feet. Cover and revegetation would be placed as described in Subalternative 3A. Water management features would be similar to those described under Subalternative 3A. The total volume of waste rock to be removed under Subalternative 3B is approximately 30.1 million yd^3. The volume of waste rock to be removed from individual rock piles which would not have an in-place regrade would be as follows:

- Goathill South 0.3 million yd^3
- Sugar Shack South 7.3 million yd^3
- Middle 12.1 million yd^3
- Sulphur Gulch South 9.1 million yd^3
- Spring Gulch 1.3 million yd^3

The total surface area for grading and revegetation is approximately 660 acres. The total volume of material to cover the rock piles is estimated to be approximately 3.8 million yd^3 based on a 36-inch cover thickness.

9.3.4.4.2 On-Site Waste Rock Repository

No waste rock pile respository(ies) would have to be constructed as the waste rock to be removed under Subalternative 3B would be placed at the Spring Gulch or Sulphur Gulch North/Blind Gulch waste rock piles. An estimated 30.1 million yd3 of waste rock would be placed at these rock piles under Subalternative 3B.

9.3.4.4.3 Ground Water Management, Extraction and Treatment

Ground water management, extraction, and treatment under Subalternative 3B are the same as described for Subalternative 3A. Differences in rock pile configurations between Subalternatives 3A and 3B result in different restoration timeframes and waste rock seepage production; however, the ground water management, extraction, and treatment methods are the same.

9.3.4.4.4 Water Treatment

Mine Site water treatment under Subalternative 3B is the same as described for Subalternative 3A.

9.3.5 Long-Term Reliability of Each Alternative

The No Further Action and Limited Action alternatives (Alternatives 1 and 2) do not include source containment or piping of waste rock seepage and, therefore, rely on land use controls in the long term to protect human health or the environment after cessation of mining. The fencing and signage would only be located in specific areas and would have to be maintained in perpetuity. Trespassers and terrestrial receptors would continue to have potential for direct contact. The proprietary controls are intended to limit human exposure in perpetuity. There are weaknesses in the long-term reliability of CMI's proprietary controls (see discussion in Section 9.2.6, above).

All of the alternatives would require ground water remediation to varying degrees in the long term. The No Further Action and Limited Action alternatives do not include source control measures and, therefore, would require the perpetual operation of existing ground water extraction and seepage interception systems. Cleanup goals would not be achieved in Red River alluvium, colluvium, and bedrock ground water as there are no source control measures.

Operation of ground water extraction systems at the base of the mine site tributary drainages, in combination with source control measures at the waste rock piles and/or waste rock removal under Subalternatives 3A and 3B, would allow the cleanup goals to be reached and maintained for most, if not all, of the Red River alluvial aquifer. However, these systems will have to be operated for the long term and, based on modeling results, some wells and the underground mine dewatering will need to operate in perpetuity to maintain cleanup goals for the alluvial aquifer.

The perpetual dewatering of the underground mine is a necessary component of all the alternatives as there is a hydrogeologic connection between bedrock ground water and the Red River alluvial aquifer and surface water. Long-term mine dewatering increases the potential for equipment failure or shutdown and subjects the alternatives to periodic replacement costs.

At the completion of mining, the No Further Action alternative would not address the handling of collected ground water when the water is no longer disposed at the tailing facility, as there would be no water treatment. Perpetual water treatment would be required for the other alternatives to handle the water from the underground mine and varying amounts of water collected from the ground water extraction and seepage interception systems, depending on whether source control measures are implemented and the degree of their effectiveness. Water treatment in perpetuity increases the potential for plant failure or shutdown and costs would be incurred periodically to replace the water treatment system.

The earthmoving alternatives (Subalternatives 3A and 3B) to regrade, cover, and revegetate the massive waste rock piles would be effective and permanent options for source control and prevent direct contact by terrestrial receptors to waste rock. However, there are several factors which increase the complexity of successfully implementing these alternatives. First, the sheer size and volume of the waste rock piles (ranging up to nearly 54 million yd^3 for individual piles), combined with steep (angle of repose) slopes and even steeper underlying bedrock topography, would complicate any regrading effort and necessitate waste rock removal and/or enlargement of existing footprints for many of the rock piles to achieve required interbench slope angles. Depending on individual waste rock pile characteristics, the volume of waste rock to be removed to achieve required slope angles could be quite large. Additionally, removal of waste rock could expose natural hydrothermal scars (scars) underlying some waste rock piles, which could create potential for run-off/sediment that could impact surface water and increase the potential for slides if not covered.

Second, the degree of infiltration and percolation reduction that can ultimately be achieved by the store and release/evapo-transpiration cover systems on steeply reclaimed slopes is currently uncertain, as there are a number of variables which would have to be considered. These include slope angle, cover material, type and frequency of amendment application, vegetative type, and erosion control. The choice of Spring Gulch non-acid generating waste rock as borrow material for covering the waste rock piles is not ideal for promoting vegetative success. Because it is abundant and located on the mine site, it would be the least costly and most practicable option for such a large-scale earthmoving effort. But the waste rock lacks adequate soil properties such as percent fines and organic material, and has little water holding capacity. It would have to be heavily amended (with multiple applications) to promote vegetative growth to a level that is necessary for the success of a store and release/evapo-transpiration cover system.

For the revegetation test-plot study conducted over the last eight years, CMI did not fully evaluate the broad range of design parameters (*e.g.*, minimum grain size requirements, different types and application rates of amendments, vegetation types, etc.) for optimizing infiltration reduction within the cover test plots. Additionally, CMI did not adequately evaluate and quantify the degree of infiltration/percolation reduction as part of the study, a critical objective to satisfy the requirements of Ground Water Discharge Permit DP-1055 for reducing infiltration to the maximum extent practicable. For these and other reasons, NMED never approved the revegetation test-plot study for testing cover parameters. The study is currently being performed under the direction and oversight of MMD, but has yet to be deemed successful (see Revegetation Test-Plot Study, Section 2.4.5.2, above). MMD has requested that additional treatability studies for the cover system be performed as part of any pilot study for the waste rock piles in the CERCLA response action.

The quantity of waste rock leachate production that is reduced by the store and release/evapo-transpiration cover system is critical to the success of the source control alternatives in achieving the remediation goals in colluvial and bedrock ground water at certain locations at the mine site, in particular under the footprint of the remaining waste rock piles. Based on modeling, CMI could not demonstrate that the remediation goals would be achieved for ground water in these areas when assuming a reduction in waste rock seepage of approximately 60 percent (a preliminary estimate for FS purposes only). However, the 60-percent reduction does not represent a design performance criterion for the cover system. In order to reach the remediation goals, a significantly higher percent reduction in infiltration/percolation through the cover system would have to be attained by the cover system.

9.3.6 Expected Outcome of Each Alternative

The expected outcome at the mine site for any of the alternatives is the continued use of the land and resources for mining operations through the remaining life of the facility. Potential risk from exposure is reduced through access restrictions, health and safety programs and institutional controls.

An expected outcome of all alternatives, excluding the No Further Action alternative, following permanent cessation of mining and milling is the available use of the land for long-term waste management through the use of engineering controls and institutional controls to control exposure. The layered proprietary controls are intended to restrict future residential use, surface water and ground water use, and certain construction activities.

All of the alternatives (excluding No Further Action) reduce risk to the recreational visitor/trespasser at the mine site. The source containment alternatives (Subalternatives 3A and 3B) prevent direct contact by terrestrial receptors to waste rock and protect herbivorous native wildlife and plants from exposure by metal uptake and bioaccumulation in plants.

Source control and ground water remediation (Subalternatives 3A and 3B) are expected to achieve remediation goals or background levels in the alluvial aquifer within a 10-year timeframe, hence restoring ground water to its beneficial use as a drinking water supply. In the area of Spring 13, if the contamination in alluvial ground water is not mining related, but rather from natural sources, remediation goals would not be attained and the water would not be restored to its beneficial uses.

Subalternatives 3A and 3B are also expected to achieve remediation goals for colluvial and bedrock ground water at the mine site through source control and reduction of acid rock drainage, as well as active ground water remediation and seepage collection within tributary drainages. To achieve such an outcome, the reduction in infiltration by the cover system would need to be significantly higher than the 60 percent modeled by CMI during the FS. Depending on the natural background levels estimated by the USGS for individual drainages at the mine site (*i.e.,* pre-mining baseline water quality), colluvial and bedrock ground water remediated to background levels in certain drainages may be unsuitable for drinking water as highly mineralized rock and scar formation has resulted in background concentrations exceeding standards or health-based criteria. The timeframe to establish effective source control measures includes the 25 to 28 years for regrade, cover, and revegetation of the waste rock piles, and an additional period of time to establish the vegetation.

Source control and ground water extraction/seepage collection under Subalternative 3A and 3B are also expected to reduce the migration of contaminated ground water to Red River surface water, thereby improving water quality in the river and overall protection of trout (survival and growth measures). The remediation goals established for the Red River take into account storm events in the Red River Valley and the related changes caused by those storm events to surface water quality.

9.4 Tailing Facility Area Alternatives

The following four alternatives and two subalternatives were developed for the Tailing Facility Area:

- **Alternative 1** – No Further Action
- **Alternative 2** – Limited Action (Institutional Controls; Source Containment; Continued Ground Water Withdrawal Operations; Piping of Water in Eastern Diversion Channel)
- **Alternative 3** – Source Containment; Continued Ground Water Withdrawal Operations with Upgraded Seepage Collection; Piping of Water in Eastern Diversion Channel
    - Subalternative 3A – Continue Ground Water Withdrawal Operations with Upgraded Seepage Collection
    - Subalternative 3B – Continue Ground Water Operations with Upgraded Seepage Collection and Treatment
- **Alternative 4** – Source Containment; Ground Water Extraction and Treatment; Piping of Water in Eastern Diversion Channel

The tailing facility is an operating facility and, therefore, components of the remedial alternatives for source containment would not be implemented for the tailing impoundments until after cessation of tailing disposal activities. The other components of the remedial alternatives that reduce human health and environmental risk and remediate ground water contamination would be implemented at the start of remedial action.

9.4.1 Common Elements of the Alternatives

There are common elements to the remedial alternatives for the Tailing Facility Area except the No Further Action alternative. They are land use controls, including access controls and temporary well drilling restrictions to prevent ground water use, tailing dust control measures, ambient air quality monitoring along the perimeter of the facility, and source containment. General elements discussed above for all areas to be remediated on CMI property include general maintenance and monitoring, including ground water monitoring, and storm water management.

9.4.1.1 Access Controls

As the tailing facility covers nearly two square miles of land, the entire facility is not fenced off. However, limited fencing and restrictive entry to the tailing facility are in place to control access. All of the alternatives include the continuation of controlled access with the existing fencing and signage during operation of the facility. The fencing and signage will be maintained after closure.

9.4.1.2 Tailing Dust Control Measures

As discussed in Section 2.2.2, above, CMI uses several different operational methods to control dust at the tailing facility. Tailing is deposited into small cells of approximately 100 acres in size and a water cover is used to the extent practicable. In addition, soil binders (*i.e.,* emulsion/tackifiers), soil cover, and straw mulch are used in areas where water cover cannot be maintained. Snow fencing is also used to disrupt the wind currents and reduce windblown dust. These dust control measures would continue for the remaining operating life of the facility.

9.4.1.3 Air Monitoring

The ongoing voluntary air monitoring program (PM_{10} monitoring, $PM_{2.5}$ monitoring during earthmoving remediation activities) would be incorporated into the CERCLA remedy and a contingency plan for dust suppression would be implemented in the event of mining-related exceedances of ambient air quality standards beyond the property boundary that threaten human health. Currently, air monitoring is performed at six stations surrounding the perimeter of the facility within the CMI property boundary.

9.4.1.4 Source Containment

Source containment is a component of all alternatives (excluding the No Further Action alternative). Conditions of Mining Permit TA001RE-96-1 and Ground Water Discharge Permit DP-933 specify a minimum of 3 feet of soil cover to be placed on the tailing facility, graded, and revegetated at the cessation of tailing disposal operations. The cover type would be a store and release/evapotranspiration cover designed to prevent the infiltration and percolation of water through the tailing material to ground water that would cause an exceedance of ground water quality standards. In limiting infiltration and percolation, the cover would also reduce oxidation and acid generation of the tailing. Tailing and water will no longer be placed at the tailing facility at closure; therefore, natural dewatering of the tailing will occur and seepage will decrease with time once the facility is covered.

A store-and-release/evapo-transpiration cover system is an appropriate cover type for the climate conditions near Questa and the type of borrow materials that are locally available. It would also provide a condition that allows for the re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding areas, not conflicting with the approved post-mining land use. The vegetation would be composed of primarily native grasses.

The cover component of the alternatives also prevents exposure by the recreational visitor/trespasser and wildlife to molybdenum in tailing and tailing pond sediment within the footprint of the two impoundments.

The estimated area to be covered is approximately 1,050 acres. This would include the historic surface tailing adjacent to, but outside the current impoundments. The volume of cover material is estimated at 5.4 million yd^3. The source of the cover material would be the alluvial soils in the northern portion of the tailing facility. It is anticipated that cover placement will be accomplished over multiple years due to the size of the facility.

The final cover will be revegetated with grasses and forbs and possibly woody shrubs. Revegetation is designed to optimize the effectiveness of the cover to reduce infiltration into underlying materials, promote evapo-transpiration from the cover system, and provide cover stability and protection from wind and water erosion.

The final surface of the cover will be graded for positive drainage in order to provide for long-term diversion of flow around and from the surface of the tailing impoundments. Run-off will be collected in ditches that direct the water to the large storm water diversion channels on the west and east sides of the tailing facility. Existing drainage ditches are lined with rip-rap and designed to break up the path lengths, thereby reducing the potential for concentrated flows on the cover surface.

Although soils in the area outside the tailing impoundments (EA-7) do not require remediation based on protection of terrestrial ecological receptors, one location outside of the impoundment footprints with elevated molybdenum will be excavated and placed at the tailing facility prior to cover placement. This soil sample (TSS11-4) is located at the dry/maintenance area south of the Change House. The extent of elevated molybdenum in soil at this location is considered to be small in comparison to the impoundment area to be covered. The area of affected soil at this single location was estimated to be approximately 200 yd^3.

9.4.1.5 Institutional Controls

Government controls would be used to limit exposure to contaminated ground water. In addition, CMI's proprietary controls are intended to legally restrict land and resource use at the tailing facility to minimize the potential for human exposure. They are used in the following manner for the Tailing Facility Area remedial alternatives:

- Well drilling restrictions would be imposed by the New Mexico Office of State Engineer to temporarily restrict ground water use at the Tailing Facility Area; the prohibition would only apply to new requests for water well permits and cannot be enforced against existing water well permit holders.

The restrictive covenants established by CMI for the tailing facility are intended to prohibit all residential land uses prior to the Termination of Mining Date,[67] and thereafter to allow only light industry (including renewable energy projects) and park, recreational or athletic field uses. The restrictive covenants are intended to prohibit the use of surface water (including seeps or springs) and underlying ground water (including the installation or operation of a well to obtain ground water) at all timesfor any purpose except closure or reclamation. Certain construction activities are also prohibited.

9.4.2 Key Applicable or Relevant and Appropriate Requirements

Key ARARs that provide a basis for developing the remedial alternatives for the Tailing Facility Area are the same as those discussed for the Mine Site Area alternatives (see Section 9.3.2, above). A summary of the chemical-, action-, and location-specific ARARs that apply to each remedial alternative for the Site is presented in Tables 9-1 through 9-12.

[67] The Declaration of Restrictive Covenants for the tailing facility defines the Termination of Mining Date to mean the "date that permanent cessation of all mining activities including mineral beneficiation at the entire mine site occurs."

9.4.3 To-Be-Considered Items

9.4.3.1 New Mexico Ground Water Discharge Permit

TBC items identified for the Tailing Facility Area alternatives include the New Mexico Mining Permit TA001RE (Permit Revision 96-1), which provides conditions for reclamation and closure of the tailing impoundments and incorporates the closeout plan. Conditions include post-mining land use, surface shaping, building demolition and cleanup plan, cover placement, leachate collection, water treatment and disposal, ground water and surface water monitoring, revegetation, and a contingency plan.

TBC items also include the New Mexico Ground Water Discharge Permit DP-933, which specifies conditions for controlling discharges of contaminants from the site into ground water and surface water. In issuing modified DP-933 in 2008, NMED made several findings, including (1) that ground water beneath the tailing facility is of sufficient quality (concentrations of total dissolved solids are less than or equal to 10,000 milligrams per liter) to require protection from discharges under the New Mexico Water Quality Act and WQCC regulations, (2) the tailing facility is located at a place of withdrawal of water for present or reasonably foreseeable future use within the meaning of WQCC regulations at § 20.6.2.3103 NMAC, (3) tailing seepage and mine water discharged to the tailing facility moves directly or indirectly to ground water and causes pollution at concentrations in excess of state standards, and (4) CMI is required to prevent and abate ground water and surface water pollution pursuant to §§ 20.6.2.3107 and .3109 NMAC.

Conditions which must be satisfied for approval to operate the tailing facility under Ground Water Discharge Permit DP-933 include the following:

- Upon cessation of tailing disposal operations, CMI must implement the closure plan, including (1) surface shaping to ensure positive drainage and eliminate ponding, (2) an evaluation of tailing settlement prior to placement of cover, (3) covering with a minimum of 36 inches of alluvium to serve as a water storage and release cover for minimizing infiltration of precipitation into the underlying tailing and subsequent discharge of tailing leachate into ground water and surface water, (4) revegetation to optimize effectiveness of store and release cover by promoting evapotranspiration, and provide cover stability from wind and erosion, (5) removal of the tailing pipeline and closure of associated sumps, and (6) continue to operate seepage interception and ground water abatement systems.

- Under Ground Water Discharge Permit DP-933, any collected tailing seepage, extracted contaminated ground water, and decant water from the tailing which is not discharged to the Red River pursuant to the existing NPDES permit issued by EPA may be pumped back to the tailing facility.

9.4.3.2 Health-Based Criterion for Molybdenum in Ground Water

EPA developed a health-based criterion of 0.08 mg/L for molybdenum in ground water. A criterion of 0.05 mg/L was originally developed in the HHRA based on an oral reference dose (RfD) of 0.005 µg/kg-day for soil in EPA's Integrated Risk Information System (IRIS) database and a daily consumption rate of 1.5 liters of water. Subsequently, after further literature review, EPA modified the criterion to 0.08 mg/L for molybdenum based on a daily consumption rate of 1 liter of water in the updated EPA Child Factor Exposure Handbook published in 2008. The New Mexico ground water quality standard for molybdenum of 1.0 mg/L is an irrigation standard. Since ground water in the Tailing Facility Area is used for drinking water, EPA believes the health-based criterion for molybdenum of 0.08 mg/L is more protective and, therefore, it is used as a remediation goal.

9.4.4 Distinguishing Features of Each Alternative

9.4.4.1 Alternative 1 – No Further Action

Estimated Construction Timeframe: *None*

Estimated Timeframe to Reach Remediation Goals:	*Not Achieved*
Estimated Capital Cost:	*$0*
Estimated Life Time O&M Costs:	*$30,151,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$12,425,000*
Number of Years Cost is Projected:	*30 years*

Alternative 1 continues the current actions at the tailing facility with no additional actions.

The major components are the following:

- Continue controlled access (fencing, signage, etc.) to the site;
- Continue operation of the existing seepage interception systems and pumpback system;
- Discharge of collected water under existing NPDES permit;
- Continue tailing dust control measures;
- Continue ground water monitoring, general site maintenance, and storm water management;
- Continue air monitoring of PM_{10} at air monitoring stations;
- Institutional controls: Declaration of Restrictive Covenants, and temporary well drilling restrictions.

The No Further Action alternative (Alternative 1) includes continued operation of the seepage interception systems that collect tailing water seepage south of Dam No. 1 and on the eastern abutment of Dam No. 4. The seepage interception systems include rock drains, seepage barriers, and extraction wells. The system began operation in 1975 and currently collects approximately 550 gpm of water. The flow from seepage barriers and rock drains accounts for nearly 80 percent of the total water collected, whereas 20 percent of the total water collected is from the extraction wells. The 002 seepage interception system is located south of Dam No. 1 and consists of a combination of shallow rock-filled drains, seepage barriers, and extraction wells. The largest component of the system is a 200-foot-long upper seepage barrier perpendicular to the arroyo, which consists of a drain that was placed in a trench that is approximately 20 feet deep. The estimated seepage collection rate from the upper 002 barrier is 200 gpm. The lower 002 seepage barrier is located farther south near Embargo Road, and consists of an 80-foot-long and 20-foot-deep trench with a perforated drain line in the bottom. The Outfall 002 system also includes extraction wells that are located along the base of Dam No. 1 and within the drainage to the south (EW-2, -3, -4, -5A, -5B, -5C, -5D, -5E, and -6).

The 003 seepage interception system includes seepage barriers across a drainage on the eastern slope of Dam No. 4 and an extraction well, EW-1. The upper 003 seepage barrier consists of a 20-foot-deep and 50-foot-long trench and drain, which collects seepage originating from the Dam No. 4 impoundment. The seepage collection rate is estimated to be 60 gpm. The lower 003 seepage barrier is located a few hundred feet farther to the east (downgradient) of the upper barrier. Similar to the upper barrier, it is 50 feet long and 20 feet deep. The lower 003 barrier has been dry in recent years.

The water collected from the seepage interception systems flows by gravity through pipelines to a concrete manhole (Outfall 002 manhole) where the water combines and flows into a 1,500-foot long pipeline that discharges to the bank of the Red River at Outfall 002 under the NPDES permit. In fall 2003, CMI installed a pumpback system to reduce the load of metals and other inorganic constituents discharged at Outfall 002. The pumpback system consists of a new manhole located approximately 750 feet north of the existing Outfall 002 manhole. Seepage-impacted ground water is pumped back northward over Dam No. 1 through a 4-inch-diameter HDPE pipeline approximately 6,200 feet in length and discharged at the Dam No. 5A impoundment. Of the 550 gpm collected from the seepage interception systems at the tailing facility, approximately 150 gpm is pumped back to the Dam No. 5A impoundment and approximately 400 gpm is discharged to the Red River through Outfall 002. Ground Water Discharge Permit DP-933 regulates discharges from the facility that have the potential to impact the underlying aquifer. Continuation of the current water collection management at the tailing facility is included in Alternative 1. Based on an operational water balance and seepage loading analysis for the tailing facility, approximately 280 gpm of tailing seepage and 270 gpm of native ground water is being collected by the existing systems and 2,510 gpm of tailing seepage is uncollected. The estimated flow rates for components of the seepage interception system are depicted in Table 9-14.

Uncontrolled seepage primarily is documented to be infiltrating/percolating downward from the portion of the tailing facility in the vicinity of Dam No. 4 (est. 770 gpm) and Dam No. 5A (est. 1,700 gpm) to the basal bedrock (volcanic) aquifer. Bedrock ground water flow patterns identified in the RI Report (URS 2009a) show this deep ground water is moving to the south-southwest toward the Red River. This seepage-impacted bedrock ground water (with elevated molybdenum and sulfate) has been detected/measured in monitoring wells south of Dam No. 4 (MW-11 and MW-13), as well as in nearly every spring along the Red River between the tailing facility and the Red River State Fish Hatchery (one mile southwest of the tailing facility). Concentrations of molybdenum, and in some instances sulfate, have been steadily increasing in some local wells and springs since 2002. It is highly likely that this increase in concentrations correlates to an increase in mining and tailing disposal operations, as well as water management activities in the Dam No. 5A area, during this same time period. Mine constituents also exist in ground water downgradient of the seepage interception system south of Dam No. 1, supporting the determination that there may be some bypass of tailing seepage around the existing interception systems. Ground water also appears to be affected by an area of historic buried tailing located northwest of the Change House. Irrigation water in a diversion channel that infiltrates into the subsurface may mobilizes contaminants in the historic buried tailing downward to ground water. Another possible source of the ground water contamination near the Change House is the southeast movement of tailing seepage from behind Dam No. 1.

Under Alternative 1, molybdenum concentrations in ground water will not decrease to below the remediation goal of 0.08 mg/L after 30 years of closure, based on the numerical modeling analysis. After the tailing impoundments are no longer receiving tailing slurry, infiltration of tailing seepage will continue due to the addition of pumpback water, draining of impounded tailing, and precipitation that collects and infiltrates the tailing impoundment surface. Alternative 1 assumes continued pumpback of approximately 150 gpm of tailing seepage and ground water collected at the seepage interception systems to the Dam No. 4/5A impoundment, with no cover.

9.4.4.2 Alternative 2 – Limited Action (Institutional Controls; Source Containment; Continue Ground Water Withdrawal Operations; Piping of Water in Eastern Diversion Channel)

Estimated Construction Timeframe:	*6 years*
Estimated Timeframe to Reach Remediation Goals:	*15 years after cover placement*
Estimated Capital Cost:	*$28,472,000*
Estimated Life Time O&M Costs:	*$16,443,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$32,332,000*
Number of Years Cost is Projected:	*30 years*

Alternative 2 (Limited Action) includes the components of Alternative 1 with the addition of source containment and piping of irrigation water within the eastern diversion channel. Source containment is discussed above under Common Elements.

The major components of this alternative include:

- Continue controlled access (fencing, signage, etc.) to the site;
- Continue operation of the existing seepage interception and pumpback system;
- Discharge of collected water under existing NPDES permit;

- Continue tailing dust control measures;
- Continue ground water monitoring, general site maintenance, and storm water management;
- Continue air monitoring program at air monitoring stations;
- Institutional controls (deed restrictions): Declaration of Restrictive Covenants, and temporary well drilling restrictions;
- Cover and revegetate tailing facility (and removal of limited soil area at the dry/maintenance) at the cessation of tailing deposition;
- Pipe unused irrigation water in the eastern diversion channel to prevent infiltration through the historic buried tailing;
- Performance monitoring downgradient (southeast) of Dam No. 1 (in the area of wells MW-4 and MW-17) to assess the effects on ground water quality from piping irrigation water in the eastern diversion channel; and allow leading edge of plume near the change house to recede by natural attenuation;
- Performance monitoring downgradient (south and west) of Dam No. 4 and (south) Dam No. 1, including the basal portion of the alluvial aquifer and the bedrock aquifer, to assess the effects of remedial action (*e.g.,* upgraded seepage barriers, extraction well systems, cover) on ground water quality.

Alternative 2 reduces infiltration and water contact with the historic buried tailing northwest of the Change House by constructing piping in the eastern diversion channel. It was assumed that water in the diversion channel will be directed into the pipe and discharged south near Dam No. 1, thereby by-passing the area of historic buried tailing.

A concrete dam will be constructed in the bottom the diversion channel to prevent unused irrigation water from continuing to flow in the channel. Water behind the dam will enter the pipe and be conveyed approximately 6,000 feet past the historic buried tailing and discharged near Dam No. 1. The leading edge of the seepage-impacted ground water associated with the historic buried tailing northwest of the Change House will be allowed to naturally attenuate. Ground water southeast of Dam No. 1 will be monitored to assess the effectiveness of piping the irrigation water on reducing COCs in ground water in this area.

Under Alternative 2, the estimated time for molybdenum concentrations in ground water to decrease below the remediation goal of 0.08 mg/L is approximately15 years following closure, based on numerical modeling. After the tailing impoundments are no longer receiving tailing slurry and are covered, infiltration of tailing seepage will continue due to draining of impounded tailing. The total volume of tailing seepage and ground water to be collected by the seepage interception system is 550 gpm, the same as that for Alternative 1 (see Table 9-14). Approximately 150 gpm of the tailing seepage and ground water collected will be pumped back onto the impoundments until cleanup is achieved in the Dam No. 1 arroyo (10 to 15 years). Following drainage and cessation of pumpback, only small amounts of precipitation will infiltrate through the cover into the tailing and underlying ground water. The area downgradient of Dam No. 4 will take less time (less than 15 years) to reach the remediation goal due to the high hydraulic conductivity and rapid flushing rate of the volcanic aquifer. It was assumed that clean up of ground water at the entire tailing facility would take 15 years even though some areas (below Dam No. 1) may achieve the remediation goal for molybdenum sooner.

9.4.4.3 Subalternative 3A – Source Containment; Continued Ground Water Withdrawal Operations with Upgraded Seepage Collection; Piping of Water in Eastern Diversion Channel

Estimated Construction Timeframe:	*6 years*
Estimated Timeframe to Reach Remediation Goals:	*20 years after cover placement*
Estimated Capital Cost:	*$28,878,000*
Estimated Life Time O&M Costs:	*$17,592,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$33,018,000*

Number of Years Cost is Projected: *30 years*

Subalternative 3A is the same as Alternative 2 with the addition of upgrading the 002 and 003 seepage barriers to mitigate off-site migration of tailing seepage and performance monitoring to assess the effects of remedial actions on ground water quality.

The major components of this alternative include:

- Continue controlled access (fencing, signage, etc.) to the site;
- Cover and revegetate tailing facility (and removal of limited soil area at the dry/maintenance) at the cessation of tailing deposition;
- Pipe unused irrigation water in the eastern diversion channel to prevent infiltration through historic buried tailing;
- Replace the lower 002 seepage barrier with extraction wells and replace the upper 003 seepage barrier with a deeper barrier to intercept tailing seepage in deeper strata;
- Continue operation of existing seepage interception system and pumpback system;
- Discharge of collected water under existing NPDES permit;
- Ground water characterization in the basal bedrock aquifer downgradient (south) of Dam No. 1 to evaluate the need for further ground water remediation (includes installing a well(s) to replace former well TPZ-5B);
- Performance monitoring downgradient (southeast) of Dam No. 1 (in the area of wells MW-4 and MW-17) to assess the effects on ground water quality from piping irrigation water in the eastern diversion channel; and allow leading edge of plume near the change house to recede by natural attenuation;
- Performance monitoring downgradient (south and west) of Dam No. 4 and (south) Dam No. 1, including the basal portion of the alluvial aquifer and the bedrock

aquifer, to assess the effects of remedial actions (*e.g.,* upgraded seepage barriers, extraction well systems, cover) on ground water quality;

- Continue tailing dust control measures;
- Continue ground water monitoring, general site maintenance, and storm water management;
- Continue air monitoring program at air monitoring stations;
- Institutional controls: Declaration of Restrictive Covenants and temporary well drilling restrictions.

Subalternative 3A includes an upgrade to the existing seepage interception systems to limit tailing seepage bypass of the 002 system in the Dam No. 1 arroyo and the 003 system off the southeast flank of Dam No. 4. The upgrade to the Outfall 002 system includes installation of new ground water extraction wells across the Dam No. 1 arroyo just downgradient of the location of the existing lower 002 seepage barrier. The upgrade to the Outfall 003 system includes the replacement of the upper 003 seepage barrier with a new seepage barrier that extends approximately 30 feet below the existing barrier.

The new extraction wells would be located at CMI's property boundary in the Dam No. 1 arroyo to limit off-site and downward migration of tailing seepage contaminants (primarily molybdenum and sulfate). There would be four wells, placed along a 250-foot wide transect across the Dam No. 1 arroyo, with each well pumping at 30 gpm.

The new upper 003 seepage barrier would be connected to the existing pipeline and the water would flow via gravity to the Outfall 002 manhole. The upgraded seepage barrier is estimated to produce 180 gpm, an increase of 120 gpm compared to the existing 003 barrier. The estimated additional seepage and ground water collected by the upgraded system is approximately 250 gpm compared to Alternative 2. The total water to be collected by the existing and upgraded system is 790 gpm (see Table 9-14).

Subalternative 3A would also include additional ground water characterization in the bedrock aquifer south of Dam No. 1 in the area of former well TPZ-5B. The purpose of a monitoring well to replace former well TPZ-5B is to verify whether elevated molybdenum and manganese concentrations observed during two historical sampling events at TPZ-5B are representative of current aquifer conditions. Water quality data collected from this well would be used to assess the need for remediation of the bedrock aquifer in this area. It is assumed that one monitoring well would be installed in the bedrock aquifer.

Subalternative 3A would include ground water monitoring downgradient (south) of Dam No. 1, (south and west) Dam No. 4, and (southeast) historic buried tailing to assess the performance of remedial actions in reducing ground water concentrations to below the remediation goals in these areas.

Cover and regrading of the tailing impoundments at closure and the piping of irrigation water in the historic buried tailing area would result in decreased ground water concentrations. Cover placement and limited excavation near the dry/maintenance area would be performed consistent with Alternative 2.

For Subalternative 3A, the time for molybdenum concentrations in ground water to decrease below the remediation goal of 0.08 mg/L is estimated to be approximately 20 years following closure, a slightly longer timeframe compared to Alternative 2. After the tailing impoundments are no longer receiving tailing and are covered, tailing seepage would continue due to draining of impounded tailing. Approximately 300 gpm of tailing seepage and ground water collected at the seepage interception system would be pumped back to the impoundments until cleanup is achieved in the Dam No. 1 arroyo (10 to 20 years). Following drainage and cessation of pumpback, it is expected that only small amounts of water from precipitation would infiltrate through the cover and percolate downward into the tailing and underlying ground water.

9.4.4.4 Subalternative 3B – Source Containment; Continued Ground Water Withdrawal Operations with Upgraded Seepage Collection; Piping of Water in Eastern Diversion Channel; Water Treatment

Estimated Construction Timeframe:	*6 years*
Estimated Timeframe to Reach Remediation Goals:	*15 years after cover placement*
Estimated Capital Cost:	*$29,043,000*
Estimated Life Time O&M Costs:	*$18,547,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$33,758,000*
Number of Years Cost is Projected:	*30 years*

TABLE 9-15
TAILING FACILITY WATER TREATMENT
FOR ALTERNATIVE 3B

Water Treatment Cost Analysis	
Estimated Capital Cost	$22,076,000
Estimated O&M Cost	$73,027,000
Year 0 Construction; 30-Year Period of Analysis	
Estimated Present Value Cost	$51,989,000
Year 10 Construction; 40-Year Period of Analysis	
Estimated Present Value Cost	$26,428,000
Year 20 Construction; 50-Year Period of Analysis	
Estimated Present Value Cost	$13,435,000
Year 30 Construction; 60-Year Period of Analysis	
Estimated Present Value Cost	$6,830,000

Subalternative 3B is the same as Subalternative 3A with the addition of water treatment.

The major components of this alternative are:

- Continue controlled access (fencing, signage, etc.) to the site;
- Cover and revegetate tailing facility (and removal of limited soil volume at the dry/maintenance area) at the cessation of tailing deposition;
- Pipe unused irrigation water in the eastern diversion channel to prevent infiltration through historic buried tailing;
- Replace the lower 002 seepage barrier with extraction wells and replace the upper 003 seepage barrier with a deeper barrier to intercept tailing seepage in deeper strata;
- Discharge of collected water under existing NPDES permit;
- Water treatment of pumpback seepage;
- Performance monitoring downgradient (southeast) of Dam No. 1 (in the area of wells MW-4 and MW-17) to assess the effects on ground water quality from piping irrigation water in the eastern diversion channel; and allow leading edge of plume near the change house to recede by natural attenuation;
- Performance monitoring downgradient (south and west) of Dam No. 4 and (south) Dam No. 1, including basal alluvial and bedrock aquifers, to assess the effects of remedial actions (*e.g.,* upgraded seepage barriers, extraction well systems, cover) on ground water quality;
- Ground water characterization in the basal bedrock aquifer downgradient (south) of Dam No. 1 to evaluate the need for further ground water remediation [includes installing a well(s) to replace former well TPZ-5B];
- Continue tailing dust control measures;
- Continue ground water monitoring, general site maintenance, and storm water management;
- Continue air monitoring program at air monitoring stations;

- Institutional controls: Declaration of Restrictive Covenants and temporary well drilling restrictions.

In addition to replacing the selected existing seepage barriers, Subalternative 3B includes a water treatment component. The total water collection rate for Subalternative 3B, similar to Subalternative 3A, would be 790 gpm, 400 gpm of which would be discharged through Outfall 002 (see Table 9-14). Following collection, the remaining water (390 gpm) would be treated at the existing ion exchange treatment plant and/or new treatment plant located south of Dam No. 4, rather than being pumped back to the impoundments, as with Subalternative 3A. Estimated costs for water treatment are summarized on Table 9-15 and include start of water treatment in Years 0, 10, 20, and 30 Construction, with a 30-year O&M period.

The existing ion exchange treatment plant is located south of Dam No. 4 and would likely be used for treatment of extracted ground water and/or a new treatment facility would be constructed. Modifications may be necessary if contaminants in ground water, in addition to molybdenum, require removal (*e.g.,* uranium). Reverse osmosis may be included for additional treatment or another technology determined in design. A discharge point for the treated water has not been determined and would be evaluated during remedial design.

Either an evaporator would be installed in conjunction with the water treatment system or an evaporation pond constructed at the tailing facility for treatment of the reverse osmosis reject, if required. Suitable areas would be relatively flat, a few acres in size, and accessible year round. If a solid residual is generated during the treatment process, it would be disposed of at an appropriate location. Cover placement and limited excavation near the dry/maintenance area would be performed consistent with Alternative 2.

For Subalternative 3B, the estimated time for molybdenum concentrations in ground water to decrease below the remediation goal of 0.08 mg/L is approximately15 years following closure, based on numerical modeling.

After the tailing impoundments are no longer receiving tailing and are covered, tailing seepage would continue due to draining of the impounded tailing. Following drainage of the tailing, it is assumed that only small amounts of precipitation would infiltrate through the cover into tailing and the underlying ground water.

9.4.4.5 Alternative 4 – Source Containment, Ground Water Extraction and Treatment; Piping of Water in Eastern Diversion Channel

Estimated Construction Timeframe:	*6 years*
Estimated Timeframe to Reach Remediation Goals:	*8 years after cover placement*
Estimated Capital Cost:	*$30,442,000*
Estimated Life Time O&M Costs:	*$20,876,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$35,939,000*
Number of Years Cost is Projected:	*30 years*

TABLE 9-16
TAILING FACILITY WATER TREATMENT
FOR ALTERNATIVE 4

Water Treatment Cost Analysis	
Estimated Capital Cost	$54,533,000
Estimated O&M Cost	$197,162,000
Year 0 Construction; 30-Year Period of Analysis	
Estimated Present Value Cost	$135,051,000
Year 10 Construction; 40-Year Period of Analysis	
Estimated Present Value Cost	$68,653,000
Year 20 Construction; 50-Year Period of Analysis	
Estimated Present Value Cost	$34,899,000
Year 30 Construction; 60-Year Period of Analysis	
Estimated Present Value Cost	$17,741,000

Alternative 4 is the same as Subalternative 3B except that ground water extraction southeast of Dam No. 1, south of Dam No. 1, and south of Dam No. 4 are included. Select existing seepage barriers would be upgraded as described in Subalternative 3A to increase the collection of tailing seepage from the Dam No. 1 impoundment and the eastern flank of the Dam No. 4 impoundment.

The major components of this alternative are:

- Continue controlled access (fencing, signage, etc.) to the site;
- Cover and revegetate tailing facility (and removal of limited soil area at the dry/maintenance) at the cessation of tailing deposition;
- Pipe unused irrigation water in the eastern diversion channel to prevent infiltration through historic buried tailing;
- Replace the lower 002 seepage barrier with extraction wells and replace the upper 003 seepage barrier with a deeper barrier to intercept tailing seepage in deeper strata;
- Ground water extraction in the upper alluvial aquifer southeast of Dam No. 1 in the area downgradient of the historic buried tailing;
- Ground water extraction downgradient (south) of Dam No. 4;
- Continue discharge of collected water;
- Water treatment;
- Ground water characterization in the basal bedrock aquifer downgradient (south) of Dam No. 1 to evaluate the need for further ground water remediation (includes installing a well(s) to replace former well TPZ-5B);
- Performance monitoring downgradient (south and west) of Dam No. 4 and (south) Dam No. 1, including basal portion of the alluvial aquifer and the bedrock aquifer,

to assess the effects of remedial actions (*e.g.*, upgraded seepage barriers, extraction well systems, cover) on ground water quality;

- Continue tailing dust control measures;
- Continue ground water monitoring, general site maintenance, and storm water management;
- Continue air monitoring program at air monitoring stations;
- Institutional controls: Declaration of Restrictive Covenants and temporary ground water use and well drilling restrictions.

In addition to the Subalternative 3B components, Alternative 4 includes ground water extraction southeast of Dam No. 1 (in the area of wells MW-4 and MW-17) to capture contamination in the alluvial aquifer. It is assumed that five extraction wells would be installed along an east-west line, approximately 240 feet apart, to create a continuous zone of ground water capture over the 1,200 feet of potentially affected aquifer. For conceptual-level design, each well is assumed to be pumped at 10 gpm for a total extraction rate of 50 gpm.

Like in Subalternative 3B, Alternative 4 includes additional ground water characterization in the basal bedrock aquifer south of Dam No. 1, in the area of former well TPZ-5B. If the characterization indicates concentrations above the remediation goal for molybdenum, ground water extraction would be included to address this area.

Alternative 4 includes ground water extraction in the basal bedrock (volcanic) aquifer south of Dam No. 4 (in the area of wells MW-11 and MW-13). The objective of the extraction is to create a zone of ground water capture across the former arroyo to prevent further downgradient migration of seepage from the Dam No. 4 impoundment (including the Dam No. 5A impoundment and decant pond). A water balance conducted based on CMI's water usage for calendar year 2006 found that the total estimated seepage that is available to migrate from the tailing facility south of Dam No. 4 is 2,510 gpm. This seepage rate was used to develop a preliminary conceptual design for ground water extraction in this area. Based on hydraulic analysis, it was determined that hydraulic capture could be achieved by installing three wells with a total extraction rate of 3,500 gpm. The extraction wells would be placed in the area of MW-11, MW-13, and to the west of NW-11.

For Alternative 4, the estimated time for molybdenum concentrations in ground water to decrease below the remediation goal of 0.08 mg/L is approximately 8 years following closure. After the tailing impoundments are no longer receiving tailing and are covered, tailing seepage will continue due to draining of the impounded tailing. For Alternative 4, it is assumed that all water collected from extraction wells and seepage barriers would be treated. Following drainage of the tailing, it is assumed that only small amounts of precipitation will infiltrate through the cover into the tailing and underlying ground water.

As in Subalternative 3B, Alternative 4 includes a water treatment component. Estimated costs for water treatment are summarized on Table 9-16. The total water collection rate for Alternative 4 is assumed to be 4,300 gpm (see Table 9-14). The volume of water to be collected and treated is an order of magnitude greater than that for Subalternative 3B, reflecting the highly transmissive nature of the fractured volcanic aquifer in the vicinity of Dam No. 4.

9.4.5 Long-Term Reliability of Each Alternative

The No Further Action alternative (Alternative 1) is not protective of human health or the environment. Current fencing and restricted access in place at the tailing facility limit human contact (recreational visitor/trespasser) with tailing and tailing pond sediment, but these actions would have to be maintained in the long term. Wildlife (*e.g.,* deer and elk) is not adequately protected by the fencing. Elk have been observed foraging at the impoundments in the late evening by local ranchers and tracks have been seen on the impoundments by regulatory officials. Such exposures would be expected to continue after tailing disposal operations cease. Operation of existing seepage interception systems provide hydraulic capture of a portion of tailing seepage, but the majority of the seepage is not collected and migrates downgradient of the tailing impoundments. Also, the proprietary controls recorded by CMI restrict land and water use, but only for CMI's property. They do not address contamination off of CMI property. Additionally, there are weaknesses in the long-term reliability of CMI's proprietary controls (see discussion on use of institutional controls for Mill Area alternatives, Section 9.2.5, above).

For the other Tailing Facility Area alternatives, covering the tailing with 36 inches of soil after deposition ceases is an effective and reliable source control measure.[68] Cover provides a barrier to reduce human and ecological contact with the tailing and tailing pond sediment and reduces tailing seepage over time by reducing or eliminating infiltration and percolation. For the cover to be effective in the long term, maintenance and monitoring would be required. Burrowing animals or erosion may impact the integrity of the cover over time and repairs would be required. For light industry use of the tailing impoundment after cessation of tailing disposal operations, including renewable energy projects, the integrity of the cover in adequately reducing infiltration and percolation would have to be maintained for long-term protection of ground water in the areas of such land uses.

The piping to be used in the eastern diversion channel would have to be maintained for as long as the channel is used for irrigation water. This would continue to prevent irrigation water from coming into contact with the historic buried tailing outside of the impoundment and contaminating ground water. Periodic replacement of the piping and supporting structures would be required in the long term.

The seepage interception systems (barrier drains and extraction wells) and the water treatment plant are reliable technologies for remediating ground water for the long term.

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[68] A five-year pilot demonstration will be conducted by CMI to evaluate cover depths of 1-, 2-, and 3-feet. The pilot demonstration will evaluate the extent of infiltration and percolation for all three cover depths. If it is demonstrated to the satisfaction of EPA that a 1-foot or 2-foot cover depth is successful, EPA has agreed to approve the alternate cover depth as part of the remedy for the tailing facility. The cover depth pilot demonstration has been combined with CMI's concentrated photovoltaic solar facility pilot demonstration. A joint EPA/NMED/EMNRD letter to CMI, dated November 13, 2009, outlining the agreement and the "definition of success" accepted by the agencies is presented in Appendix C.

However, replacement and maintenance costs would be incurred as equipment breakdowns in these systems are likely to occur periodically over time.

After the tailing impoundments are no longer receiving tailing and are covered, tailing seepage would continue for some time due to draining of the impounded tailing. Once the tailing impoundment has been dewatered and tailing seepage eliminated, the continuation of effective and permanent source control at the tailing facility would allow the permanent shut off of the seepage interception systems and water treatment plant after all ground water standards and health-based criteria are achieved.

EPA recognizes that the tailing facility is an operating facility with ongoing discharges of tailing seepage to ground water. An operational water balance and seepage loading analysis shows that significant volumes of seepage-impacted water (approximately 2510 gpm) are leaking from the facility, the majority of it to the basal bedrock (volcanic) aquifer under the Dam No. 4 impoundment and behind the Dam No. 5A impoundment. This includes the pumpback water disposed behind Dam No. 5A. This will continue to occur for the remaining operating life of the tailing facility as well as for some time after cessation of tailing disposal, while draining of the impounded tailing occurs. The discharge of tailing seepage from the facility to ground water deemed protectable by the State of New Mexico at levels that cause exceedances of New Mexico ground water quality standards is a violation of New Mexico Water Quality Act regulations (§ 20.6.2 NMAC). NMED, through its permitting process for Ground Water Discharge Permit DP-933, has directed CMI to evaluate and implement other water disposal alternatives to reduce the volume of water that is disposed at the tailing facility.

9.4.6 Expected Outcome of Each Alternative

The tailing facility is expected to continue to be an operating facility until some unknown time in the future. For this operational period, the existing land use controls provide protection to the recreational visitor/trespasser and workers are protected through the health and safety programs and hazard communication currently implemented and monitored by

CMI and enforced by MSHA. The existing fencing and entry restriction are not considered effective in protecting wildlife (deer or elk).

Because the tailing facility is an operating facility, the implementation of the source control measures for the tailing impoundments (*i.e.*, regrade, cover, and revegetation) would not be completed until permanent cessation of tailing disposal operations.[69] Therefore, the tailing facility will continue to be a source of ground water contamination until after source control is implemented. The implementation of the ground water remediation and other components of the alternatives would occur at the start of remedial action and not be dependent on the operational status of the tailing facility.

For the No Further Action alternative (Alternative 1), continuing to operate the existing seepage interception and ground water extraction systems would not achieve the remediation goals for ground water based on a 30-year period of analysis after closure. Implementation of the ground water components of all other alternatives is expected to restore ground water to its use as a drinking water source within varying timeframes depending on the level of remediation. For Subalternative 2, ground water remediation goals would be achieved within approximately 15 years following placement of the cover, assuming collection of 550 gpm of seepage. Subalternative 3A and 3B, with upgraded seepage interception systems that collect 790 gpm (an increase of 250 gpm compared to Alternative 2), have similar or longer restoration timeframes of 20 and 15 years, respectively. The difference between 3A and 3B, is the pumping of approximately 300 gpm back onto the impoundments until cleanup is achieved for 3A (20 years) compared to the treatment of the seepage, rather than pumpback, for 3B (15 years). Alternative 4 achieves the ground water remediation goals in the shortest timeframe of 8 years.

Cover placement after cessation of tailing disposal operations for all the alternatives (excluding No Further Action) is expected to reduce human health and ecological risks by

[69] The date of permanent cessation of tailing disposal operations is not to be construed as the Termination of Mining Date as defined in the Declaration of Restrictive Covenants for the tailing facility. The Termination of Mining Date is more broadly defined as the permanent cessation of all mining activities, including mineral beneficiation, at the entire mine.

preventing exposure to tailing and tailing pond water, as well as plants that may uptake molybdenum from the tailing.

An expected outcome of all alternatives following permanent cessation of tailing disposal operations is the available use of the land (tailing impoundments) for long-term waste management through the use of engineering controls. An expected outcome once remediation goals are achieved would be to return the Tailing Facility Area to a condition that is protective for anticipated future uses of wildlife habitat, light industry and residential. Ground water would be restored to its use as a drinking water supply.

9.5 Red River and Riparian and South of Tailing Facility Area Alternatives

Three alternatives and two subalternatives are presented below for the Red River, Riparian, and South of Tailing Facility Area. Red River surface water poses a potential ecological risk, but it is addressed through reduction of impacted seeps and springs entering the river along the mine site. Shallow ground water was identified to pose a potential human health risk, but the ground water in the area south of the tailing facility is addressed for the Tailing Facility Area discussed above.

The Red River and Riparian and South of Tailing Facility Area alternatives are as follows:

- **Alternative 1** – No Further Action
- **Alternative 2** – Cap Soil and Tailing Spill Deposits
- **Alternative 3** – Removal of Soil and Tailing Spill Deposits and Off-Site Disposal
    - Subalternative 3A – Removal of Soil and Tailing Spill Deposits and Off-Site Disposal
    - Subalternative 3B – Removal of Soil and Tailing Spill Deposits and On-Site Disposal

9.5.1 Common Elements to the Alternatives

There are no common elements to these alternatives, as they consist only of capping and removal. The removal alternative (Alternative 3) includes multiple options for disposal of contaminated soil and tailing spill material.

9.5.2 Key Applicable or Relevant and Appropriate Requirements

Key ARARs that provide a basis for developing the remedial alternatives for the Red River, Riparian, and South of Tailing Facility Area are presented below. A summary of the chemical-, action-, and location-specific ARARs that apply to each remedial alternative for the Site is presented in Tables 9-1 through 9-12.

9.5.2.1 Clean Water Act Regulations

The Clean Water Act regulations of 40 C.F.R. Part 122 and Part 125 are applicable requirements for the EPA-administered NPDES permit program and the criteria and standards for NPDES. These would be applicable action-specific requirements to be addressed for managing and disposing of ground water collected from the dewatering of soils in the area south of the tailing facility.

9.5.2.2 Clean Water Act – Dredge and Fill Regulations

Dredge and fill regulations of the Clean Water Act at 40 C.F.R. Part 230 and 33 C.F.R. Parts 322 and 323 are applicable location-specific requirements. They establish requirements for permits to authorize the discharge of dredged or fill material into waters of the U.S., which includes inland wetlands.

9.5.2.3 Executive Order on Floodplain Management

Executive Order on Floodplain Management (Executive Order No. 11988) requires federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid, to the extent possible, the adverse impacts associated with direct and indirect development of a floodplain.

9.5.2.4 Executive Order on Protection of Wetlands

Executive Order on Protection of Wetlands (Executive Order No. 11990) requires federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction, loss, or net degradation of wetlands and to avoid support of new construction in wetlands if a practical alternative exists.

9.5.2.5 New Mexico Water Quality Act Regulations

New Mexico Water Quality Act regulations at § 20.6.2.2101 NMAC establish surface water protection regulations for general requirements. These include biochemical oxygen demand, chemical oxygen demand, settleable solids, fecal coliform, and pH in effluent. These would be applicable chemical-specific requirements.

9.5.2.6 New Mexico Standards for Interstate and Intrastate Surface Waters

Standards for Interstate and Intrastate Surface Waters in § 20.6.4.122 NMAC establish water quality designated uses and criteria for a specified stream segment and § 20.6.4.900 NMAC provides surface water standards applicable to designated uses.

9.5.2.7 New Mexico Air Quality Regulations

New Mexico air quality regulations at § 20.2 NMAC establish air quality regulations.

9.5.2.8 New Mexico Water Quality Control Commission Regulations

New Mexico WQCC regulations at § 20.6.2.2202 NMAC establish requirements for the disposal of refuse. These are applicable location-specific requirements.

The WQCC regulations of §§ 20.6.2.3101 to .4115 NMAC provide protection for ground water with less than or equal to 10,000 mg/L total dissolved solids.

9.5.2.9 New Mexico Solid Waste Regulations

New Mexico Solid Waste regulations at §§ 20.9.2, .4, and .6 NMAC establish siting and design criteria and closure/post closure requirements for municipal, special waste, and construction and demolition waste landfills. These would be applicable action-specific requirements.

9.5.2.10 New Mexico Coal Mining Regulations

New Mexico coal mining regulations at § 19.8.20 NMAC establish cover and revegetation requirements, the use of temporary impoundments, and other requirements. These regulations are considered relevant and appropriate action-specific requirements.

9.5.3 Distinguishing Features of Each Alternative

9.5.3.1 Alternative 1 – No Further Action

Estimated Construction Timeframe:	*Not Applicable*
Estimated Timeframe to Reach Remediation Goals:	*Not Applicable*
Estimated Capital Cost:	*$0*
Estimated Life Time O&M Costs:	*$177,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$65,000*

Number of Years Cost is Projected: *30 years*

This alternative would include no additional actions to address potential ecological risks from contact with tailing/soil in the Red River riparian area. CMI has previously removed a large portion of the historic tailing spill deposits in the riparian area (approximately 55 percent) and no additional removal is proposed.

The major component of this alternative would be the continued placement of copper blocks in the area south of the tailing facility to reduce the potential risk to livestock (primarily cattle). CMI currently provides copper blocks to landowners for this purpose. The copper blocks are commonly used to supplement the diet of animals that graze in areas with high molybdenum concentrations in soil and plants. The molybdenum interferes with copper uptake in some animals such as cattle, sheep, and possibly other large herbivorous mammals (deer and elk).

9.5.3.2 Alternative 2 – Cap Soil and Tailing Spill Deposits

Estimated Construction Timeframe:	*1.75 years*
Estimated Timeframe to Reach Remediation Goals:	*1.75 years*
Estimated Capital Cost:	*$2,080,000*
Estimated Life Time O&M Costs:	*$558,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$2,281,000*
Number of Years Cost is Projected:	*30 years*

Alternative 2 would include placement of a cap over tailing spill deposits along the Red River riparian area (low lying areas) and the area south of the tailing facility. The major components of this alternative are:

- Cap and apply erosion mats and/or armoring over tailing spill deposits along the Red River riparian corridor;

- Dewatering area south of the tailing facility;
- Stabilize soil in area south of the tailing facility;
- Cap and revegetate affected soil south of tailing facility.

The cap would consist of a layer of soil, erosion mats and/or armoring applied to provide protection of the cap, and revegetation. The estimated area containing tailing spill deposits is approximately 3 acres. Suitable alluvial soil is available from on-Site borrow areas such as the tailing facility for the cap. Capping of tailing spill deposits would require approximately 4,400 yd^3 of soil, assuming a 6-inch or 12-inch depth of cover, depending on the size of the spill. In addition, approximately 1,600 yd^2 of erosion control mats and 1,600 yd^3 of armoring would be placed on top of the cap material to provide protection against erosion.

Approximately 8 acres were identified south of the tailing facility where molybdenum-contaminated soil presented a risk to livestock and wildlife. The area would be capped with a 1-foot layer of soil and revegetated. Suitable alluvial soil is available at the tailing facility as borrow material and would be appropriately screened prior to transport. The volume of cap material is estimated to be approximately 13,000 yd^3. Due to the wet nature of the soil in this area, dewatering of soil would be performed using shallow trenches for some areas.

9.5.3.3 Subalternative 3A – Removal of Soil and Tailing Spill Deposits and Off-Site Disposal

Estimated Construction Timeframe:	*2.25 years*
Estimated Timeframe to Reach Remediation Goals:	*2.25 years*
Estimated Capital Cost:	*$5,947,000*
Estimated Life Time O&M Costs:	*$412,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$6,096,000*

Number of Years Cost is Projected: *30 years*

Subalternative 3A would remove tailing spill deposits in the Red River riparian area and molybdenum-contaminated soil in the area south of the tailing facility, with off-Site disposal of the soil.

The major components of this subalternative are:

- Excavate soil south of tailing facility and tailing spill deposits along the Red River corridor;
- Dewater soil in area south of the tailing facility;
- Stabilize soils excavated from area south of the tailing facility;
- Transport and dispose of the excavated soil/tailing at an appropriate off-Site facility;
- Backfill excavations with alluvial soil.

In the Red River riparian area, the tailing spill deposits would be excavated to a depth where tailing is no longer visible. The estimated total area containing tailing spill deposits is approximately 3 acres. The volume of tailing spill deposits requiring excavation is estimated to be 3,800 yd^3. The excavations would be backfilled with clean alluvial soil and revegetated, if needed.

For the area south of the tailing facility, approximately 8 acres would be excavated and backfilled with clean alluvial soil. Affected soil would be removed initially to a depth of approximately 2 feet. Confirmation soil sampling would be conducted to determine if cleanup levels have been attained. If not, additional soil would be excavated until cleanup levels are met or an EPA acceptable depth has been reached. Based on an excavation depth of 2 feet the estimated volume of soil requiring excavation is approximately 26,000 yd^3. Due to the wet nature of the excavated soil, portions of the area may need to be dewatered.

The source of fill material is the alluvial borrow area in the northern portion of the tailing facility. The alluvial fill would be appropriately screened prior to transport and placement. Excavated soil would be transported and disposed of at a solid waste landfill, which may be located approximately 30 miles away, one way.

9.5.3.4 Subalternative 3B – Removal of Soil and Tailing Spill Deposits and On-Site Disposal

Estimated Construction Timeframe:	*2 years*
Estimated Timeframe to Reach Remediation Goals:	*2 years*
Estimated Capital Cost:	*$3,442,000*
Estimated Life Time O&M Costs:	*$412,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$3,591,000*
Number of Years Cost is Projected:	*30 years*

Subalternative 3B includes removal of the tailing spill deposits in the Red River riparian area and affected soil in the area south of the tailing facility and on-Site placement of the excavated soil at the tailing facility.

The major components of this subalternative are:

- Excavate soil south of tailing facility and tailing spill deposits along the Red River corridor;
- Dewater soil in area south of tailing facility;
- Stabilize soils excavated from south of tailing facility;
- Transport and placement of the excavated soil/tailing at the tailing facility;
- Backfill excavations with alluvial soil.

The activities associated with Subalternative 3B are the same as those described for Subalternative 3A except the excavated soil/tailing would be transported and placed at the tailing facility.

9.5.4 Long-Term Reliability of Each Alternative

The No Further Action (Alternative 1) is not effective in the long term and does not provide a permanent solution as molybdenum concentrations remain above the remediation goals of 11mg/kg (protection of livestock) in the soil south of the tailing facility, 41 mg/kg (protection of deer and elk), and 54 mg/kg (protection of birds and non-grazing mammals) in tailing spill deposits.

The soil cap alternative (Alternative 2) would require long-term maintenance as soil erosion, run-off, and physical activities could compromise the integrity of the cap. Erosion mats and/or armoring would improve long-term reliability, but long-term maintenance would still be required.

Alternatives 3A (removal of soil and tailing spill deposits with off-Site disposal) is reliable in the long term since the removal is permanent and the excavated areas would require no further monitoring or maintenance as there would be no residual contamination above remediation goals. Adequate control and long-term maintenance would be required for the off-Site disposal facility that receives the excavated soil and tailing material.

Alternative 3B (removal of soil and tailing spill deposits with on-Site disposal) would result in the permanent removal of molybdenum contamination with no residual contamination above the remediation goals. However, the on-Site containment cell that would receive the excavated soil and tailing would require long-term maintenance and monitoring to ensure the integrity of the containment cell.

9.5.5 Expected Outcome of Each Alternative

The expected outcome of all the alternatives, with the exception of the No Further Action alternative (Alternative 1), is to reduce risk to terrestrial wildlife (including deer, elk, birds, and non-grazing mammals) and livestock. Achieving the molybdenum remediation goals of 11 mg/kg in soil south of the tailing facility, 41 mg/kg for deer and elk, and 54 mg/kg in other terrestrial areas for protection of birds and non-grazing mammals would allow the land located south of the tailing facility to be used for wildlife habitat or livestock grazing and protect birds and non-grazing mammals within the riparian corridor.

The removal of "hot spot" tailing spill deposits would also be of some benefit to local residents. Although the potential risk to human health from exposure to tailing (direct contact or incidental ingestion) is below levels which are considered harmful by EPA, local residents have a strong fear of such exposure. The community is fearful of exposure to tailing from the following sources: (1) numerous historic tailing spills from pipeline breaks which resulted in tailing being deposited in the Red River, the riparian corridor along the Red River, Hunt's Pond, and the irrigation ditches (*acequias*) which receive water from the Red River, (2) tailing used as bedding for the Village of Questa's municipal water supply system piping and the potential for contamination of drinking water at residential taps, and (3) tailing dust that blows from the tailing facility into Questa that may result in inhalation exposure. These concerns were communicated to EPA through the community outreach efforts during the RI/FS.

9.6 Eagle Rock Lake Alternatives

The following four alternatives and two subalternatives were developed for Eagle Rock Lake:

- **Alternative 1** – No Action
- **Alternative 2** – Inlet Storm Water Controls; In-Lake Capping of Sediment

- **Alternative 3** – Inlet Storm Water Controls; Dredge Sediment and Disposal
  - Subalternative 3A – Inlet Storm Water Controls; Dredge Sediment and Off-Site Disposal
  - Subalternative 3B – Inlet Storm Water Controls; Dredge Sediment and On-Site Disposal
- **Alternative 4** – Inlet Storm Water Controls; Backfill Lake and Construct New Lake[70]

9.6.1 Common Element of the Alternatives

9.6.1.1 Inlet Storm Water Controls

A common element to the remedial alternatives for Eagle Rock Lake, with the exception of the No Action alternative (Alternative 1), is the inlet controls to manage storm water entering the lake. Engineering controls would be included on the inlet structure to the lake to reduce the sediment load from entering the lake during storm events or other high-flow conditions that entrain sediment in the river. Flows into Eagle Rock Lake range from approximately 100 to 400 gpm. Storm events generate a considerable sediment load in the river that originates from drainages upstream of the mine site, and controls on the inlet are designed to limit the sediment load to the lake. Closing the headgate would be accomplished through the use of specific conductance and turbidity probes that monitor the river water and automatically close the headgate if prescribed values are exceeded.

[70] Alternative 4 was originally Alternative 5 in the Proposed Plan and the FS Report. It was out of sequence with the other alternatives because the original Alternative 4 (removal of Eagle Rock Lake) was eliminated during the initial screening phase of the FS since it would likely be an unfavorable cleanup option to the local community.

9.6.2 Key Applicable or Relevant and Appropriate Requirements

Key ARARs that provide a basis for developing the remedial alternatives for Eagle Rock Lake are presented below. Federal and state surface water quality regulations, standards, and criteria are not listed here as surface water quality is being addressed through source control (inputs to the Red River) at the mine site (see Key ARARs for Mine Site Area, Section 9.3.2). A summary of the chemical-, action-, and location-specific ARARs that apply to each remedial alternative for the Site is presented in Tables 9-1 through 9-12.

9.6.2.1 Clean Water Act Regulations

Clean Water Act regulations at 40 C.F.R. Part 122 and Part 125 are applicable requirements for the EPA-administered NPDES permit program. These would be applicable action-specific requirements to be addressed for managing and disposing of water from the dewatering of dredged lake sediments.

9.6.2.2 Clean Water Act – Dredge and Fill Regulations

Dredge and fill regulations of the Clean Water Act at 40 C.F.R. Part 230 and 33 C.F.R. Parts 322 and 323 are applicable location-specific requirements. They establish requirements for permits to authorize the discharge of dredged or fill material into waters of the United States, which includes inland wetlands.

9.6.2.3 Executive Order on Floodplain Management

Executive Order 11988 on Floodplain Management requires federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid, to the extent possible, the adverse impacts associated with direct and indirect development of a floodplain.

9.6.2.4 Executive Order on Protection of Wetlands

Executive Order 11990 on Protection of Wetlands requires that federal agencies avoid, to the extent possible, the adverse impacts associated with the destruction, loss, or net degradation of wetlands and supporting new construction in wetlands, if a practical alternative exists.

9.6.2.5 New Mexico Standards for Interstate and Intrastate Surface Waters

Standards for Interstate and Intrastate Surface Waters in § 20.6.4.122 NMAC establish water quality designated uses and criteria for a specified stream segment.

9.6.2.6 New Mexico Air Quality Regulations

New Mexico air quality regulations at § 20.2 NMAC establish air quality regulations.

9.6.2.7 New Mexico Water Quality Control Commission Regulations

New Mexico WQCC regulations at § 20.6.2.2202 NMAC establish requirements for the disposal of refuse. These are applicable location-specific requirements.

9.6.2.8 New Mexico Solid Waste Regulations

New Mexico Solid Waste regulations at §§ 20.9.2.10 NMAC, 20.9.4.9 NMAC, 20.9.4.13 NMAC, 20.9.4.14 NMAC, 20.9.6.9 NMAC and 20.9.6.12 NMAC establish siting and design criteria and closure/post closure requirements for municipal, special waste, and construction and demolition waste landfills and testing and quality control for liners. These would be applicable action-specific requirements.

9.6.3 Distinguishing Features of Each Alternative

9.6.3.1 Alternative 1 – No Action

Estimated Construction Timeframe:	*Not Applicable*
Estimated Timeframe to Reach Remediation Goals:	*Not Applicable*
Estimated Capital Cost:	*$0*
Estimated Life Time O&M Costs:	*$149,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$54,000*
Number of Years Cost is Projected:	*30 years*

Under this alternative, no action would be taken at Eagle Rock Lake to reduce the risk to benthic macroinvertebrates from exposure to contaminated sediment. The contaminated sediment would be left in place.

9.6.3.2 Alternative 2 – Inlet Storm Water Controls; In-Lake Capping of Sediment

Estimated Construction Timeframe:	*1.5 years*
Estimated Timeframe to Reach Remediation Goals:	*1.5 years*
Estimated Capital Cost:	*$286,000*
Estimated Life Time O&M Costs:	*$495,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$469,000*
Number of Years Cost is Projected:	*30 years*

This alternative would include in-lake capping of the lake-bottom sediment. Covering the existing sediment with a cap would provide more suitable sediment for the aquatic insect populations.

The major components of this alternative include:

- Inlet controls to manage storm water entering the lake;
- In-lake capping of sediments.

Capping would include placement of approximately 1 foot of suitable alluvial fill on the bottom of the 3-acre lake. The volume of alluvial fill that would be required for the cap is approximately 4,900 yd^3. The source of the fill would be the borrow area (alluvial soil) at the tailing facility.

9.6.3.3 Subalternative 3A – Inlet Storm Water Controls; Dredge Sediment and Off-Site Disposal

Estimated Construction Timeframe:	*2.25 years*
Estimated Timeframe to Reach Remediation Goals:	*2.25 years*
Estimated Capital Cost:	*$2,274,000*
Estimated Life Time O&M Costs:	*$495,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$2,457,000*
Number of Years Cost is Projected:	*30 years*

This alternative would include dredging of the sediment in the lake that poses a risk to the BMI community and the disposal of the excavated sediment at an appropriate off-Site facility.

The major components of this subalternative include:

- Inlet controls to manage storm water entering the lake;
- Dredge and dewater sediment;
- Transport and dispose of the excavated sediment at an appropriate off-Site facility.

Dredging of sediment is also proposed as part of Subalternative 3B. Two types of dredging are available: (1) hydraulic dredging from a barge, or (2) drainage of the lake to allow the sediments to dewater, followed by excavation of the sediment. Hydraulic dredging was selected because it would have less impact to the lake and recreational use of the lake. Additionally, this type of dredging would be quicker than draining and excavating sediment, since the sediment may take several months to naturally dry to a point where it can be excavated.

The dredged sediment would be pumped to a staging area near the lake. The staging area would need to be of sufficient size to temporarily impound the dredged sediment. A temporary berm would be constructed around the staging area to contain the sediment. The sediment would then be dewatered to facilitate drying and the excess water would be temporarily impounded then allowed to flow back into the lake.

Once dewatered, the dredged sediment would be transported and disposed of at an appropriate off-Site facility. It is assumed that the sediment could be handled as a solid waste and would be hauled to a solid waste facility, which may be approximately 30 miles away, one way. The estimated volume of sediment to be dredged is 15,000 yd^3, based on an approximate 3-foot depth of dredging over the 3-acre lake.

9.6.3.4 Subalternative 3B – Inlet Storm Water Controls; Dredge Sediment and On-Site Disposal

Estimated Construction Timeframe:	*2 years*
Estimated Timeframe to Reach Remediation Goals:	*2 years*
Estimated Capital Cost:	*$1,352,000*
Estimated Life Time O&M Costs:	*$504,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$1,538,000*
Number of Years Cost is Projected:	*30 years*

Subalternative 3B includes inlet storm water controls, dredging and dewatering of sediment, and on-Site disposal. This alternative is the same as Subalternative 3A except for on-Site disposal of sediment.

The major components of this subalternative include:

- Inlet controls to manage storm water entering the lake;
- Dredge and dewater sediment;
- Transport and place the excavated sediment at an appropriate on-Site facility.

Approximately 15,000 yd^3 of dewatered sediment would be placed at an appropriate on-Site facility. Proposed cells to be constructed at the mine site for the water treatment plant filter cake/sludge could be used to contain this sediment. It is estimated that each cell would contain approximately 7,500 yd^3.

9.6.3.5 Alternative 4 – Inlet Storm Water Controls; Backfill Lake and Construct New Lake

Estimated Construction Timeframe:	*1.5 years*
Estimated Timeframe to Reach Remediation Goals:	*1.5 years*
Estimated Capital Cost:	*$1,299,000*
Estimated Life Time O&M Costs:	*$527,000*
Discount Rate:	*7%*
Estimated Total Present Value Cost:	*$1,495,000*
Number of Years Cost is Projected:	*30 years*

This alternative would include draining the lake, constructing a comparable sized lake near the existing lake, backfilling the existing lake with alluvial fill and revegetating.

Constructing a new lake would mitigate the risk to the BMI population by providing a more suitable substrate for a BMI ecosystem.

The major components of this alternative include:

- Drain the existing lake;
- Excavate and construct new lake;
- Excavate current breach dam and remove existing headgate;
- Backfill the existing lake;
- Construct earthen dam and inlet/outlet structures at new lake;
- Inlet controls to manage storm water entering the new lake;
- Relocate or construct infrastructure.

In Alternative 4, the existing lake would be drained by breaching the earthen dam at the lake's outlet. Breaching would proceed slowly to minimize sediment from discharging into the river. A dead pool of water is expected to be present in the lake after the dam is breached, and the remaining water would be removed and contained for use at CMI facilities or discharged. The inlet from the river to the lake would be removed. The volume of soil estimated to backfill the existing lake is estimated to be approximately 37,000 yd^3, based on an average depth of the lake of 7.5 feet.

A new lake is proposed to be constructed. The new lake would cover the same approximate area (3 acres) as the existing lake and would have a comparable maximum water depth of approximately 8 feet and storage volume of approximately 23 ac-ft. An earthen dam would be constructed on the west side of the new lake at a height of less than 10 feet. Excavated material would be used to construct the dam. An inlet and outlet would be constructed, similar to the existing lake, with a headgate at the inlet. Erosion controls (*i.e.,* riprap) would be placed around the outlet. A channel from the outlet to Red River would be excavated and lined-with riprap. The outlet channel would convey water from the lake back to the river, similar to the existing lake. Water would be supplied to the new lake by a new headgate and concrete diversion at the river located on the eastern end of the lake. A channel would be excavated from the headgate to the new lake and lined with riprap. Storm water controls would be added to the inlet of the new lake, similar to Alternatives 2 and 3, to minimize the sediment load entering the lake. Once constructed, the new lake would be filled by diverting water from the river. Excavated material from the new lake would be used to backfill the existing lake.

9.6.4 Long-Term Reliability of Each Alternative

The No Action alternative (Alternative 1) is not protective of the benthic macroinvertebrate population as no remedial action is proposed for the sediment. For all other alternatives, the inlet storm water controls should be reliable and effective means of reducing sedimentation during storm events, or other high-flow events, that may entrain sediment into the river for the long term. However, there is a potential that the motorized headgate and associated equipment might break down and require replacement. It is anticipated that replacement costs would be incurred over the long term to ensure the controls function as designed.

The inlet storm water controls are the key to the long-term reliability of all these alternatives. Without effective inlet controls, the likelihood of re-sedimentation of the existing lake or new lake with sediment and metals during high-flow events is fairly high. Assuming that source control and reduction of inputs to the river along the mine site are effective alternatives for the Mine Site Area, the source of the sediment would be debris flows from the scar-impacted tributary drainages located upstream of the mine site.

For ensuring long-term reliability, other measures would also be necessary for some alternatives. The in-lake sediment capping alternative (Alternative 2) would eventually require cap replacement over the long-term. The dredging and off-Site/on-Site disposal alternatives (Subalternatives 3A and 3B) permanently remove contaminated sediment.

However, the integrity of the on-Site sediment disposal cells would need to be managed and monitored for the long term and it is assumed that periodic repairs to the cells would be necessary. The alternative for backfilling the existing lake and constructing a new lake (Alternative 4) would not require additional measures to ensure long-term reliability other than the effective operation of inlet storm water controls for the new lake. The contaminated sediment in the existing lake would be permanently capped with alluvial fill and the new lake would eventually provide a more suitable substrate for the benthic macroinvertebrate ecosystem.

9.6.5 Expected Outcome of Each Alternative

The implementation of these alternatives, excluding the No Action alternative, is expected to reduce the risk to the benthic macroinvertebrate population from exposure to metals in sediment within a very short time frame (1.5 to 2.25 years).

The anticipated environmental benefit is the re-establishment of the benthic macroinvertebrate populations as an important food source for fish in Eagle Rock Lake. Additionally, anticipated socio-economic and community revitalization impacts are the improved conditions of the lake as a popular recreational area (fishing) for the local community. However, the lake will not be available for such recreational use during remedy implementation (1.5 to 2.25 years).

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10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The NCP at 40 C.F.R. Part 300 requires EPA to evaluate alternatives against nine criteria to determine which alternative is preferred. The first two criteria are referred to as the "Threshold Criteria." They are overall protection of human health and the environment and compliance with ARARs. Response actions under CERCLA must satisfy the Threshold Criteria. The next five criteria are referred to as the "Balancing Criteria." They are long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness; implementability; and cost. The balancing criteria are used to weigh major tradeoffs among alternatives. The last two criteria are referred to as the "Modifying Criteria." They are state acceptance and community acceptance.

10.1 Summary of the Nine Evaluation Criteria

10.1.1 Threshold Criteria

- **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.

- **Compliance with ARARs**

  Section 121(d) of CERCLA and the 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) and the NCP § 300.430(f)(1)(ii)(C).

10.1.2 Balancing Criteria

- **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 met. This criterion includes the consideration of residual risk that will remain on site following remediation and the adequacy and reliability of controls.

- **Reduction of Toxicity, Mobility, or Volume Through Treatment**

  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.

- **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. Included with this evaluation is an estimate of the natural resources to be consumed and increased emissions to be produced for each alternative.

- **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.

- **Cost**

  Cost includes estimated capital and annual operations and maintenance costs, as well as present value costs.

10.1.3 Modifying Criteria

- **State/Support Agency Acceptance**

  This criterion considers whether the state agrees with EPA's analyses and preferred alternative, as described in the remedial investigation/feasibility study and proposed plan.

- **Community Acceptance**

  This criterion considers whether the local community agrees with EPA's analyses and preferred alternative, as described in the remedial investigation/feasibility study and proposed plan. Comments received on the preferred alternative, as well as all the other alternatives presented in the proposed plan, are an important indicator of community acceptance. Community acceptance is fully considered after the public comment period and documented in the record of decision.

10.2 Mill Area

A summary of the comparative analysis of alternatives for the Mill Area is discussed below.

10.2.1 Overall Protection of Human Health and the Environment

All of the alternatives, except Alternative 1 (No Further Action), are protective of human health and the environment by eliminating, reducing, or controlling risks posed by the contaminated soil through removal, treatment, engineering controls and/or institutional controls, and other land use controls. All of the alternatives provide access restrictions and institutional controls intended to protect the public and limit future residential land and commercial use. The temporary well drilling prohibitions to be imposed by the Office of the State Engineer would limit human receptor exposure to ground water.[71] The restrictive covenants recorded by CMI are intended to protect the integrity of the engineered covers.[72] Current mine workers are afforded protection when they comply with worker health and safety and hazard communications program requirements enforced by MSHA during mining and milling operations. All of the alternatives, except No Further Action, include placement of a final cover at mill decommissioning that would be protective of either water treatment and other light industry uses or ecological receptors in those areas designated for forestry as an approved post-mining land use.

Subalternatives 5A, 5B, and 5C (Soil Removal – High Occupancy Scenarios with Treatment/Disposal Options) provide adequate protection for potential future residents because PCB- and molybdenum-contaminated soil would be removed to protective levels and either treated and/or disposed off-Site or on-Site. The proprietary controls are not necessary components of Subalternative 5A to ensure protection of human health, as all soil contamination above levels considered protective for the future resident is removed.

Subalternatives 4A and 4B (Soil Removal – High Occupancy Scenario with Treatment/Disposal Options and Cap) are also protective of potential future residents through the removal of PCB-contaminated soil. However, residual PCB and molybdenum contamination remains in soil at concentrations above protective levels and is capped. The cap will prevent direct contact/ingestion of contaminated soil. The integrity of the cap will need to be protected through the use of institutional controls (restrictive covenants) for the remedy to remain protective.

[71] Mining-related contamination has not been detected in ground water at the Mill Area
[72] The restrictive covenants are intended to prohibit uses that may adversely affect the integrity of any remedial measures, but to allow excavation up to 10 feet in the mill area. However, no excavation could be allowed in the area of the cover (soil cover or asphalt cap) for certain alternatives, as such activity would destroy the integrity of the cap.

Alternative 3 (Soil Removal – Low Occupancy Scenario with Off-Site Treatment/Disposal) is protective of potential future commercial/industrial land uses, as soil with PCB concentrations above the TSCA low occupancy level of 25 mg/kg would be removed and treated/disposed off-Site. The anticipated future land uses at the Mill Area are commercial/industrial and forestry. Based on the results of the HHRA (CDM 2009a), EPA determined that molybdenum did not pose a risk to a future commercial/industrial worker at the Mill Area. The proprietary controls recorded by CMI would not be necessary as a component of Alternative 3 to protect the future commercial/industrial worker.

Alternative 2 (Limited Action) provides protection from exposure by targeted removal of soil containing PCBs greater than 50 mg/kg and gravel placement on soil with PCBs greater than 25 mg/kg. These actions would protect human receptors by preventing direct contact/ingestion of soil.

The institutional controls allow for light industry use in Designated Use Areas after the termination of mining, which could expose future industrial workers to PCB-contaminated soil for Alternative 1.

10.2.2 Compliance with ARARs

The key chemical-specific ARARs are the TSCA regulations at 40 C.F.R. Part 761, which address the management and cleanup of PCBs. These regulations specify the following PCB cleanup levels:

- **1 mg/kg** for removal of waste in high occupancy areas (*e.g.,* residential) without further conditions;
- **10 mg/kg** for removal of waste in high occupancy areas with installation of a cap (for PCB levels greater than 1 mg/kg and less than or equal to 10 mg/kg);
- **25 mg/kg** for removal of waste in low occupancy areas (*e.g.,* commercial or industrial) without conditions;

- **50 mg/kg** for removal of waste when the site is secured by a fence and marked with appropriate signage.

Alternatives 2 and 3 and Subalternatives 4A, 4B, 5A, 5B, and 5C would comply with all ARARs summarized on Tables 9-1, 9-6, and 9-8, including the TSCA regulations. Alternative 1 is also expected to comply with all ARARs, except that the TSCA soil cleanup levels at 40 C.F.R. Part 761, Subpart D would not be met because no soil is removed.

10.2.3 Long-Term Effectiveness and Permanence

Each alternative, except the No Further Action alternative, provides some degree of long-term protection as they all consist of soil removal with treatment and/or disposal and with or without capping.

Alternative 3 and Subalternatives 5A, 5B, and 5C provide a permanent remedy through removal of contaminated soil. These alternatives include the off-Site treatment and disposal of PCB-contaminated soil. Subalternative 5A also includes the off-Site disposal of molybdenum-contaminated soil. This is more effective than Subalternatives 5B and 5C, which require long-term management of an on-Site disposal facility for molybdenum-contaminated soil (*i.e.,* impoundment at the tailing facility or repository at the mine site). Off-Site facilities have established reliable controls for long-term management of soils. Molybdenum concentrations do not pose a risk for the commercial/industrial worker and therefore are not addressed in Alternative 3.

Subalternatives 4A and 4B provide a long-term remedy as PCBs greater than 10 mg/kg would be removed and treated/disposed off Site. However, they would require maintenance of the soil and asphalt cap that cover residual PCB and molybdenum contamination, with the asphalt cap requiring less maintenance. Alternative 2 (Limited Action) provides a lesser degree of long-term effectiveness and permanence, as soil containing PCBs greater than 50 mg/kg would be removed. However, residual molybdenum and PCB contamination would remain above protective levels for residential and commercial/industrial uses. Alternative 1 (No Further Action) provides the lowest degree of long-term effectiveness and permanence as land use restrictions (recorded institutional controls and access restrictions) would limit exposure to contaminated soil by some receptors (potential future residents), but no remediation would be conducted.

Placement of a vegetative cover in the Mill Area at decommissioning would add to the long-term effectiveness of all the alternatives, excluding the No Further Action alternative, by providing a barrier to human and ecological receptors from direct contact/ingestion of soil. Long-term maintenance of the cover would be required to continue its permanence.

Overall, Alternative 3 and Subalternative 5A are the most effective and permanent in the long term, followed by Subalternatives 5B and 5C, Subalternatives 4A and 4B, Alternative 2, and then Alternative 1.

10.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 and Subalternatives 4A, 4B, 5A, and 5B provide reduction in toxicity, mobility, and volume through treatment of high concentrations (greater than 50 mg/kg) of PCBs in soil (incineration) at an off-Site treatment, storage and disposal facility. In Subalternative 5C, all soil with PCB concentrations greater than the residential cleanup level of 1 mg/kg would be treated on-Site by thermal desorption. The quantity of soil that would be treated in Subalternative 5C is greater than that for the other alternatives. There would be no reduction of toxicity, mobility, or volume through treatment under Alterative 1 (No Further Action) or Alternative 2 (Limited Action).

There is no reduction of toxicity, mobility, or volume by treatment of the molybdenum in soil for any of the alternatives.

Overall, Subalternative 5C provides the greatest reduction in toxicity, mobility, and volume, followed equally by Alternative 3, and Subalternatives 4A, 4B, 5A and 5B.

Alternative 1 and Alternative 2 do not reduce toxicity, mobility or volume of the affected contaminated soil.

10.2.5 Short-Term Effectiveness

Alternative 1 (No Further Action) provides no increased short-term risk or exposure because no construction-related actions would be implemented that create additional risks to workers or the community. Alternative 2 (Limited Action) would have minimal increased risk to workers and the community. The regrade, cover, and revegetation of the Mill Area upon closure may pose construction hazards to workers; however, these potential risks are expected to be minimal in the short-term because appropriate personal protective equipment and health and safety measures would be used during construction. Truck haulage of the PCB-affected soil to an off-site facility increases the potential for traffic hazards on public roads. Potential additional risk to workers and the community may occur during implementation of the targeted soil removal actions in Alternative 3 and Subalternatives 4A and 4B, and the large-scale soil removals in Alternatives 5A, 5B, and 5C. Risks to workers may occur during excavation around buildings with buried utilities. Risks associated with truck haulage for import of cap material on local roads will increase the potential for traffic hazards in the community. Subalternatives 5A and 5B include increased truck traffic due to the increased volume of soil being handled. There would also be increased risks to workers during the operation of the thermal treatment system and management of byproducts in Subalternative 5C.

Overall, the alternatives from the most effective (least short-term impacts) to the least effective (greatest short-term impacts) for remedy implementation are as follows: Alternative 1, greater than Alternative 2, greater than Alternative 3, greater than Subalternatives 4A, then 4B, then Subalternative 5C, then Subalternatives 5A equal to 5B.

10.2.6 Implementability

All of the alternatives are implementable. Alternative 1 (No Further Action) does not include construction activities and would be the easiest to implement. Alternative 2 includes limited construction activities and would be the next easiest to implement. Alternative 3 and Subalternatives 4A, 4B, 5A, 5B and 5C include excavation, transport, and disposal of larger volumes of soil, which is common practice. Excavation and backfill of approximately 2,000 to 3,300 yd^3 of soil in Alternative 3 and Subalternatives 4A and 4B results in shorter construction periods and uses less construction equipment to complete than the 160,000 yd^3 of soil in Subalternatives 5A, 5B, and 5C. Subalternative 5A would include transport of the largest quantity of soil (160,000 yd^3) and the longest haul distances for disposal as three off-Site facilities would be needed (local solid waste landfill for molybdenum soil; RCRA Subtitle C treatment facility for greater than 50 mg/kg PCB-soils; and RCRA Subtitle C non-treatment facility for less than or equal to 50 mg/kg PCB-soils). Subalternative 5B would include the second largest quantity of soil to be transported (113,000 yd^3) for treatment/disposal off-Site, followed by Alternative 3 and Subalternatives 4A and 4B with 2,000 to 3,300 yd^3. Subalternatives 5B and 5C would include transport of molybdenum soils (49,000 yd^3) a shorter distance to an on-Site location.

Subalternatives 4A and 4B include import of materials from off-Site locations (clay soil – 100 miles and asphalt – 30 miles). Preparation of the clay soil cap (compaction) to achieve TSCA requirements for Subalternative 4A would result in a longer construction period than asphalt paving in Subalternative 4B.

Subalternative 5C would include on-Site thermal treatment of soil. Thermal desorption contractors are limited and the technology requires multiple treatment trains (*i.e.,* soil preprocessing, soil treatment, air treatment, and PCB recovery), resulting in the on-Site transport of complex equipment and use by specially trained operators. Collection and management of treatment byproducts (air emissions) would require additional sampling and monitoring. Thermal treatment of 113,000 yd^3 of PCB-contaminated soil would take 3-4 years to complete.

Overall, Alternative 1 would be the easiest to implement, followed by Alternative 2. Alternative 3 is the next easiest to implement and notably easier than Subalternatives 4A and 4B, which include clay soil/asphalt transport and placement for the cap. Subalternatives 5A, 5B, and 5C involve the greatest construction activities, including the excavation and backfill of large volumes of soil and transport of soil over large distances (Subalternatives 5A and 5B) or on-Site treatment and disposal of soil (Subalternative 5C).

10.2.7 Cost

Table 10-1 presents a summary of cost for the Mill Area alternatives. All of the alternatives (excluding No Further Action) involve various soil removal and on-Site/off-Site disposal options which significantly affect the cost. Alternatives with the larger volume of soil to remove/dispose tend to have the higher costs. Alternative 1 does not include construction activities and has the lowest cost. For Alternative 2, an additional cost of 2.1 million (present value) would provide limited excavation of high concentration PCB soils with off-Site disposal and temporary gravel placement. An increase of $100,000 (present value) for Alternative 3 includes targeted soil removal for the commercial/industrial land use scenario. An increase of approximately $11 million (present value) over Alternative 3 would provide limited soil removal and cap installation (Subalternatives 4A and 4B); with the asphalt cap (4B) costing $2 million less than the clay soil cap (4A). An approximate $30 to $36 million (present value) increase in cost over Subalternatives 4A/4B would add removal of a significantly larger volume of soil (Subalternatives 5A, 5B, and 5C). On-Site treatment and disposal of PCB soils (5C) cost approximately the same as off-Site treatment and disposal (5B).

10.2.8 State/Support Agency Acceptance

The State of New Mexico supports Alternative 3, the preferred alternative identified in EPA’s Proposed Plan for the Mill Area.

10.2.9 Community Acceptance

As previously noted in Section 3.0 above, a significant effort has been put forth to communicate with the public on progress of the CERCLA RI/FS and remedy selection process for the Site. The community has been a vocal participant throughout the CERCLA process to the extent that feedback from community groups and residents has modified investigation activities.

TABLE 10-1
ALTERNATIVES COST SUMMARY FOR MILL AREA

Alternative Description	Cost in Current Dollars ($)		Present Value Cost ($)
	Construction (Capital)	O&M	
1 – No Further Action	0	802,000	327,000
2 – Limited Action (ICs; Targeted Removal; H&S, Hazard Communication)	2,078,000	923,000	2,451,000
3 – Soil Removal (PCBs >25 mg/kg); Off-Site Treatment/Disposal	2,176,000	923,000	2,549,000
4A – Soil Removal (PCBs >10 mg/kg); Off-Site Treatment/Disposal; Soil Cap	13,064,000	946,000	13,446,000
4B – Soil Removal (PCBs >10 mg/kg); Off-Site Treatment/Disposal; Asphalt Cap	10,444,000	2,847,000	11,502,000
5A – Soil Removal (PCBs >1 mg/kg); Off-Site Treatment/Disposal	47,269,000	1,206,000	47,746,000
5B – Soil Removal (PCBs >1 mg/kg); Off-Site Treatment/Disposal (PCBs); On-Site Disposal (Molybdenum)	43,190,000	1,206,000	43,667,000
5C – Soil Removal (PCBs >1 mg/kg); On-Site Treatment/Disposal	43,337,000	1,206,000	43,814,000

Notes:
< = Less than
> = Greater than

For the Mill Area, public comments were generally supportive of EPA's Preferred Alternative to address PCBs and molybdenum in soil to industrial clean-up standards. Specific comments on EPA's Preferred Alternative are stated below.

- The Red River Remediation Group (R3G) strongly advocated that the proposed 6-inch cover depth for the Mill Area is inconsistent with the 36-inch cover depth required under New Mexico Mining Permit TA001RE for the post-mining land use designation that includes forestry and water management. R3G recommended that the ROD should require a 36-inch thick cover over the entire Mill Area unless otherwise justified as part of the remedial design or other identified post-mining land use; and

- The Rio Colorado Reclamation Committee (RCRC) community group[73] and local residents at public meetings and in letter correspondence requested that the Mill Area remedial action be implemented quickly and use local labor forces. They also advocated that PCB characterization sampling and confirmation sampling be sufficiently comprehensive and that EPA ensures no public funding is used for the cleanup anywhere on the Site. They further requested that three feet of cover is used to close the area in accordance with the State of New Mexico permits.

The other significant community group, Amigos Bravos, as well as the Village of Questa were generally supportive of the Preferred Alternative.

10.3 Mine Site Area

A summary of the comparative analysis of alternatives for the Mine Site Area is discussed below.

[73] The Rio Colorado Reclamation Committee (RCRC) community group that submitted comments on the Proposed Plan is a newly formed community group and does not represent the original RCRC which was awarded EPA's Technical Assistance Grant in 2001. The original RCRC formerly changed its name to the Red River Remediation Group (R3G) in 2009.

10.3.1 Overall Protection of Human Health and the Environment

All of the alternatives, except the No Further Action alternative (Alternative 1) and Limited Action alternative (Alternative 2), are protective of human health and the environment by eliminating, reducing, or controlling risks posed by contaminated ground water and surface water through engineering controls, land use controls, and active ground water and surface water remediation.

All of the alternatives provide land use controls (access restrictions and institutional controls) to protect the public and restrict future residential and commercial uses. Temporary well drilling prohibitions to be imposed by the New Mexico Office of the State Engineer would limit human receptor exposure to ground water, and proprietary controls would restrict future land use. Also, current mine workers are afforded protection when they comply with worker health and safety and hazard communications program requirements enforced by MSHA during mining operations.

Alternative 3 (Source Containment, Water Management, and Ground Water Extraction and Treatment) provides protection of human health and the environment by source containment for the waste rock piles, active ground water remediation, seepage collection, and perpetual mine dewatering and water treatment. Source containment would reduce net percolation and acid rock drainage/metals leaching to ground water and Red River surface water. It would be provided by regrading waste rock piles to minimum 3H:1V interbench slopes (Subalternative 3A) or minimum 2H:1V interbench slopes (Subalternative 3B), followed by cover placement and revegetation. Subalternative 3A would be superior to Subalternative 3B for supporting an erosion-resistant cover that would provide a long-term stable medium to promote vegetative growth capable of reducing net percolation and, hence, acid production and metals leaching.

The combination of source containment, institutional controls, and active ground water remediation and seepage collection would protect human receptors that may be exposed to surface water contamination or use ground water drawn from wells for drinking water. These measures will also protect aquatic life (trout) from exposure to COCs in Red River surface water at zones of upwelling ground water.

Subalternatives 3A (3H:1V Slope) and 3B (2H:1V Slope) would also provide protection by mitigating instability concerns associated with the steep (nearly angle of repose) waste rock piles through regrading to 3H:1V or 2H:1V interbench slopes. However, Subalternative 3A would be superior to Subalternative 3B as it would result in shallower slopes than Subalternative 3B. As discussed below, there are also inherent dangers of personnel fatalities and injuries associated with constructing, repairing, and maintaining the steeper 2H:1V slope surfaces.

CMI has previously conducted interim reclamation of the Goathill North and Sugar Shack West waste rock piles in 2005 and 2008 to address stability concerns. It is noted that partial/complete removal of waste rock would be necessary to achieve the 3H:1V interbench slopes at some waste rock piles. The actual location for waste rock disposal would be selected during the remedial design, with the open pit being a potential repository. Depending on the location(s) selected, there would be differing levels of potential environmental impacts. The use of any repository for waste rock placement would result in increased emissions and safety concerns associated with haul truck traffic. If the pit repository or Spring Gulch waste rock pile are not utilized, other on-site locations may impact greenfields. If an off-site repository is selected, such concerns are more significant in terms of emissions and safety, and a potentially distant undisturbed greenfield would be impacted.

Alternative 1 (No Further Action) and Alternative 2 (Limited Action) are not protective of human health or the environment as there are no engineering controls for source containment and hence ground water cannot be restored to its beneficial use at all places of withdrawal for present and reasonably foreseeable future use. Potential exposure to contaminated ground water off the mine property would remain a possibility. The recreational visitor and trespasser are not protected from exposure to contaminated surface water (seepage) for Alternative 1. For Alternative 2, the recreational visitor and trespasser are protected by the piping of seepage to the Capulin seepage catchments and pumpback pond and fencing of the area.

10.3.2 Compliance with ARARs

The alternatives/subalternatives for the Mine Site Area would comply with chemical-specific, location-specific, and action-specific ARARs with the possible exception of federal drinking water standards at 40 C.F.R. Part 141, Subparts B and G (MCLs and MCLGs) and Subpart F (MCLGs), and the New Mexico water quality standards at Water Supply Regulations § 20.7.10.100 NMAC (MCLs and MCLGs) and WQCC § 20.6.2.3103 NMAC (standards for ground water). These standards may not be met for certain contaminants in ground water at specific locations at the mine site.

Some of the chemical-specific ARARs are currently below some ground water cleanup levels that represent natural background levels for tributary drainages and the northern portion of the Red River alluvial aquifer at the mine site (Table 12-11). It is EPA's policy to generally not clean up to concentrations below natural background levels under CERCLA[74]. New Mexico regulations likewise do not require cleanup (abatement) actions to achieve the numeric standard for a specific contaminant, if that contaminant is present in natural background levels above the numeric standard (Water Quality Act § 20.6.2.4101 B NMAC).

Since natural background levels in ground water at specific areas of the mine site exceed some federal and state standards, the standards would not be met by any of the alternatives. Ground water modeling and other analyses were performed during the RI/FS to evaluate whether natural background levels, as selected cleanup levels, could be achieved through the use of source containment measures and ground water and seepage collection systems. For Alternatives 1 (No Further Action) and 2 (Limited Action), the modeling results showed the existing collection systems (with no source control) would not achieve the

[74] See Role of Background in the CERCLA Cleanup Program, USEPA, OSWER 9285.6-07P

cleanup levels. For Subalternatives 3A (3H:1V Slope) and 3B (2H:1V Slope), cleanup levels would be achieved in the alluvial aquifer through source control and the operation of upgraded ground water remediation systems. The modeling effort did not demonstrate that cleanup levels would be achieved in colluvium and bedrock for all COCs at all locations on the mine site, in particular under the footprint of the rock piles and adjacent areas of the drainages. However, the cleanup levels would be met in colluvium and bedrock within Capulin Canyon and Goathill Gulch drainages downgradient of new subsurface seepage interceptor trenches and in the Goathill and Slick Line Gulch colluvial fans downgradient of the extraction wells. The modeling results are presented in Appendices E2 and E3 of the FS Report (URS 2009b).

Although EPA approved the FS Report, there is significant uncertainty with the modeling results performed by CMI and its consultants. Assumptions in the modeling effort included only a 60 percent reduction in net infiltration through the store and release/evapotranspiration cover system to be constructed on the waste rock piles under Subalternatives 3A (3H:1V Slope) and 3B (2H:1V Slope). EPA accepted this assumption for FS purposes, but not as a potential performance criterion in design of the cover system. A higher performance cover design (*i.e.,* higher percent infiltration reduction) would be necessary to satisfy the remedial action objective established by EPA in this ROD for reducing acid rock drainage and metals leaching in waste rock piles to levels that would not cause exceedances of ground water standards or natural background levels. To achieve this remedial action objective, a significantly greater level of reduction in net infiltration and net percolation through the cover system would be required. This is considered a feasible undertaking and EPA’s expectation is that all cleanup levels, including those representing federal or state standards, health-based criteria, or natural background levels, would be met in all ground waters at the mine site. As stated previously, the shallower slopes of Subalternative 3A would be superior to the steeper slopes of Subalternative 3B for reducing net percolation and, hence, meeting ARARs.

10.3.3 Long-Term Effectiveness and Permanence

Subalternative 3A (3H:1V Slope) and Subalternative 3B (2H:1V Slope) would be effective and permanent. A permanent store and release/evapotranspiration cover system would be constructed on regraded waste rock, consisting of a minimum of 36 inches of amended Spring Gulch Waste Rock Pile material and revegetation with grasses, shrubs, forbs and trees. The cover system would provide a permanent barrier but requires long-term maintenance and monitoring and storm water run-on/run-off controls.

Subalternative 3A would achieve shallower slopes as compared to Subalternative 3B, thus significantly increasing the long-term structural and erosional stability of the rock pile and associated cover. Secondary weathering minerals found in the mine site waste rock piles such as illite and smectite clays, gypsum, and iron oxides have properties that can adversely affect stability such as the brittle nature of the oxides, the fine grain size of the clay particles, and the swelling nature of the clays.

The shallower slopes of Subalternative 3A would also reduce surface water flow velocities, thus reducing erosion. Erosion on the steeper 2H:1V slopes would be greater and require a significant increase in the level of effort to maintain and repair the cover system for the long term.

The shallower slopes of Subalternative 3A would be more favorable for optimizing vegetative growth as a necessary component of evapotranspiration cover performance. Cover performance is the most critical aspect of the remedy for reducing acid-rock drainage and metals leaching and achieving ground water cleanup levels. The degree of success (*i.e.,* reduction in net percolation) which can be achieved by a cover system constructed on steeper (2H:1V) slopes has a higher level of uncertainty and would need to be demonstrated through the performance of additional treatability or pilot studies.

Subalternative 3B presents greater inherent dangers of personnel fatalities and injuries associated with constructing, repairing, and maintaining the steeper slope surfaces as compared to Subalternative 3A. The risk of equipment roll-over due to operating either on a slope in a direction not perpendicular to the slope's contour, or too close to the edge of a bench, increases markedly on the steeper slopes. The higher risk incidence becomes exacerbated because of the increase need for maintenance and repair on steeper slopes.

Subalternative 3A would result in the exposure of hydrothermal scars. The scars may also compromise the long-term effectiveness of the cover's vegetation downslope of scar areas.

Subalternative 3A would result in the exposure of the near vertical outcrops of hydrothermal scar material. As a result of such exposure, the area for incident rainfall would be minimized and runoff would be maximized resulting in little to no infiltration of water in these areas. The soil erosion which feeds the natural mud/debris flows within scar-impacted tributary drainages observed north of the mine site originates from the colluvial fans at the base of the scars and not from the near vertical faces. The absence of scar-related debris has been observed on the upper north side of the regraded Goathill North Waste Rock Pile. A veneer of coarse waste rock over steep scared areas will encourage infiltration of rainfall as observed in the roadside waste rock piles and likely result in further impacts to ground water. Therefore, consistent with observations at the Goathill North Waste Rock Pile and in natural scar drainages north of the mine site, EPA expects that debris flows will not occur from areas where regrading exposes near vertical scar faces and that the vertical exposed scars are a lesser environmental consequence than scars covered with a veneer of overly steepened coarse waste rock.[75]

For Subalternative 3A, approximately 122 million yd^3 of the waste rock piles would be removed and transported to an on-Site repository for long-term management. This increases the collateral impact of the remediation through increased truck haulage and other direct and indirect environmental impacts. For Subalternative 3B, a balanced-cut-fill would be achieved within and between waste rock piles and approximately 35 million yd^3 of waste rock would be removed, lessening the collateral impacts from truck haulage. For

[75] EPA's assessment of the environmental impact of exposing hydrothermal scars in this ROD is a modification of the assessment performed by CMI on behalf of EPA, as documented in the FS Report.

Subalternative 3B it is expected to take an additional 3 years to complete the earthwork on the waste rock pile due to the slower progress on steeper slopes. This adds to the collateral damage of Subalternative 3B (28 years) versus Subalternative 3A (25 years).

Perpetual mine dewatering would be required to maintain the water level in the underground mine below the Red River. Mine dewatering and the additional water extraction and collection in Subalternatives 3A and 3B would result in the need for water treatment and management of treatment-related waste in the long term. Some extraction wells may also need to be operated in perpetuity to maintain cleanup levels.

Alternative 1 (No Further Action) and Alternative 2 (Limited Action) would not provide long-term protection and would be only partially effective. Infiltration and net percolation through the waste rock would continue to produce acid and metals leaching as a continuing source of contamination to colluvial and bedrock ground water. The ground water withdrawal well system along the roadside waste rock piles is somewhat effective at reducing contaminant concentrations in the alluvial aquifer. However, concentrations are not expected to reach cleanup levels and operation of the system would continue for the long-term. The Spring 13 and 39 collection systems are also effective at reducing contaminant load to the Red River, but will require long-term management.

Under Alternatives 1 and 2, the current practice of disposing contaminated mine water at the tailing facility (see Water Usage/Disposal at Mill, Section 2.3.1.4, above) would continue until the termination of mining. The conveyance of this contaminated water to the tailing facility for discharge contributes to the contamination in ground water beneath the impoundments. Long-term effectiveness and permanence increases when water treatment is added to Alternative 2 six months prior to mill decommissioning.

Overall, the alternatives that have the highest long-term effectiveness and permanence in order of most effective to least effective are as follows: Subalternative 3A, which is more effective than Subalternative 3B, which is more effective than Alternative 2, and then Alternative 1.[76]

10.3.4 Reduction in Toxicity, Mobility, or Volume through Treatment

The type of mining waste and mill waste (source material) that are addressed by the alternatives developed for the Site are high volume, low level threat waste (*i.e.,* waste rock, tailing). The EPA expects to use engineering controls instead of treatment for this type of waste [40 C.F.R. § 300.430(a)(1)(iii)(B)]. Therefore, because waste rock is not treated in these alternatives, there is no reduction of toxicity, mobility, or volume of the mining-related source material at the Mine Site Area.

There is reduction of toxicity, mobility, or volume of contamination in surface water and ground water through treatment for Subalternatives 3A and 3B and Alternative 2 (Limited Action). The timing of water treatment for these alternatives is six months prior to mill decommissioning. However, Subalternatives 3A and 3B also include options for the start of water treatment at Years 0, 10, 20, and 30 Construction. The amount of reduction in the toxicity, mobility, or volume would depend on timing of water treatment, with the earlier start of treatment resulting in the greater degree of reduction. Alternative 1 would not include water treatment.

Overall, Subalternatives 3A and 3B provide greater reduction in toxicity, mobility, and volume through treatment, followed by Alternative 2, then Alternative 1.

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[76] The ranking of these alternatives in order of most effective and permanent to least effective and permanent in this ROD differs from the comparative analysis presented in the FS Report. The FS Report did not adequately assess the advantages of the shallower (3H:1V) slope for cover placement as compared to steeper (2H:1V) slopes. Such advantages were thoroughly discussed between EPA, NMED, MMD, and CMI during implementation of the FS (see EPA/NMED letters to CMI dated August 12, 2008 and May 28, 2009).

10.3.5 Short-Term Effectiveness

Alternative 1 (No Further Action) would provide no increase in short-term risk because no construction-related actions are proposed that create additional risk to workers, the community, or the environment.

Alternative 2 and Subalternatives 3A (3H:1V Slopes) and 3B (2H:1V Slopes) include actions that would increase potential risk to workers and the environment when water treatment is added because it would require construction of a water treatment plant and conveyance structures. Additional risks to workers and the environment beyond those already described would most likely occur during implementation of Subalternatives 3A and 3B. These activities would require extensive earthmoving activities over large areas and in steep terrain. Additionally, the estimated construction periods required for Subalternatives 3A (25 years) and 3B (28 years) result in greater risk. The movement of rock below the first bench of the roadside waste rock piles (Subalternatives 3A and 3B) includes greater risk and interruptions to vehicles on State Highway 38. Therefore, the road may need to be temporarily shut down either partially or completely for multiple hours/days throughout this period of time. This could create traffic delays and have a negative impact on tourism in the town of Red River and other nearby recreational areas. The volume of waste rock requiring removal to an on-Site repository in Subalternative 3A could result in potentially three times as many accidents as Subalternative 3B. As stated above, Subalternative 3B would present greater inherent dangers of personnel fatalities and injuries associated with constructing, repairing, and maintaining the steeper slope surfaces as compared to Subalternative 3A.

All identified short-term risks to workers would be mitigated through legally required worker health and safety training and protection measures.

Overall, the short-term effectiveness of the alternatives from most effective (least short-term impacts) to least effective (greatest short-term impacts) is as follows: Alternative 1 greater than Alternative 2, greater than Subalternative 3B, and then Subalternative 3A.

10.3.6 Implementability

All of the alternatives are implementable. Alternative 1 (No Further Action) does not include construction activities and would be the easiest to implement. Alternative 1 also includes institutional controls that are recorded for the property. Enforcing institutional controls requires administrative coordination and effort over time. When water treatment is added to Alternative 2 (Limited Action), construction work would be required to build a water treatment plant, sludge repository, and conveyance structures. The water treatment technology is readily available and generally proven. Water treatment equipment can be obtained from multiple suppliers, but long lead times may be required to procure piping and liner material. Large quantities of chemicals would have to be transported and stored on-Site. Labor, materials, and equipment are available to implement Alternative 2.

The earthmoving alternatives are equally implementable, but pose challenges and potential difficulties due to their large scale. Approximately 122 million yd^3 and 33 million yd^3 of waste rock (from multiple waste rock piles) would be relocated with Subalternatives 3A and 3B, respectively. The partial/complete removal or balanced-cut-fill of the roadside waste rock piles in Subalternatives 3A and 3B would require additional equipment, longer durations, and increased potential construction hazards due to their massive size and steep slopes and underlying slopes. Exposed steep, altered native materials, especially those containing scars, would be difficult to reclaim. Subalternative 3A results in significantly greater areas of scar exposure. Placement of waste rock in an on-Site repository (Subalternative 3A) would require a somewhat longer haul distance compared to regrade within the waste rock pile or balanced-cut-fill within and between other waste rock piles. Assuming that 71-yd^3 capacity haul trucks would be used to transport the waste rock and cover material, the timeframe to complete construction of Subalternatives 3A and 3B are 25 and 28 years, respectively.

Overall, Alternative 1 (No Further Action) does not require construction and would be the easiest to implement, followed by Alternative 2 (Limited Action). Subalternative 3B

(2H:1V Slope) would be the next easiest to implement. Subalternative 3A (3H:1V Slope) would involve the largest scale construction activities, including almost complete removal of the roadside waste rock piles and partial removal of all the other waste rock piles, except Goathill South.

10.3.7 Cost

Table 10-2 presents a quantitative comparison of cost among alternatives for the Mine Site Area. Alternative 1 (No Further Action) would not include construction activities and has the lowest cost. In Alternative 2 (Limited Action), an increase of approximately $250,000 (present value) over Alternative 1 would include piping of seepage to, and fencing around, the Capulin seepage catchment and pumpback pond. For approximately an additional $302 million (present value) over Alternative 2, balanced-cut-fill, partial/complete removal and/or regrade to minimum 3H:1V interbench slopes, cover, and revegetation of waste rock piles would be achieved for Subalternative 3A. A decrease in cost of approximately $196 million (present value) below Subalternative 3A would include balanced-cut-fill, and/or regrade and cover of waste rock piles to minimum 2H:1V interbench slopes for Subalternative 3B, with a significant decrease in exposed scar and steep, potentially altered (contaminated) native material. Additional water collection, extraction and piping from the toe of Capulin Waste Rock Pile and below the toe of Goathill North Waste Rock Pile, as well as new extraction wells in the roadside waste rock pile drainages, in lower Capulin Canyon, and lower Goathill Gulch/Slick Line Gulch (Subalternatives 3A/3B) add a cost of approximately $600,000 (present value). With water treatment added to the alternatives, overall costs increase approximately $5 to $35 million (present value) depending on whether the year of implementation is Year 0 to Year 30 Construction.

10.3.8 State/Support Agency Acceptance

The State of New Mexico has expressed support for Subalternatives 3A and 3B with water treatment at Year 0 Construction, the Preferred Alternatives and water treatment timing identified in EPA's Proposed Plan for the Mine Site Area. Subalternative 3A is preferred, as currently cited in Mining Permit TA001RE-96-2. However, there are several concerns which have been raised by MMD regarding remediation of the waste rock piles.[77] They are as follows:

TABLE 10-2
ALTERNATIVES COST SUMMARY FOR MINE SITE AREA

Alternative Description	Cost in Current Dollars ($)		Present Value Cost ($)
	Construction (Capital)	O&M	
1 – No Further Action	0	20,198,000	8,265,000
2 – Limited Action (ICs; Water Management and Treatment)	150,000	20,455,000	8,524,000
3A – 3H:1V Balanced-Cut-Fill; Partial/Complete Removal, Regrade and Cover, Water Management; Ground Water Extraction and Treatment	600,351,000	68,772,000	309,982,000
3B – 2H:1V Balanced-Cut-Fill, Regrade, and Cover; Water Management; Ground Water Extraction and Treatment	231,448,000	71,720,000	114,421,000
Water Treatment for Subalternatives 3A/3B (Year of Construction; Period of Analysis)			
Year 0; 30-Year POA	20,263,000	41,063,000	34,541,000
Year 10; 40-Year POA			17,559,000
Year 20; 50-Year POA			8,926,000
Year 30; 60-Year POA			4,538,000

- **Preferred Factor of Safety for Critical and Non-Critical Slopes:** The remedial design must identify specific factors of safety for slopes that pose a low risk to human health and safety and slopes that pose a high risk. For slopes that pose a low risk, MMD agrees with a 1.3 factor of safety. However, for slopes where there is an immediate danger to human health and safety, or severe consequences of failure, a factor of safety of 1.5 must be applied to the final reclaimed slope. MMD sites a

[77] New Mexico Energy, Minerals and Natural Resources Department Comment Letter to the EPA National Remedy Review Board, dated August 19, 2009

number of resources which support such factors of safety, including New Mexico coal mining regulations at § 19.8.20.2034 NMAC, Disposal of Excess Spoils: General Requirements, which require a factor of safety of 1.5.

- **Resolution of the Molybdenum Remediation Goal Related to the Spring Gulch Borrow Material:** Spring Gulch waste rock will likely comprise the majority of the cover material used at the mine site. For this reason, MMD believes that proper characterization of the spatial distribution of molybdenum in the Spring Gulch Waste Rock Pile be stipulated in the ROD before the design or implementation phases of the CERCLA response action. Until this is accomplished, the overall suitability of the Spring Gulch waste rock as cover material will remain in question.

- **Additional Treatability Studies:** While MMD believes that considerable useful information has been derived from the ongoing revegetation test plots, key cover performance questions remain to be answered and should be resolved by additional closely targeted test plots. These test plots should be required in the ROD or by MMD permit. The current test-plot program has demonstrated that Spring Gulch waste rock used as cover is resistant to erosion, though perhaps not to the extent that would provide a long-term stable surface without adequate vegetative cover. However, it has also shown that Spring Gulch waste rock is a poor plant growth medium as the properties that provide erosion resistance (coarse rock-dominated texture) is the source of poor water and nutrient holding characteristics. The likelihood that organic amendments will be used in large quantities to improve plant-growth characteristics raises concerns that such amendments may substantially increase surface runoff, decrease erosion resistance, and still provide insufficient water holding properties for the cover system to protect ground water. Therefore, MMD proposes that the Selected Remedy will require test plots to demonstrate (1) the anticipated improvement in vegetative productivity with organic amendment application, (2) that amendments will not substantially reduce the erosion resistance of the cover material, (3) that moisture-holding properties will be sufficient to provide an effective evapotranspirative cover system that protects ground water.

- **On-Site Disposal of Waste Rock:** MMD believes that the use of an off-Site disposal location for waste rock to be removed under Subalternative 3A is infeasible. MMD considers the on-site disposal (at the mine site) of waste rock at locations such as the open pit is a viable option for partial rock pile removal. MMD disagrees with CMI's concerns about compromising future mining by using the open pit as a waste rock repository, stating that with careful planning, waste rock placement in the open pit can avoid potential resources. MMD also states that the redisturbance of previously reclaimed areas to access economical resources is common in the mining industry. The most promising potential site for placement of moved waste rock, in MMD's view, is Capulin Canyon.

The New Mexico Department of Game and Fish also provided the following comments on the Preferred Alternatives and water treatment at the mine site:

- Preferred Subalternative 3B is favored over Subalternative 3A because of the reduced area of surface disturbance both in terms of the rock pile footprint and the potential need for an on-site repository;
- EPA is urged to remain flexible toward the use of "geomorphic" options using variable slope/cover thickness combinations;
- Implementation of revised test plots as part of the selected action, incorporating soil amendments, is strongly supported;
- The most likely receptors for ingestion of seepage catchment water are terrestrial and avian wildlife which may use the impoundments for drinking. The catchments were not included for detailed evaluation of ecological risk because they will not contain trout. The conclusion of low ecological risk should be contingent on maintenance of effective wildlife exclusion measures at any catchments that remain after implementation of the Selected Remedy.

10.3.9 Community Acceptance

The Preferred Alternative for the Mine Area resulted in a number of comments from the community groups. They all agreed that source containment (using flexible design criteria) and reclamation of the waste rock piles, as well as contaminated ground water collection were imperative. However, there were differences of opinions on the comprehensiveness of the clean up and one group questioned whether water treatment was necessary in the immediate term. Specific comments to EPA's Preferred Alternatives included:

- R3G requested that EPA:
  - Require enhanced capture and removal/management/treatment of ground water resulting from percolation through the rock piles with particular attention given to those areas that are not highly likely to be captured by dewatering of the underground mine , and that might impact the Red River or the associated alluvial aquifer; and
  - Eliminate any requirements for vegetation test plots pilot tests that would delay actual remediation implementation, particularly those tests that fail to incorporate the necessary amendments and approaches that are most likely to result in revegetation success.
- Amigos Bravos provided comments that questioned:
  - The selection of Subalternative 3B (*i.e.,* 2H:1V slopes) because they believe that this subalternative is not sufficiently protective or sustainable over the long-term; rather they prefer Subalternative 3A (*i.e.*, 3H:1V slopes);
  - The use of Spring Gulch waste rock material as cover material because of the coarse nature and lack of substantive organic matter, rendering the material inadequate for storing water and growing enough vegetation to function as a store and release/evapotranspiration cover; and

  - Exclusion of the subsidence areas and the open pit from the proposed remedial action.

- The Village of Questa desires that EPA:

  - Continue to collect data on the migration of contaminants to address the complexities and ever-changing conditions anticipated to continue for years at the Site;

  - Include the Village of Questa as a party to the design process facilitating collaboration of technical input with appropriate stakeholders; and

  - Eliminate the requirement of water treatment because collected water is used operationally, is not a significant environmental concern, and may impose undue financial hardship on the mine.

- The RCRC community group, and local residents at public meetings and in letter correspondence requested that EPA:

  - Begin the cleanup as soon as possible;

  - Require that the remedial efforts use the local labor force as much as possible;

  - Ensure that the owner not only pays for the cleanup, but establishes a sound financial assurance vehicle to provide the needed long-term funding for the Site rather than EPA using taxpayer funds;

  - Require funding set-asides to address reduced local property values and potential long-term health effects from contamination; and

  - Require that water treatment begin immediately.

10.4 Tailing Facility Area

A summary of the comparative analysis of alternatives for the Tailing Facility Area is discussed below.

10.4.1 Overall Protection of Human Health and the Environment

All of the alternatives except No Further Action (Alternative 1) would provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through engineering controls, active ground water remediation and treatment, and institutional controls. Alternative 1 does not include cover of the tailing impoundments and, therefore, would not prevent the continued migration of tailing seepage to ground water. Alternative 1 also does not reduce dietary exposure of wildlife to molybdenum contamination in tailing and plants that uptake molybdenum.

Recreational visitors and trespassers would be protected from dermal contact and incidental ingestion of tailing by fencing and restricted access to the property during the remaining operating life of the tailing facility. Workers would be protected though health and safety and hazard communication programs.

Placement of a store and release/evapotranspiration cover over the tailing impoundments after tailing deposition ceases (Alternative 2, Subalternatives 3A and 3B, and Alternative 4) protects wildlife and human receptors from direct contact/ingestion of tailing and reduces infiltration and migration of tailing seepage to ground water. Cover placement would also result in the natural dewatering of the tailing and decreased seepage over time, further protecting human health and the environment by ultimately eliminating tailing-seepage contamination to ground water.

Temporary well drilling restrictions to be imposed by the New Mexico Office of the State Engineer to restrict ground water use both on and off CMI property would protect users of the ground water until cleanup levels are attained.

The proprietary controls recorded by CMI restrict residential uses (excluding parks and recreational and athletic fields) and ground and surface water uses. However, they are not necessary to protect human health for these alternatives as the temporary well drilling restrictions and drainage of the tailing ponds at closure adequately reduce the human health risks. The restrictive covenants are also written to provide protection of the integrity of any remedial measures conducted at the tailing facility. However, they allow excavations to a maximum depth of 10 feet. Such permitted use would allow excavation into tailing material as the thickness of the cover would only be 3 feet. Furthermore, they would only cover CMI-owned property, but not the surrounding private property. The restrictive covenants are conditioned on the post-closure land use being something other than wildlife habitat, such as for nonresidential, light industrial use (*e.g.,* renewable solar energy production)[78].

In the near term, livestock and large herbivorous mammals such as mule deer and Rocky Mountain elk are protected to some extent from exposure to molybdenum-contaminated soil and vegetation through placement of interim soil covers, which reduces exposure to tailing. However, metals uptake and bioaccumulation in plants rooting in tailing material may still pose a threat to these animals for those covered areas. The current three-wire barbwire fencing surrounding the tailing facility would protect livestock but its effectiveness has been shown to be limited at preventing deer and elk from access to the facility.

Various components of the alternatives to mitigate ground water contamination, including the tailing seepage interception systems, all protect human health. Piping of unused irrigation water in the eastern diversion channel would potentially mitigate contamination to ground water southeast of Dam No. 1 that may be sourced from the historic buried tailing northeast of the Change House. Alternative 4 would include extraction of contaminated ground water from wells to be placed southeast of Dam No. 1.

[78] CMI has commenced construction of a 5-year solar facility pilot demonstration for the northeastern portion of the tailing facility. The 1-megawatt solar facility will utilize concentrated photovoltaic (CPV) technology.

Continued operation of seepage interception systems (Alternatives 1 and 2), in combination with the existing extraction wells, facilitates seepage capture and ground water remediation. However, these existing systems have been unsuccessful in capturing all the tailing seepage migrating from the tailing impoundments. The upgrade to seepage barriers 002 and 003 in Subalternatives 3A and 3B and Alternative 4 would provide protection through additional seepage collection and improved ground water remediation for the alluvial aquifer.

Active ground water remediation (pump and treat) at the basal volcanic aquifer south of Dam No. 4 (Alternative 4) would protect users that drink this ground water. The basal volcanic aquifer is currently being used by the New Mexico Department of Game and Fish as a source of water for the Red River State Fish Hatchery, including a limited number of residential dwellings for several permanent workers and their families.

The ground water remedial components of these alternatives would take several years of operation to achieve cleanup levels. In the interim, other actions such as providing a temporary alternate water supply to current users of the ground water [*e.g.,* placement of point-of-use treatment systems (filter installed at taps)] may be necessary to protect human health. For the workers and their families at the Red River State Fish Hatchery, analytical results from tap samples recently collected by NMED show contaminant (molybdenum) levels to be just below the cleanup level. Monitoring of the tap water at the hatchery would continue as part of these alternatives. If the molybdenum levels increase above the cleanup level, further actions would be taken to prevent exposure to the contaminated ground water. For the limited residential area south of the tailing facility with ground water contamination, EPA is not aware of any use of the contaminated ground water for drinking or other domestic purposes, as most, if not all, of the homes are connected to the Village of Questa municipal water supply. However, if users of this contaminated ground water are identified, similar such actions would be taken to protect human health.

Water treatment in Subalternative 3B and Alternative 4 protects human health and the environment through removal of contaminants from ground water.

10.4.2 Compliance with ARARs

The No Further Action alternative (Alternative 1) would comply with ARARs, except that federal standards of 40 C.F.R. Part 141, Subparts B and G (MCLs) and Subpart F (MCLGs), and standards of the New Mexico WQCC § 20.6.2.3103 NMAC (standards for ground water) and water supply regulations, § 20.7.10.100 NMAC (MCLs and MCLGs), would not be met for a number of constituents. Contaminants that currently exceed ARARs would continue to have the potential for exceedance because infiltration of precipitation and pumpback water would continue to leach contaminants from the tailing material to ground water.

All remaining alternatives and subalternatives would comply with ARARs. A summary of the ARARs as they pertain to these alternatives are presented in Tables 9-3, 9-7 and 9-10.

10.4.3 Long-Term Effectiveness and Permanence

The No Further Action alternative (Alternative 1) would not be effective in the long term. Fencing and restricted access limit human and livestock contact with tailing and the interim cover limits terrestrial wildlife contact with tailing; however, these actions are not permanent in the long term. Cover placement in Alternative 2, Subalternatives 3A and 3B, and Alternative 4 would provide a permanent and effective long-term barrier for reducing infiltration and preventing exposure of tailing to ecological receptors. Alternative 4 and Subalternatives 3A and 3B would be more effective than Alternative 2 at collecting seepage and seepage-impacted groundwater, thereby reducing the migration of COCs from tailing to downgradient ground water and surface water. Subalternative 3B and Alternative 4 would provide increased long-term effectiveness through water treatment.

Overall, the alternative that would be the most effective and permanent in the long-term is Alternative 4, followed by Subalternative 3B, Subalternative 3A, Alternative 2, and then Alternative 1.

10.4.4 Reduction in Toxicity, Mobility or Volume through Treatment

As stated in the evaluation of alternatives for the Mine Site Area, above, EPA expects to use engineering controls instead of treatment for high volume, low-level threat mining waste [40 C.F.R. § 300.430(a)(1)(iii)(B)]. Therefore, because tailing is not treated in these alternatives, there is no reduction of toxicity, mobility, or volume of the tailing through treatment. There is a reduction of toxicity, mobility, and volume of contaminants in ground water through water treatment (Subalternative 3B and Alternative 4). The other alternatives have no reduction through treatment.

10.4.5 Short-Term Effectiveness

Alternative 1 provides no short-term impacts because no construction-related actions are included that may pose a risk to workers, community, or the environment. There would be potential risks to workers and the environment during placement of the cover for all other alternatives. The primary risk to workers is the safety risk inherent to large earthmoving activities over large areas.

Minimal risks to the community would be expected, as the borrow source is located at the tailing facility. However, excavation and hauling alluvial soil for construction of the cover for the tailing impoundments will require large earthmoving activities over an extended period of time that may result in short-term impacts to the environment, including diesel emissions and dust. These potential impacts would be managed through an appropriate air monitoring program. An estimated 5.4 million yd^3 of cover soil would be required, assuming a 36-inch cover depth. The estimated duration for remedy implementation would be approximately 6 years.

Installation of piping in the diversion channel (all alternatives) and upgraded seepage barriers and ground water extraction wells (Subalternatives 3A and 3B and Alternative 4) also include risks to workers associated with construction activities. Subalternative 3B and Alternative 4 likely include potential risks to workers, community, and the environment with the addition of water treatment, due to construction associated with modifying the existing water treatment plant and installation of conveyance structures. Since Alternative 4 includes larger treatment requirements, more risk may be associated with the additional construction.

Overall, the alternative most effective in the short-term would be Alternative 1, followed by Alternative 2, Subalternatives 3A and 3B, and then Alternative 4.

10.4.6 Implementability

All of the alternatives are implementable. The No Further Action alternative (Alternative 1) would not include construction activities and, therefore, would be the easiest to implement. All of the other alternatives are similar in the use of technologies and process options. The alternatives are implementable as the technologies are available and generally proven.

The installation of piping in the eastern diversion channel is easily installed; however, piping may require long lead time for procurement. Cover of the 1,050 acres tailing facility after tailing disposal operations cease is technically implementable. The alluvial soil borrow source is located at the tailing facility and the quantity of material required for cover is available. Standard construction equipment is available from multiple contractors. The construction timeframe for cover place would be six years. Some components are already in place and operable, including seepage interception and pumpback systems, monitoring and dust control. Continued dust control measures require application of emulsion/tackifiers, soil cover, and straw mulch, but these activities are easily implementable.

Well drilling restrictions would have to be established by the State Engineers Office. Construction of a new seepage barrier/extraction wells is technically implementable, but may require shut down during construction and this is expected to pose construction delays. Continued operation of the seepage interception system is not difficult and only requires periodic maintenance and replacement of pumping equipment.

Alternative 4 includes ground water extraction from the basal bedrock (volcanic) aquifer south of Dam No. 4, which is highly transmissive and would require pumping several thousand gpm to hydraulically contain and collect contaminated ground water. Additionally, water treatment (Subalternative 3B and Alternative 4) requires modification to the existing ion exchange plant and long-term operations and maintenance of the system. The modified facility may be required to accommodate additional reverse osmosis treatment and an evaporator to handle reject, if needed. The water treatment equipment is supplied by multiple vendors. Resins are readily available from a limited number of suppliers.

Overall, Alternative 1 is easiest to implement, followed by Alternative 2, and then Subalternatives 3A and 3B. Alternative 4 involves the largest construction and operational effort.

10.4.7 Cost

A summary of costs for alternatives at the Tailing Facility Area is presented in Table 10-3. With the exception of the No Further Action alternative (Alternative 1), costs associated with the remaining alternatives (when excluding water treatment) are similar, ranging from approximately $28 - $34 million (Construction) and $32 - $36 million (present value). Most of the construction costs are associated with grading and placement of the 36-inch soil cover over the 1050-acre tailing impoundment (approximately $20 million). Upgrades to the seepage interception systems for Subalternative 3A increases cost approximately $660,000 over Alternative 2. When including water treatment for Subalternative 3B and Alternative 4, costs vary significantly depending on the timing of water treatment. For

Subalternative 3B, water treatment of the pumpback seepage (estimated at 400 gpm) increases the cost approximately $7 to $52 million (present value) over Subalternative 3A depending on whether the year of implementation is Year 0 or Year 30 Construction. For Alternative 4, the installation of extractions wells and additional collection and treatment of ground water from south of Dam No. 4 and southeast of Dam No. 1 (4,500 gpm) increases the cost approximately $18 to $135 million (present value) over Subalternative 3B.

10.4.8 State Acceptance

The State of New Mexico supports the modified Subalternative 3B, the Preferred Alternative identified in EPA's Proposed Plan for the Tailing Facility Area. The modified Subalternative 3B includes ground water extraction southeast of Dam No. 1, a component of Alternative 4. The Preferred Alternative also includes water treatment at Year 0 Construction.

MMD provided separate comments on the EPA's Preferred Alternative for the Tailing Facility Area, including:

- Solar facility and cover depth pilot demonstrations promise to provide useful information about minimum cover depth for reclamation, currently planned as an application of 3 feet;
- EPA should specify in the ROD that overall elevation gradients across the tailing surface will exceed 1 percent and incorporate a more natural drainage pattern or geomorphic design; it is anticipated that regrade with less than 1 percent overall slope may suffer from post-construction differential settling that leads to ponding and unpredictable drainage patterns or erosion.

TABLE 10-3
ALTERNATIVES COST SUMMARY FOR TAILING FACILITY AREA

<table>
<tr><th rowspan="2">Alternative Description</th><th colspan="2">Cost in Current Dollars ($)</th><th rowspan="2">Present Value Cost ($)</th></tr>
<tr><th>Construction (Capital)</th><th>O&M</th></tr>
<tr><td>1 – No Further Action</td><td>0</td><td>30,151,000</td><td>12,425,000</td></tr>
<tr><td>2 – Limited Action (ICs; Source Containment; Continue Ground Water Withdrawal; Piping Water in Diversion Channel)</td><td>28,472,000</td><td>16,443,000</td><td>32,332,000</td></tr>
<tr><td>3A – Source Containment; Continue Ground Water Withdrawal with Upgraded Seepage Collection, Piping Water in Diversion Channel</td><td>28,878,000</td><td>17,592,000</td><td>33,018,000</td></tr>
<tr><td>3B – Same as 3A with Water Treatment</td><td>29,043,000</td><td>18,547,000</td><td>33,758,000</td></tr>
<tr><td>3B – Water Treatment
(Year of Construction; Period of Analysis)</td><td></td><td></td><td></td></tr>
<tr><td>Year 0; 30-Year POA</td><td rowspan="4">22,076,000</td><td rowspan="4">73,027,000</td><td>51,989,000</td></tr>
<tr><td>Year 10; 40-Year POA</td><td>26,428,000</td></tr>
<tr><td>Year 20; 50-Year POA</td><td>13,435,000</td></tr>
<tr><td>Year 30; 60-Year POA</td><td>6,830,000</td></tr>
<tr><td>4 – Source Containment; Ground Water Extraction and Treatment; Piping Water in Diversion Channel</td><td>30,442,000</td><td>20,876,000</td><td>35,939,000</td></tr>
<tr><td>4 – Water Treatment
(Year of Construction; Period of Analysis)</td><td></td><td></td><td></td></tr>
<tr><td>Year 0; 30-Year POA</td><td rowspan="4">54,533,000</td><td rowspan="4">197,162,000</td><td>135,051,000</td></tr>
<tr><td>Year 10; 40-Year POA</td><td>68,653,000</td></tr>
<tr><td>Year 20; 50-Year POA</td><td>34,899,000</td></tr>
<tr><td>Year 30; 60-Year POA</td><td>17,741,000</td></tr>
</table>

The New Mexico Department of Game and Fish also provided separate comments to EPA, including:

- The solar energy pilot project is not opposed. However, a one-foot cover depth should not be considered because it may not be feasible to maintain it in the long term, even if it is deemed successful in a short-term evaluation period. Five years is not a sufficient period to judge either vegetation success or uptake of molybdenum or other contaminants from the underlying tailing material.
- The tailing impoundments are used by terrestrial and avian wildlife for drinking and by waterfowl for migration rest stops and nesting. Although the impoundments are not considered "suitable aquatic habitat," presumably because they will be eliminated following the completion of mining activity, they do present a risk to wildlife now and for the short-to-medium-term future.
- The springs which supply drinking water to the Red River State Fish Hatchery exceeds the EPA's preliminary remediation goal for molybdenum due to contamination from a ground water plume originating from the tailing facility. It is recommended that CMI provide and maintain either an alternative drinking water source, or a means of purifying the water in order to protect the health of our hatchery employees and their families. In addition, there should be ongoing monitoring of the spring water, which is also used for hatchery operations, as well as an analysis of the molybdenum content of the fish reared in the spring water and potential impacts to the public from eating the fish.

10.4.9 Community Acceptance

The Preferred Alternative for the Tailing Facility Area (modified Subalternative 3B and water treatment at Year 0 Construction) received the most critical comments from the community groups. As with the Mine Site Area, the community generally agreed that source containment, cover and reclamation of the tailing, as well as remediating contaminated ground water were imperative. However, there were passionate comments on terminating tailing facility operations because of ongoing ground water contamination from the leaking facility and blowing tailing dust that directly impact the local residents. Specific comments to EPA's Preferred Alternative included:

- R3G requested that EPA:
  - Mandate immediate closure and reclamation of the tailing facility and associated pipeline (its utmost concern);
  - Mandate immediate mitigation of dust excursion from the tailing facility that continues to cause deleterious impacts to the community;
  - Require that the tailing facility be covered with three feet of cover per state of New Mexico permits to minimize infiltration, potential acid generation, and control dust; and
  - Select Alternative 4 for the tailing facility and require that all waters discharging from under the tailing facility be captured and treated, just like contaminated water on the mine site.
- Amigos Bravos requested that EPA:
  - Select an alternative that provides for the closure of the tailing facility that effectively terminates further disposal of tailing and other mine waste;
  - Abandon the selection of Subalternative 3B as the preferred alternative and, instead, select the more aggressive actions included in Alternative 4; and
  - Require a three-foot thick cover across the tailing facility per state of New Mexico permits and CERCLA preferences rather than allow the solar energy pilot test and associated cover thickness testing results to dictate the final cover thickness.
- The Village of Questa requested that EPA:
  - Continue to collect data on the migration of contaminants to address the complexities and ever-changing conditions anticipated to continue for years at the tailing facility; specifically for more comprehensive monitoring of the basal bedrock (volcanic) aquifer south of the tailing facility;

- Significantly expand the number of monitoring wells in Year 0 Construction associated with Subalternative 3B to allow a better understanding of the hydraulics and water quality on the west side of the tailing facility, directly under the western impoundment, and southwest of the facility;
- Immediately mitigate dust excursions from the tailing facility and construct the appropriate 3-foot thick cover;
- Immediately upgrade the monitoring network to allow a comprehensive evaluation of uranium in ground water that is originating from tailing seepage in the vicinity of Dams No. 1 and 4; and
- Eliminate the requirement of water treatment in Year 0 Construction because the majority of tailing water leaves the facility to the west and there may be an undue financial hardship on Chevron Mining Inc.

- Local residents at public meetings and in letter correspondence requested that EPA:
  - Begin the clean up as soon as possible;
  - Require that the remedial efforts use the local labor force as much as possible;
  - Ensure that the local residents are included in discussions of remedial plans and that property access is negotiated with individual property owners prior to mobilization;
  - Include an alternative to immediately and permanently close the tailing facility;
  - Implement a program to immediately mitigate dust excursion from the tailing facility;
  - Construct a perimeter fence around the tailing facility to exclude wildlife from contacting surface contaminants (*i.e.*, water, plants and soil);

- Include monitoring programs to require funding set asides to address reduced local property values and potential long-term health effects from contamination; and
- Require that water treatment begin immediately.

10.5 Red River and Riparian and South of Tailing Facility Area

A summary of the comparative analysis of alternatives for the Red River and Riparian and South of Tailing Facility Area is discussed below.

10.5.1 Overall Protection of Human Health and the Environment

All of the alternatives with the exception of the No Further Action alternative (Alternative 1) would be protective of the environment by eliminating, reducing, or controlling risks through capping or removal of molybdenum-contaminated soil, with either on-Site or off-Site disposal. The No Further Action would allow soil with concentrations of molybdenum above the preliminary cleanup level to remain in place south of the tailing facility and within riparian areas along the river. For the riparian areas, there would be minimal effect on wildlife as approximately 55 percent of the spill deposits have already been cleaned up, and most of the remaining deposits are small in overall size (over half are less than or equal to five yd^3). The capping alternative (Alternative 2) eliminates or reduces direct exposure of ecological receptors to contaminated soil, but the cap will require maintenance and residuals will remain in place. Removal of contaminated soil and tailing spill deposits (Subalternatives 3A and 3B) removes the source and eliminates the direct exposure pathway to ecological receptors.

Protection of human health was not evaluated because soil south of the tailing facility and tailing spill deposits do not pose a human health risk. Protection of human health from exposure to ground water contamination would be dependent on alternatives developed for the Tailing Facility Area. The alternatives that reduce seepage or improve seepage collection would improve ground water quality in the area south of the tailing facility.

The continued use of copper blocks in pastures south of the tailing facility would provide protection to livestock from molybdenum toxicity.

10.5.2 Compliance with ARARs

All of the alternatives would meet their respective ARARs. They are summarized in Tables 9-4, 9-7, and 9-10. Compliance of ground water ARARs south of the tailing facility would be addressed through alternatives at the Tailing Facility Area.

10.5.3 Long-Term Effectiveness and Permanence

The No Further Action alternative (Alternative 1) would not be effective in the long term and does not provide a permanent solution. Molybdenum concentrations above cleanup levels would remain in soil south of the tailing facility and tailing spill deposits along the Red River riparian zone. A soil cap (Alternative 2) provides a barrier to reduce direct exposure. However, the permanence of the cap would be impacted by soil erosion, run-off and physical activities that could compromise the cap integrity. Routine maintenance would be required for the long term. Erosion mats and/or armoring may increase effectiveness. Affected soil south of the tailing facility and tailing spill deposits along the riparian remain in place and require long-term O&M. The long-term effectiveness of the cap south of the tailing facility is also dependent on reductions in tailing seepage by alternatives for the Tailing Facility Area. Removal of the contaminated soil and tailing spill deposits (Subalternatives 3A and 3B) would be the most effective in the long-term and permanent. The source is removed and disposed of at an off-Site facility with adequate control and long-term maintenance (Subalternative 3A) or placed at an on-Site facility that requires long-term maintenance and monitoring (Subalternative 3B). Disposal of the excavated material at an on-Site facility (3B) would require long-term maintenance and monitoring. Depending on where excavated material is placed, additional maintenance and monitoring may not be necessary because they would already be performed as part of other source containment alternatives.

Overall, Subalternative 3A would be the most effective and permanent in the long term, followed by Subalternative 3B, Alternative 2, and then Alternative 1.

10.5.4 Reduction of Toxicity, Mobility, or Volume through Treatment

There is no reduction in toxicity, mobility, or volume through treatment for any of the alternatives.

10.5.5 Short-Term Effectiveness

The No Further Action alternative (Alternative 1) would provide no short-term risks because no construction-related actions are included. Potential short-term risks to workers and the community would occur during capping of contaminated soil and tailing spill deposits (Alternative 2). Additionally, short-term impacts to the riparian ecosystem would likely occur during placement of the cap and erosion controls (erosion mats and/or armoring) from the use of construction equipment. An estimated 17,200 yd^3 would be required for capping. The greatest risk to workers and the community would be expected during the soil removal alternatives (Subalternatives 3A and 3B) because of the additional earthmoving equipment activities (excavation, hauling, and backfilling). Approximately 29,500 yd^3 of contaminated soil would be excavated, with a similar volume of clean fill to be backfilled. Estimated timeframes for implementation are 1.75 years (Alternative 2) and 2.25 years (Subalternatives 3A and 3B). Impacts of removing material off-Site would include the potential for vehicle accidents and potential to spill material.

Excavation and hauling materials would require large earthmoving activities over an extended period of time that may result in short-term impacts to the environment, including diesel emissions and dust. Use of heavy equipment within the sensitive riparian zone along the Red River and south of the tailing facility would likely damage vegetation and habitat during implementation of Alternative 2 and Subalternatives 3A and 3B. South of the tailing facility where the water table is shallow, use of heavy equipment to construct the cap would also likely damage the existing riparian zone.

Overall, the alternative that is most effective in the short term (*i.e.,* least amount of short term impacts) is Alternative 1, followed by Alternative 2, Subalternatives 3A and 3B.

10.5.6 Implementability

All of the alternatives are implementable. The No Action alternative (Alternative 1) does not include construction activities and is easiest to implement. The other alternatives involve the same level of construction activities and are equally implementable. Capping (Alternative 2) or removal (Subalternatives 3A and 3B) of contaminated soil south of the tailing facility area would require site preparation prior to construction because of the shallow water table and boggy nature of the area. Site preparation includes dewatering of the area and stabilization of the soils. Materials, labor, and equipment are locally available to implement the remedy. For Subalternative 3A, multiple off-Site disposal facilities exist and could accept the excavated soil. On-Site disposal at the tailing facility (Subalternative 3B) is feasible, but placement of soil must occur prior to cover placement at the tailing facility. If the soil is placed at the tailing facility, no additional long-term monitoring and maintenance would be required, as they would already be performed for the tailing facility. Administrative coordination with private landowners would be required to access the area south of the tailing facility, and with federal land-management agencies and landowners along the riparian area.

10.5.7 Cost

A summary of costs for alternatives at the Red River, Riparian, and South of Tailing Facility Area is presented in Table 10-4. The No Further Action alternative (Alternative 1) would not include construction activities and has the lowest cost. An increase in cost of approximately $2.2 million (present value) over Alternative 1 would include capping of soil south of the tailing facility area and tailing spill deposits along the Red River riparian corridor. An additional $1.3 to $3.8 million (present value) over Alternative 2 would provide excavation and disposal of the contaminated soil and tailing spill deposits (Subalternatives 3A and 3B). Off-Site disposal of excavated soil/tailing (3A) would cost approximately $2.5 million (present value) over on-Site disposal (3B).

TABLE 10-4
ALTERNATIVES COST SUMMARY FOR RED RIVER AND RIPARIAN AND SOUTH OF TAILING FACILITY AREA

Alternative Description	Cost in Current Dollars ($)		Present Value Cost ($)
	Construction (Capital)	O&M	
1 – No Further Action	0	177,000	65,000
2 – Cap Soil and Tailing Spill Deposits	2,080,000	558,000	2,281,000
3A – Removal of Soil and Tailing Spill Deposits and Off-Site Disposal	5,947,000	412,000	6,096,000
3B – Removal of Soil and Tailing Spill Deposits and On-Site Disposal	3,442,000	412,000	3,591,000

10.5.8 State/Support Agency Acceptance

The State of New Mexico supports Subalternative 3B, the Preferred Alternative identified in EPA's Proposed Plan for the Red River, Riparian, and South of Tailing Facility Area. The New Mexico Department of Game and Fish provided the following separate comment:

- During removal of contaminated soil from the Red River riparian zone and south of the tailing facility, best management practices should be applied to minimize physical damage or indirect kill by dewatering of native riparian vegetation. Any woody riparian vegetation which is removed or damaged should be replaced at a 2:1 ratio. Advanced coordination regarding the tailing spill cleanup is requested as this could have major effects on our angler constituents.

10.5.9 Community Acceptance

The primary concerns from the community regarding the Preferred Alternative (Subalternative 3B) for the Red River and Riparian and South of Tailing Facility Area are described separately for the area south of the tailing facility and the Red River and riparian areas. They are stated below.

South of Tailing Facility Area:

- Include dredging impacted sediments from the *acequias*, which are used to irrigate the local farms and ranches; and
- Ensure clean up of the drinking water sources, including Spring 18 (for the Red River State Fish Hatchery).

Red River and Riparian Areas:

- R3G requested that EPA ensure all tailing spills are remediated in the riparian corridor; and
- Local residents desire an aggressive cleanup for sediment and surface water in the Red River which will restore the river back to a prosperous, productive and diverse fishery, as well as address the on-site and off-site contamination to the river on a watershed basis.

10.6 Eagle Rock Lake

A summary of the comparative analysis of alternatives for Eagle Rock Lake is discussed below.

10.6.1 Overall Protection of Human Health and the Environment

All of the alternatives except the No Action alternative (Alternative 1) would provide adequate protection of the environment after remedial actions are complete and the ecosystem recovers. In the short-term, remedial actions proposed in each of the alternatives (capping, dredging, and lake-backfilling) would result in a loss of the benthic macroinvertebrate ecosystem. The in-lake capping of sediment (Alternative 2) would improve the quality of the benthic zone by providing a barrier to the contaminated sediment and overlaying a suitable 1-foot sediment layer on the lake bottom. However, until a new benthic macroinvertebrate community is established, the existing community would be smothered. The dredging of contaminated sediment with on-Site or off-Site disposal (Subalternatives 3A and 3B) removes the source of contamination from the lake, but also destroys the existing macroinvertebrate ecosystem. A new macroinvertebrate community would establish itself on the new lake bottom over time. The backfilling of the existing lake (Alternative 5) also destroys the ecosystem, but in the long term the new lake would re-establish a new macroinvertebrate ecosystem. All of the alternatives (excluding No Action) would provide inlet storm water controls to reduce the volume of contaminated sediment that would enter the lake during rain storms or other high flow events that may entrain sediment into the Red River, thus providing continued protection to the benthic macroinvertebrate community.

Protection of human health would not be addressed by the alternatives because EPA's HHRA (CDM 2009a) found that the Eagle Rock Lake does not pose a risk to human health.

10.6.2 Compliance with ARARs

All of the alternatives would comply with ARARs. The ARARs identified for these alternatives are summarized in Tables 9-5, 9-7, and 9-12.

10.6.3 Long-Term Effectiveness and Permanence

Each of the alternatives is effective and permanent in the long-term except for Alternative 1 (No Action). Alternative 1 is expected to result in a reduction of potential risk to the benthic macroinvertebrates due to reduction of inputs to the river along the mine reach and natural attenuation within Eagle Rock Lake. However, accumulation of sediment in the lake from storm events would continue under Alternative 1 and this would continue to affect the benthic ecosystem. The other alternatives would provide a new substrate for the macroinvertebrate ecosystem and controls at the inlet (*i.e.,* headgate) that would minimize sedimentation in the lake. The in-lake cap (Alternative 2) would provide a suitable substrate for the macroinvertebrate ecosystem and reduce ecological risks. However, the cap would require long-term maintenance and may require replacement over the long term. Also, capping sediment reduces the overall depth of the lake, which would likely result in increased summer water temperatures, decreased lake volume, and may alter oxygen levels as well. It will also smother the existing benthic community. This has the potential to adversely affect survival of the stocked rainbow trout during the summer season. Dredging and off-Site disposal (Subalternative 3A) or on-Site disposal (Subalternative 3B) of contaminated sediment is effective and permanent. Contaminated sediment would be removed, thereby reducing ecological risks to the benthic macroinvertebrate community. A new on-Site disposal facility would be constructed and long-term management and monitoring would be required for sediment disposed of on-Site in Subalternative 3B. Alternative 5 is effective and permanent. A new lake would provide a more suitable ecosystem for benthic macroinvertebrates. Residual sediment would remain in the existing lake and would be capped with alluvial fill.

A headgate is an adequate and reliable control; however, uncertainties exist with regard to maintenance of the headgate that could impact the long-term effectiveness of the alternatives (Alternatives 3A, 3B, and 5).

Overall, the alternatives that would be the most effective and permanent in the long term are Subalternatives 3A, 3B and Alternative 5, followed by Alternative 2, and then Alternative 1.

10.6.4 Reduction in Toxicity, Mobility or Volume through Treatment

There is no reduction of toxicity, mobility, or volume through treatment for any of the alternatives.

10.6.5 Short-Term Effectiveness

For the No Action alternative (Alternative 1), there would be no short-term impacts or risks posed to workers, the community, or the environment as no remedial actions would be performed. There would be minimal risk to workers and the community for the in-lake capping, lake dredging, and backfilling/new lake alternatives, but risks to workers would be addressed through the use of personal protective equipment and health and safety programs during construction. There would be risks to the community from hauling sediment to a disposal facility, resulting in increased traffic and potential for local traffic hazards on local roads and highways. In-lake capping would require the excavation and hauling of approximately 4,800 yd^3 of material for the cap. Lake dredging (Subalternatives 3A and 3B) and lake-backfilling with construction of a new lake (Alternative 5) would result in the excavation of similar volumes of material (14,020 yd^3 to 14,500 yd^3) over construction periods between 1.5 and 2.25 years. Also, earthmoving and hauling activities will result in short-term impacts to the environment including diesel emissions and dust.

Capping or dredging the sediments or backfilling the lake would destroy the existing benthic macroinvertebrate ecosystem. A period of time would be required before a new macroinvertebrate ecosystem is re-established in the existing or new lake. The water quality would be degraded in the short-term during dredging of the lake. Recreational use (fishing) of the lake would be lost during in-lake capping or dredging for a period of time until clarity of the water improves, suspended sediment settles, and the lake is restocked with rainbow trout. Coordination with the Red River State Fish Hatchery would be required to temporarily suspend stocking of the lake.

Overall, the alternative that would be the most effective in the short term (*i.e.,* fewest short-term impacts) is Alternative 1, followed by Alternative 5, Alternative 2, and then Subalternatives 3A and 3B.

10.6.6 Implementability

Under the No Action alternative (Alternative 1), there would be no activities to implement. For the other alternatives, all the technologies are generally proven and implementable. Installation of storm water controls at the inlet, including a new motorized headgate and construction of a tilling well to house water quality probes to activate the headgate would not pose any technical difficulties. In-lake capping (Alternative 2), which would involve hauling alluvial soil from a local source to the lake and placing the material on the sediment, is not difficult to implement. Lake dredging (Subalternatives 3A and 3B) would involve construction of a bermed staging area and dewatering of the excavated sediment. Dredging would require specialized equipment that would have to be transported to the Site. Otherwise, materials and labor to implement these subalternatives are locally available.

Construction of a new lake and backfilling the existing lake (Alternative 5) would require excavation and hauling, which are technically implementable. Construction of the new lake would require a change in the point of diversion from the river and may require the addition of water rights. Off-Site disposal (Subalternative 3A) is more implementable because off-Site facilities are readily available, whereas on-Site disposal (Subalternative 3B) would require construction and management of a new lined disposal cell. Labor to implement these alternatives is locally available. However, the liner materials, though readily available, may require a long lead time to procure and deliver.

Overall, the easiest alternative to implement is Alternative 2, followed by Subalternative 3A, then 3B, and Alternative 5. There are no activities to implement for Alternative 1.

10.6.7 Cost

A summary of costs for alternatives at Eagle Rock Lake is presented in Table 10-5. The No Action alternative (Alternative 1) has the lowest cost. In-lake capping and storm water inlet controls (Alternative 2) increases cost by approximately $470,000 (present value). An increase of approximately $1 to $2 million (present value) over Alternative 2 includes dredging and disposal of the sediments (Subalternatives 3A and 3B), with off-Site disposal (3A) costing approximately $900,000 (present value) more than on-Site disposal (3B). For approximately $1 million (present value) over Alternative 2, the existing lake would be backfilled and a new lake constructed (Alternative 5). Constructing a new lake and backfilling the existing lake is similar in cost to lake dredging with on-Site or off-Site disposal (Subalternatives 3A and 3B).

TABLE 10-5
ALTERNATIVES COST SUMMARY FOR EAGLE ROCK LAKE

Alternative Description	Cost in Current Dollars ($)		Present Value Cost ($)
	Construction (Capital)	O&M	
1 – No Action	0	149,000	54,000
2 – Inlet Storm Water Controls; In-Lake Capping of Sediment	286,000	495,000	469,000
3A – Inlet Storm Water Controls; Dredge Sediments and Off-Site Disposal	2,274,000	495,000	2,457,000
3B – Inlet Storm Water Controls; Dredge Sediments and On-Site Disposal	1,352,000	504,000	1,538,000
5 – Inlet Storm Water Controls; Backfill Lake and Construct New Lake	1,299,000	527,000	1,495,000

10.6.8 State Acceptance

The State of New Mexico supports Alternative 3B, the Preferred Alternative identified in EPA's Proposed Plan for Eagle Rock Lake. The New Mexico Department of Game and Fish provided the following separate comment:

- Please coordinate the response action with the Department's Fisheries Division (505-476-8055) regarding dredging of Eagle Rock Lake, as this could have major effects on our angler constituents and may require fish salvage. Additional consultation is also requested on potential enhancements to fish habitat which might be incorporated during the construction operations.

10.6.9 Community Acceptance

The community generally accepts the Preferred Alternative (Subalternative 3B) for Eagle Rock Lake. They passionately state that the lake is the cornerstone to the community supporting recreation and tourism. The community requests that the cleanup of Eagle Rock Lake is initiated on a priority schedule, that the community is involved in decision-making, that measures are put in place to minimize the potential for recontamination of the lake and, most importantly, that there is minimal disruption to recreational use of the lake.

10.6.10 U. S. Department of Agriculture – Forest Service Acceptance

Eagle Rock Lake and the surrounding area are located on National Forest System land and the lake is managed by U.S. Forest Service. Overall, the U.S. Forest Service generally accepts the Preferred Alternative (Subalternative 3B), but makes several comments. They are described below.

- Through Executive Orders 12580 and 13016, federal land management agencies such as the U.S. Forest Service and Bureau of Land Management (BLM) have the authority to implement and oversee CERCLA response actions that occur on land under their jurisdiction. Since the response action at Eagle Rock Lake is not an emergency response and the Site is not on the NPL, the U.S. Forest Service has this authority. Therefore, the U.S. Forest Service requests that it be included as a party to the CERCLA settlement negotiations between EPA and CMI. As some of the work will occur on public lands managed by BLM, EPA may wish to consult with the U.S. Department of the Interior on whether it should also be included as a party to the negotiations.

- It is assumed that EPA, through the RI, associates the contaminated sediment in Eagle Rock Lake with the historical leaks in the tailing pipeline between 1961 and 1991. The U.S. Forest Service recommends that such connection of tailing spills from the pipeline and ultimate deposition of tailing into Eagle Rock Lake be included as part of the description of Eagle Rock Lake.

- As design plans are being finalized for remedial action at Eagle Rock Lake, it is requested that up front coordination by EPA and NMED be conducted with the U.S. Forest Service and the New Mexico Department of Game and Fish to address:

    - Timing and length of lake closure;

    - Necessary security measures (road closures, fencing, etc.) required to implement the remedial action and protect the public;

    - Impact to existing infrastructure at the lake (parking lot surfacing, trails, picnic tables, etc.) that may occur during dredging and de-watering of contaminated sediment;

    - Coordination with the U.S. Forest Service and the New Mexico Department of Game and Fish to salvage resident fish prior to dredging; and

    - Replacement/repair of existing recreational infrastructure needed to return the lake to an operational condition for visitors.

- It is suggested that EPA and NMED participate in the annual "Fish Fiesta" at Eagle Rock Lake to communicate to the local residents the objectives of the remedial action and enhanced condition that will result. Fish Fiesta is sponsored by the U.S. Forest Service, BLM, the New Mexico Department of Game and Fish and Town of Taos as an educational effort to familiarize local youth with aquatic environments and fishing as a recreational activity.

- The cleanup at Eagle Rock Lake should be timed and coordinated with the Questa Ranger District such that it does not coincide with ongoing plans to re-construct the dam at Cabresto Lake. These two lakes provide the only flat water fishing opportunities that are easily accessible to local residents and visitors alike.
- For the engineering controls at the inlet structure, EPA should consider the needs for a power supply, routine maintenance and calibration of instrumentation, security measures at the headgate to prevent vandalism or theft, and the economic impact to the U.S. Forest Service of future maintenance and cost to replace equipment if these are to be borne by the U.S. Forest Service. These costs should be funded by the responsible party.
- Hydraulic dredging usually introduces quite a lot of additional water into the sediment, making it more 'runny' and difficult to dewater and haul. There is very limited storage area in the vicinity of the lake. With long time frames needed to dewater sediment and limited storage area, the actual work will likely be extended. This is a concern with respect to recreational value and level of use.
- Draining the lake might be difficult as this pond was dug out for gravel, implying there might be a fairly rapid inflow of water from alluvium and the adjacent Red River.
- Utilizing a dragline should also be considered. The dragline could operate from the north shore of the lake and pile sediment along the access road, parking lot, and field north of the pond, taking care to preserve two nice trees by the parking lot. The dragline is a lot slower than an excavator, but has a much longer reach so that disturbing the south shore or draining the lake would not be necessary.

11.0 PRINCIPAL THREAT WASTE

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable [40 C.F.R. § 300.430(a)(1)(iii)(A)]. Identifying principal threat waste 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.

PCB-contaminated soil at the Mill Area does not warrant consideration as a principal threat waste based on concentration alone. Concentrations of total PCBs (Aroclors 1248, 1254, and 1260) at the Site range from less than 1 mg/kg to 140 mg/kg. However, with these soils located in an active milling facility, with constant truck and foot traffic and periodic road grading (and snow plowing) operations, their potential for mobility is elevated. Therefore, based on the toxicity and mobility of the PCB-contaminated soil combined, the soil with the higher PCB levels (greater than 50 mg/kg) constitutes a principal threat at the Site.

The PCB-contaminated soil will be addressed in the Selected Remedy by disposal at permitted off-Site facilities. Soil with total PCBs greater than 50 mg/kg will be transported to the nearest off-Site facility that accepts and treats PCB-affected soil. Soils with total PCBs less than or equal to 50 mg/kg will be transported to the nearest permitted facility that accepts but does not necessarily treat the PCB-affected soil.

Other source materials at the Site that EPA does not consider to be principal threat waste include waste rock at the mine site and tailing material at the tailing facility. These low-level threat wastes will be addressed in the remedy primarily through consolidation and containment.

The molybdenum-contaminated surface soil in the area south of the tailing facility, the tailings spills along the riparian corridor adjacent to the Red River, and the metals-contaminated sediment of Eagle Rock Lake are contaminated source materials of low toxicity and do not constitute principal threats at the Site.

12.0 SELECTED REMEDY

EPA has selected a remedy (the Selected Remedy) that is a combination of remedial alternatives and subalternatives for each of the five areas of the Site that warrant response action under CERCLA. The Selected Remedy is described below.

Mill Area

- **Alternative 3** – Removal of soil with high concentrations of PCBs (greater than 25 mg/kg) for low occupancy (commercial or industrial) land use and off-Site treatment and disposal of soil; backfill excavation with clean fill and placement of cover at mill decommissioning.

Mine Site Area

For the Mine Site Area, EPA is selecting two similar remedial alternatives, and will make site-specific determinations during remedial design to allow optimum flexibility.

- **Subalternative 3A** – Source containment by regrading and re-contouring waste rock piles to a minimum interbench slope of 3H:1V, with partial or complete removal of waste rock to accommodate slope requirement, covering, and revegetation; surface water (seeps/springs) interception and collection, perpetual underground mine dewatering, ground water extraction, and water treatment.
- **Subalternative 3B** – Source containment by regrading and re-contouring waste rock piles to a minimum interbench slope of 2H:1V, covering and revegetation; surface water (seeps/springs) interception and collection, perpetual underground mine dewatering, ground water extraction, and water treatment.

- **Water Treatment** – Construction of a water treatment plant will commence at the start of the remedial action (Year 0 Construction). Water treatment will be performed upon completion of plant construction.

Tailing Facility Area

- **Modified Subalternative 3B** – Source containment by regrading, covering, and revegetation of tailing impoundments; upgrading seepage collection systems; piping of water in eastern diversion channel, continue ground water extraction with additional extraction southeast of Dam No. 1 (MW-4 and MW-17 Area), and water treatment
- **Tailing Facility Water Treatment** – Construction of a water treatment plant will commence at the start of the remedial action (Year 0 Construction). Water treatment will be performed upon completion of plant construction.

Red River and Riparian and South of Tailing Facility Area

- **Subalternative 3B** – Removal of soil with molybdenum concentrations greater than 11 mg/kg in the area south of the tailing facility and tailing spill deposits with molybdenum concentrations greater than 54 mg/kg along the Red River riparian corridor; dispose of contaminated soil and tailing on Site.

Eagle Rock Lake

- **Subalternative 3B** – Install inlet storm water controls; dredge sediment to an approximate total depth of three feet below the current lake bottom and dispose of sediment on Site.

EPA will implement the Selected Remedy in two overall phases to address the complexities associated with remediation of the mine site waste rock piles as well as the status of the Site as an operating mining, milling, and tailing disposal facility. EPA will also consider the potential beneficial uses of former mine features.

Phase I

- Conduct pre-design investigation of ground water contamination before initiating design work for the ground water component of the remedy at the Tailing Facility Area as well as additional characterization of the spatial distribution, concentration and chemical form of molybdenum at the Spring Gulch Waste Rock Pile, the preferred borrow source for cover material at the Mine Site Area.
- Conduct response actions to mitigate soil contamination at the Mill Area, soil contamination and tailing spills at the Red River Riparian and South of Tailing Facility Area, sediment contamination at Eagle Rock Lake, and surface water and ground water contamination at the Mine Site Area and Tailing Facility Area.
- Conduct response actions for treatment of contaminated water collected by the tailing facility remedial systems as well as contaminated water collected from the mine site remedial systems. Although the CERCLA on-Site action does not require an NPDES permit for authorization to discharge to waters of the U.S., EPA has decided that all discharges of treated effluent to the Red River shall require an NPDES permit.
- Conduct response actions for source control at the Mine Site Area waste rock piles in a phased approach, with the design of the first rock pile conducted as a pilot study. The pilot study will incorporate treatability studies to identify appropriate cover amendments and designs to achieve water resource protection. The treatability studies will be conducted concurrently with the pilot study and will not impede the start of the design and construction of the second tier of waste rock piles to be remediated. The first waste rock pile to be remediated will likely be the Goathill North Waste Rock Pile. Upon approval of the first design, remedial construction will proceed on the Goathill North Waste Rock Pile at the same time design work is initiated for two subsequent waste rock piles, one of which shall be a

roadside waste rock pile. This work shall continue with design and construction of no less than two waste rock piles at a time through completion of this component of the remedy. The phased approach allows for a “toolbox” approach for developing individual mine reclamation designs on a rock pile-by-rock pile basis, while taking into consideration lessons learned after implementation of each design.

- Obtain temporary well drilling restrictions from the New Mexico Office of the State Engineer, with assistance from NMED. These restrictions will remain in place until ground water has been cleaned up to meet appropriate federal and New Mexico standards.

Phase II

- Conduct response actions for placement of cover at the Mill Area following permanent cessation of milling operations.
- Conduct response actions for source containment at the Tailing Facility Area following permanent cessation of tailing disposal operations.

12.1 Rationale for the Selected Remedy

12.1.1 Mill Area

EPA chose the soil removal alternative for high concentrations of PCBs (greater than 25 mg/kg) and off-Site treatment and disposal over the other soil removal alternatives because EPA has determined, based on current information, that the reasonably anticipated future land use at the Mill Area is wildlife habitat, forestry, and low occupancy commercial or industrial use following permanent cessation of milling operations and decommissioning. The selected alternative is the only alternative that will be protective of human health and the environment given these land use assumptions.

EPA's determination that the reasonably anticipated future land uses are wildlife habitat, forestry, and low-occupancy commercial or industrial use is based on several factors. These factors include (1) the past and current land use, which has been milling of ore from the mine (2) the existence of buildings and infrastructure at the Mill Area, such as roadways, parking facilities, a water supply, and an electrical power supply, (3) the NMED preliminary evaluation of place of withdrawal of water which states that the Mill Area is likely to be put to industrial use, and (4) the MMD-approved post-mining land use, which is forestry and water management under New Mexico Mining Permit TA001RE-96-2. The Mill Area is the likely location of the future water treatment plant, which is a necessary component of the Selected Remedy. However, EPA recognizes that land use may change, and that the Mill Area may be an attractive place for a future residential development after the cessation of mining and milling operations. If the actual or the anticipated future land use should change to residential or another high-occupancy land use, then additional response actions at the Mill Area would be necessary to ensure protection of human health and the environment. EPA will investigate land use at the Mill Area during its periodic five-year reviews of the remedy.

EPA expects the removal and off-Site treatment and disposal of soils contaminated with greater than 25 mg/kg of PCBs to reduce to acceptable levels the long-term risk from human exposure to PCBs. Molybdenum in soil does not pose an unacceptable risk to a future commercial or industrial worker at the Mill Area.

The cover to be placed over the Mill Area in areas designated for forestry as the post-mining land use will be a minimum of 36 inches (three feet) deep. Although the Mill Area was not evaluated for ecological risk (see Ecological Risk Assessment, Section 7.2), the 36-inch thick cover is expected to provide protection to terrestrial plants and animals because the molybdenum concentrations in Mill Area soils exceed the molybdenum remediation goal established by EPA for the mine site of 300 mg/kg, based on Site-specific molybdenum toxicity testing. A discussion of EPA's rationale for selecting the minimu 36-inch cover thickness for protectiveness is presented in Section 12.1.2 below. This cover thickness is also consistent with the cover requirements set forth in Mining Permit TA001RE-96-2. The permit requirements have been identified as TBC items. Additionally, the Spring Gulch waste rock to be used as borrow for covering Mill Area soil will be screened to meet grain size specifications and the 600 mg/kg molybdenum suitability criterion developed by EPA for screening borrow material. The suitability criterion is higher than the remediation goal because site-specific testing at the Spring Gulch Waste Rock Pile showed that a significant portion (approximately 50 percent) of the molybdenum in the waste rock was of a form (molybdenite) which is significantly less soluable and, hence, less bioavailable to plants.

12.1.2 Mine Site Area

EPA chose source containment; storm water, surface water, and ground water management; and ground water extraction and treatment, along with water treatment for the Mine Site Area. These alternatives were selected over other alternatives because the others did not include source containment for the acid generating and potentially acid generating waste rock, a critical component for effectively and permanently mitigating ground water as well as surface water contamination at the mine site.

Source containment will include both the 3H:1V alternative (balance-cut-fill, partial/complete removal, regrade and cover to 3H:1V slopes) and the 2H:1V alternative (balance-cut-fill, regrade and cover to 2H:1V slopes) to provide a “tool box” approach for remediation of each waste rock pile. EPA recognizes that each waste rock pile is unique in size, shape, and position within the tributary drainages. It may not be practicable to achieve the 3H:1V interbench slope for every waste rock pile. However, slopes of 2H:1V or shallower are likely achievable. During remedial design, each waste rock pile will be evaluated independently based factors such as, but not limited to, underlying bedrock slope, volume of waste rock to be removed, probability of revegetation success, stability, factors of safety, critical structure determinations,[79] public safety, worker safety, possible

[79] Critical structures are those that, because of their location, could result in damage to off-site properties, injury or loss of life, or unacceptable environmental consequences if there was a failure. The roadside waste

construction-related environmental impacts, and compliance with ARARs. By selecting both alternatives, EPA retains flexibility in determining the appropriate design of each waste rock pile (on a rock pile-by-rock pile basis) when balancing the relative value of these factors. Additionally, both alternatives also are consistent with conditions in the New Mexico Mining Permit (TA001RE-96-1) and Ground Water Discharge Permit (DP-1055) and Closure/Closeout Plan requirements, which are TBCs, for reclamation of the waste rock piles.

The evaluation and implementation of appropriate engineering designs for remediation of the waste rock piles will include a pilot study conducted as the remediation of the first waste rock pile (*e.g.*, Goathill North). The information obtained from the pilot study will be used in the detailed evaluation and design of subsequent waste rock piles. Additionally, based on the results of the previously unsuccessful revegetation test plots conducted by CMI for the waste rock pile cover design, closely targeted test plots (as treatability studies) will also be performed for the store and release/evapotranspiration cover system to demonstrate the anticipated improvement in vegetative productivity with organic amendment application, erosion resistance of amended cover materials, and moisture holding properties sufficient to provide an effective cover system that protects ground water. The treatability studies will also be conducted as part of the initial remediation of the waste rock piles. The pilot study will also be used to assess the frequency of needed maintenance of the cover systems resulting from erosion.

For the Mine Site (and portions of the Mill Area where the anticipated land use is not commercial/industrial), the cover system technology selected in this ROD is a store and release/ET cover system with Spring Gulch waste rock as the preferred cover material. This cover system must achieve the remedial action objective for eliminating or reducing, to the maximum extent practicable, the leaching and migration of inorganic COCs and acidity from waste rock (acid-rock drainage) to ground water. It must also be protective of

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rock piles (Sulphur Gulch South, Middle, and Sugar Shack South) are considered critical structures by NMED and MMD.

wildlife and vegetation by limiting the uptake of metals, including molybdenum, by plants at levels that would be harmful to the plants or herbivorous native wildlife.

For a store and release/ET cover system to be effective in reducing acid-rock drainage and metals leaching to ground water it has to be thick enough to store the water until it can be transpired by vegetation or evaporated at the surface, thereby minimizing the net-percolation of water beyond the depth of influence of ET. To effectively reduce net percolation below the cover, the cover material must, at a minimum, hold an equivalent amount of water to the average yearly winter precipitation. The unamended Spring Gulch waste rock has an average water holding capacity of 0.76 inches/foot. Based on this water holding capacity and the precipitation record compiled by CMI at weather stations located at and in the vicinity of the mine site, the cover thickness would have to be greater than five feet to hold an average winter precipitation of four to five inches. However, lysimeter test-plot studies conducted at the mine site indicate that the depth of effective evaporation is approximately three feet. The placement of Spring Gulch material at depths greater than three feet, even though it will increase the overall water holding capacity of the cover, will not provide any greater levels of protectiveness. Therefore, Spring Gulch waste rock will require amendments to increase water holding capacity to retain winter precipitation within the range of effective ET.

At the mine site all the waste rock piles are characterized as acid-generating or potentially acid-generating. Scientific research has shown that plant root growth is impeded in acidic materials. At low pH it has been found that cell wall integrity diminishes, trace metal availability increases, available macronutrients and beneficial soil organism activity decreases. Any of these alone or combined, may impede plant growth in acidic wastes. If a cover is underlain by acidic, metaliferous or saline materials (common at the mine site), vegetative productivity may be unsustainable in shallower covers and/or subject to increased plant uptake of metals.

At the mine site vigorous conifer trees must be an important component of the vegetative cover to protect against erosion and transpire water from the ET cover. For most conifers, about 80 percent of rooting can be expected in the top three feet of soil. Based on CMI's Site-specific Root Zone Evaluation Summary Report (Buchanan, 2008), associated field activities and direct observations for vegetation growing at the mine site, including on the waste rock piles, EPA has determined that the majority of rooting activity, including that of trees, is contained within the materials that are no more than moderately acidic. Aggressively acidic materials, about pH 4 or below severely retard root exploration. A sufficiently thick cover, amended to enhance moisture holding and promote productivity, must be provided to ensure that conifer roots can explore ample volume to grow unimpeded and provide nominal ET function.

Therefore, the minimum thickness of the cover for the mine site will be 36 inches, or three feet. This is consistent with industry standard practice, as cover systems constructed over acid generating mine wastes, like those at the mine site, typically range from about three feet to more than six feet. The three-foot cover depth will reduce acid-rock drainage and metals leaching to ground water, thereby providing effective source containment for enhancing ground water remediation efforts and overall protection of ground water resources. Equally important to protecting ground water, the specified minimum cover depth of three feet also provides protection to plants and wildlife by limiting re-exposure of underlying waste through processes of erosion and translocation of contaminants through plant uptake. The top three feet of Spring Gulch waste rock (*i.e.,* the material within the depth affected by ET) will be amended to increase the water holding capacity and improve the edaphic properties necessary to support robust vegetative growth for effective transpiration.

Storm water management is included with this response action. However, such management will only be for controlling and diverting storm water off and away from the store and release/evapotranspiration cover systems to be placed on the waste rock piles. Overall management of storm water at the mine site is conducted in accordance with the NPDES Multi-Sector General Permit for Storm Water Discharge Associated with Industrial Activity (MSGP) and CMI's Storm Water Pollution Prevention Plan (SWPPP). See Section 2.5.2 above. Under the MSGP and SWPPP, CMI is authorized to collect, convey, and discharge contaminated storm water to the open pit, the subsidence area, and the infiltration galleys at the toe of the roadside waste rock piles, where it is allowed to infiltrate into the subsurface, percolate to ground water and potentially contaminate ground water. This practice is intended to prevent storm water from discharging to the Red River. To the extent that the storm water discharge is a federally-permitted release under CERCLA § 107(j), the contamination of ground water caused by the release must be addressed under the Clean Water Act, rather than by a CERCLA response action. Therefore, based on the available information, the Selected Remedy does not include any modifications to the current approved storm water management practices, nor does it incorporate such practices into, or approve such practices as part of, this response action.

Current practices for water management and disposal are to send all water collected by the seepage interception systems, ground water extraction systems and mine dewatering to the mill for (1) use in transporting tailing as slurry to the tailing facility during milling periods, or (2) ph adjustment, blending with unimpacted water, and conveyance through the pipeline for dust suppression and pipeline maintenance during non-milling periods. The commingling of collected impacted mine water with unimpacted water results in all water discharged to the tailing impoundments exceeding New Mexico water quality standards. The water disposal practice during non-milling periods allows the discharge of this contaminated water to the tailing impoundments where the majority (estimated at 2,510 gpm based on water balance calculations) seeps downward (as tailing seepage) and contaminates ground water. NMED Ground Water Discharge Permit DP-933 requires that CMI submit a proposal for reducing the volume of mine water which is discharged to the tailing impoundments. In May 2010 NMED issued a Notice of Violation to CMI for failing to comply with this requirement. See Section 2.4.2.1.

The Selected Remedy includes treatment of all water collected at the Mine Site Area by the mine dewatering, seepage interception systems, and ground water extraction well systems, excluding the water collected as part of the NPDES Best Management Practices (discussed below). The Selected Remedy also includes treatment of all water collected at the Tailing

Facility Area, excluding the water collected by the NPDES Best Management Practices and discharged via permitted Outfall 002, as discussed in Section 12.1.3, below.

Although an on-Site CERCLA action does not require an NPDES permit for authorization to discharge to waters of the United States, due to the unique circumstances related to the on-going operations at the facility, EPA has decided to proceed with NPDES permitting for such discharges under the Selected Remedy. A pre-construction draft NPDES permit application will be developed and submitted to EPA in accordance with 40 C.F.R. Part 122. In administering an individual NPDES permit, there are explicit requirements for issuing public notice, holding public hearings, State 401 Certification under 33 U.S.C. § 1341, developing effluent discharge limitations for protecting the receiving water body, and compliance monitoring. The permit will have effluent discharge limits for specific pollutants, and a violation of a limit may subject CMI to an enforcement action.

The FS Report provides a conceptual evaluation of water treatment through use of two systems: (1) a lime high-density sludge primary treatment process with a polishing step involving reverse osmosis is assumed to be used at the Mine Site Area, and (2) an ion exchange primary treatment process with a reverse osmosis polishing step is assumed to be used at the Tailing Facility Area to meet remedial action objectives, remediation goals, and chemical-specific ARARs at the treated effluent discharge locations.

Both treatment system concepts evaluated within the FS Report could be acceptable methods to meet the remedial action objectives, remedial goals, and chemical-specific ARARs at the effluent discharge location(s). The concepts and costs presented in the FS Report are presented in this ROD. However, there are significant Site-specific complexities that preclude final determination of these concepts within this ROD but can be addressed during the subsequent remedial design (RD). These complexities include uncertainty in water flow and chemistry after blending of the individual water sources collected as part of the selected remedy and uncertainty regarding the impact of ongoing mining operations on water flow and chemistry. Issues such as long-term performance of the water treatment systems, the need for and scope of treated effluent polishing steps to meet chemical-specific ARARs, and disposal of treatment residuals (including but not limited to lime sludge, depleted resin, scale, and brine) have been conceptual in nature and have not been fully addressed to date.

It is also possible during RD to determine efficiencies in treatment system processes, locations, and sizing that result in cost savings for construction and O&M of the water treatment systems and reduce ongoing O&M and treatment residuals disposal with respect to these systems. These potential efficiencies have not been fully vetted to date.

Thus, EPA has determined that a performance-based approach is appropriate for water treatment for the Mine Site Area and Tailing Facility Area. The requirements described below shall be met, at a minimum, for water treatment.

- The water treatment system(s) shall be designed and constructed to treat all collected water from the Mine Site Area as discussed in this section, and for the Tailing Facility Area as discussed in Section 12.1.3. Treated water discharged from the final water treatment systems shall comply with all NPDES permit requirements for discharges at the treated effluent discharge locations.
- Acceptable treatment systems shall consist of conventional, readily available components that are proven capable of treating the COCs and other constituents within the influent water stream and that can be designed and constructed within the timeframes discussed below or as established through the NPDES permitting process. Delays due to evaluation and/or selection of components that cannot readily meet these requirements are unacceptable.
- The existing ion exchange plant at the Tailing Facility Area may be used for water treatment, provided that NPDES permit effluent limits can be met at the treated effluent discharge location for that plant.
- Discharge of treated effluent to surface water shall be acceptable to EPA and NMED, as this allows flexibility in determining locations for treated effluent

discharge; discharge of treated effluent to ground water shall not be performed without approval by EPA.

- The primary treatment processes for the water treatment systems shall be designed, constructed and operational within 12 months of start of the remedial action for the Site. Primary processes (*e.g.,* a lime high-density sludge process) shall be defined as the water treatment components that result in significant reductions to COC concentrations from the influent water stream prior to discharge; any delays in initial startup must be approved by EPA. It is likely that a primary treatment process (such as lime high-density sludge treatment) will achieve compliance with most, but not all chemical-specific ARARs and NPDES permit effluent discharge limits; therefore, a shakedown period not exceeding 18 months (or as determined through the NPDES permitting process) will be allowed for stable operation of the primary treatment processes and to determine the design of any secondary (supplemental) process steps required to "polish" the resulting effluent to meet all remedial action objectives, remediation goals, chemical-specific ARARs and NPDES effluent discharge limits for treated effluent prior to discharge at the approved discharge locations. During this shakedown period, strict compliance with the NPDES effluent discharge limits will not be required for the treated discharge.

- The secondary (supplemental) treatment processes for the water treatment systems shall be constructed and shall commence operation within six months of completion of the shakedown period described above. Any delays in commencing operation of the secondary treatment processes must be approved by EPA.

- After commencement of the secondary treatment processes (if any), a second shakedown period not to exceed six months (or as determined in the NPDES permitting process) will be allowed. During this time, the treatment system(s) shall demonstrate successful water treatment and full compliance with the remedial action objectives, remediation goals, chemical-specific ARARs and NPDES effluent discharge limits when operating at designed capacity and when operating under a wide range of conditions. It must be demonstrated that treatment residual removal and management can be performed effectively without causing treatment system upsets. At the end of this shakedown period, all water treatment discharge(s) shall meet remedial action objectives, remediation goals, chemical-specific ARARs and all NPDES effluent discharge limits and other requirements.

- Treatment residuals (including but not limited to sludge, spent resin, scale, and brine) shall be managed in facilities compatible with the residuals, sufficiently contained to prevent release of the residuals to the surrounding environment, and at suitable locations for the residual. Locations, design, and operation of treatment residual disposal facilities shall be approved by EPA.
- To prevent the discharge of untreated water into receiving waters, contingency measures shall be developed and implemented to manage collected water during extended periods of treatment system upset (*e.g.,* flooding, equipment malfunction or failure, extended periods of freezing, etc.).

Design of the water treatment systems and disposal facilities for treatment residuals must be approved by EPA, in consultation with NMED. The construction, operation, and maintenance of the water treatment systems and disposal facilities will be monitored by EPA and NMED. The treatment systems and disposal facilities will be designed to achieve NPDES effluent discharge limit established for compliance with state water quality standards and federal ambient water quality criteria (ARARs) in the receiving water body. Design, construction, maintenance, and monitoring of the treatment systems and disposal facilities shall be conducted according to the requirements of this ROD, the engineering standards established during RD, the NPDES permitting requirements and as approved by EPA in consultation with NMED.

12.1.3 Tailing Facility Area

The EPA chose source containment, continued ground water withdrawal operations with upgraded seepage collection, piping of water in the eastern diversion channel, ground water extraction southeast of Dam No. 1 (MW-4 and MW-17 area), and water treatment. This represents a modification to Subalternative 3B as it includes the component of Alternative 4 for ground water extraction in the alluvial aquifer southeast of Dam No. 1. The additional ground water extraction is expected to remediate ground water contamination in the area of MW-4 and MW-17. If the source of the contamination is the historic buried tailing north of the Change House, the piping of unused irrigation water in the eastern diversion channel would reduce the source. However, without ground water extraction contaminant levels will likely decrease by natural attenuation[80] over time as the contaminant continues to move downgradient. Since there are residences located near and down gradient of this ground water contamination, there is a need for active remediation of the contaminated ground water to prevent further migration of contamination and restore ground water to its beneficial use. If the source of the contamination is the eastern tailing impoundment (behind Dam No. 1), rather than the historic buried tailing, the piping of the unused irrigation water would not be expected to result in attainment of the ground water cleanup levels in this area.

Since all of the alternatives (excluding the No Further Action alternative) included source containment, the primary differences between the alternatives are related to the degree of ground water remediation. Overall, Alternative 4 is the best alternative to address ground water contamination at the Tailing Facility Area as it includes ground water extraction for the basal bedrock (volcanic) aquifer south of Dam No. 4 and is expected to restore ground water to appropriate cleanup levels (MCLs and New Mexico ground water quality standards) in the shortest time (8 years following placement of the cover). However, it is significantly more costly than the selected alternative (an increase of up to $85 million in present value) because the volume of water that would have to be extracted from the volcanic aquifer and treated (approximately 4,500 gpm) was an order of magnitude higher than the volume (approximately 400 gpm) estimated for the selected alternative. Additionally, the current limited use of this ground water in the area south of Dam No. 4

[80] The natural attenuation processes that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume or concentration of contaminants in ground water. These in-situ processes include biodegradation, dispersion, dilution, and sorption.

(*i.e.,* Red River State Fish Hatchery) and the likelihood of minimal future increase in such use led EPA to select Alternative 3B over Alternative 4.

For the Tailing Facility Area, the cover system technology selected is a store and release/ET cover system utilizing alluvial soil material from a local borrow source area. This cover system must achieve the remedial action objective for eliminating or reducing, to the maximum extent practicable, the leaching and migration of inorganic COCs from tailing to ground water at concentrations and quantities that have the potential to cause exceedances of ground water ARARs or health-based criteria. It must also be protective of wildlife and vegetation by limiting the uptake of metals, including molybdenum, by plants at levels that would be harmful to the plants or wildlife.

For the store and release/ET cover system to be effective in protecting wildlife and vegetation, it must provide a barrier to the underlying tailing waste for the long-term; which includes eliminating re-exposure of the tailing through erosion, pedoturbation by burrowing animals and translocation of contaminants to the surface through ET, with subsequent elevated concentrations in plant tissue and litter. Visual observation of rooting depth at the tailing facility indicates significant rooting of plants into underlying tailing waste where shallow (interim) soil covers have been placed. This is likely due to the tailing waste currently being non-acidic. However, pyrite content of the tailing is at a level (approximately 3 percent) which potentially could cause acidification in the future. This potential acidification of the tailing, and the mobilization of metals caused by the acidification, may be detrimental to plant productivity depending on the degree of metals uptake. Most metals have increased solubility and mobility in acidic environments, a potential future risk if the tailing waste becomes acidic. However, molybdenum is actually more soluble and mobile at a neutral pH and presents a current risk to plants rooting in the waste material. CMI's Wildlife Impact Study showed that the uptake of contaminants (primarily molybdenum) in plants was common across the shallow soil cover. For plants growing in these shallow covers the bioaccumulation factor for molybdenum was much greater than 1 in roots and shoots, strongly suggesting future translocation of molybdenum into cover materials and eventual deposition to the surface as plant litter. In addition to metals uptake by plants, visual observations of the interim covers verify significant reoccurrence of tailing on the surface due to pedoturbation and erosion of the thin covers.

For the alluvial soil cover to be effective in reducing the seepage of inorganic COCs from tailing (*i.e.,* tailing seepage) to ground water it has to be thick enough to store the water until it can be transpired by vegetation or evaporated at the surface, thereby minimizing the net-percolation of water beyond the depth of influence of ET.

To effectively reduce net percolation below the cover, the cover material must, at a minimum, hold an equivalent amount of water to store the "worst-case" infiltration quantity resulting from the critical infiltration event(s), with an appropriate factor of safety[1]. For the tailing facility, critical infiltration event(s) correspond to large, or consecutive, summer monsoonal precipitation events. Based on the estimated water holding capacity of alluvial soil (taken from the literature) and the precipitation record compiled by CMI at weather stations located at and in the vicinity of the tailing facility, the cover system would have to be greater than three feet to hold the precipitation. However, lysimeter testing conducted in site alluvial soil indicates the depth of effective evaporation is approximately four feet. As a result, placing alluvial soil at depths greater than about four feet, even though it will increase the overall water holding capacity, will likely not provide any greater levels of protectiveness.

Therefore, EPA has determined that the cover for the tailing facility must have a minimum thickness of 36 inches (three feet) to be effective as a store and release/ET cover and protect vegetation and wildlife. This is consistent with industry standard practices as cover systems constructed over mine wastes, like those at the tailing facility, typically range from about 3 feet to more than 6 feet in thickness. It is also consistent with the New Mexico Mining Permit TA001RE and Ground Water Discharge Permit DP-933.

In light of the ongoing use of ground water from the volcanic aquifer as a drinking water supply at the Red River State Fish Hatchery, the Selected Remedy will include temporary provision of an alternate water supply or placement of point-of-use treatment systems (*e.g.,* filter at tap) to current users of ground water as drinking water in those specific areas of Site-related ground water contamination (*e.g.,* Red River State Fish Hatchery and specific areas south of Dam No. 1) as needed until ground water cleanup levels are attained. At this time, EPA is not aware of anyone being exposed to contaminants in ground water at levels above federal/state standards or EPA health-based criteria. Currently, the molybdenum concentrations at the Red River State Fish Hatchery are just below EPA's health-based criterion of 0.08 mg/L. However, trends in molybdenum concentrations over time are increasing. Recently, at the request of hatchery personnel, CMI began providing bottled water to the hatchery.

Currently, CMI discharges approximately 400 gpm of untreated seepage and seepage-impacted water to the Red River via NPDES permitted Outfall 002. The remainder of the collected seepage and water is currently pumped back to the Dam 5A impoundment in order to meet the permit discharge limit for manganese at the Outfall 002 pipe. The discharge of this water to the Red River under the authority of the NPDES Program is expected to continue. To the extent that this water represents a federally-permitted release under the Clean Water Act NPDES Program, it is excluded from CERCLA response actions. Therefore, based on available information, only the seepage and water that is pumped back to the tailing impoundments and any additional seepage and water collected by the upgraded collection systems will be treated as part of the Selected Remedy. Treatment requirements are discussed in Section 12.1.2.

The selected alternative will include ground water monitoring and other monitoring along the perimeter or within the tailing piles to provide early detection of any potential acid generation and metal leaching. Pyrite and other sulfide-bearing minerals are known to be present in the tailing at levels sufficient to generate acid. At this time, the tailing appears to be sufficiently buffered with some carbonates and hydrated lime to preclude acid-generating conditions. However, over a longer time period, should these relatively soluable materials be leached by deep seepage processes or applied process waters then acid producing conditions may prevail. Although soil cover and vegetative canopy should minimize this risk, EPA believes it prudent to include such monitoring.

The selected alternative will also include additional ground water characterization for the Tailing Facility Area. In light of the significant water loss known to be occurring at the tailing impoundments (approximately 2,510 gpm based on water balance calculations), additional ground water characterization will be performed for the volcanic aquifer beneath and/or west of the tailing facility as well as other areas south of the tailing facility. NMED continues to investigate other seeps and springs west of the Guadalupe Mountains to determine if they are impacted by tailing seepage as well as some historic wells constructed in the Guadalupe Mountains by Molycorp.

12.1.4 Red River and Riparian and South of Tailing Facility Area

EPA chose the removal of soil and tailing spill deposits with on-Site disposal over the other alternatives because it is expected to achieve long-term risk reduction through the permanent removal of the source and direct exposure pathway. The alternative for capping the tailing spill deposits and contaminated soil in the area south of the tailing facility is protective. However, the cap would require long-term maintenance and contamination remains in place.

The selected alternative is also expected to reduce the risk within a reasonable timeframe and at less cost than the removal and off-Site disposal alternative. The on-Site disposal of excavated soil/tailing decreases costs by approximately $2.5 million (present value) over off-Site disposal.

12.1.5 Eagle Rock Lake

EPA chose inlet storm water controls and the dredging of lake sediment with on-Site deposal over the other alternatives because it is equally as effective in reducing risk to the benthic macroinvertebrate population, but permanently removes the contamination from the lake. The alternative for capping the sediment in place will require long-term maintenance of the in-lake cap and contamination remains in place. The alternative for filling in the existing lake and constructing a new lake would require a change in the point of diversion from the river and may require the addition of water rights. Additionally, on-Site disposal is slightly less costly ($900,000 present value) than the off-Site disposal alternative, although construction and long-term management of a new on-site disposal cell for sediment is required.

The selected alternative is supported by the U.S. Forest Service, which currently manages the lake.

12.2 Description of the Selected Remedy

This section presents a detailed description of the Selected Remedy as defined for each of the five areas at the Site which warrant CERCLA response actions. The level of detail is provided to minimize the likelihood of unanticipated changes to the scope and intent of the Selected Remedy during the remedial design phase of the response action. It must be recognized that the Selected Remedy may change somewhat as a result of the remedial design and construction process. Any significant or fundamental change to the remedy described herein will be fully documented by EPA using a technical memorandum in the Administrative Record, an Explanation of Significant Difference, or an amendment to the ROD in accordance with the NCP.

12.2.1 Mill Area

The Selected Remedy includes the following alternative for the Mill Area:

- **Alternative 3 –** Soil Removal (High Concentrations of PCBs greater than 25 mg/kg) and Off-Site Treatment and Disposal (Low Occupancy – Commercial/Industrial); Regrade, Cover, Apply Amendments, and Vegetate at Mill Decommissioning

The major components of the remedy for the Mill Area are described in detail below. As the Mill Area is an operating facility, EPA and state officials will need to coordinate all response actions with mining personnel.

Continue Controlled Access to the Site (Fencing, Signage, etc.)

The Mill Area is currently surrounded by a fence with restricted access through a central gate with a badge identification system. Signs are posted at the gate and on fences to control public access. The existing fence, restricted access through the gate, and signage will be maintained as part of remedy to protect future receptors from direct contact or ingestion of soil.

Continue Current Worker Health and Safety Program and Hazard Communication

Under current operations, CMI provides a worker health and safety program and hazard communication that specifically addresses potential risks from exposure to PCBs. The worker programs will continue. Oversight of worker health is a responsibility of the Mine Safety and Health Administration (MSHA) of the U.S. Department of Labor.

Excavate Soil contaminated by PCBs in Concentrations above the TSCA cleanup level of 25 mg/kg for Low Occupancy (Commercial/Industrial) Use

Approximately 2,400 yd^3 of soil with total PCB concentrations above the TSCA cleanup level of 25 mg/kg for low occupancy/commercial/industrial use will be excavated from an area covering about 0.6 acres. Figure 12-1 depicts the area of PCB contamination requiring excavation. Affected soil will be removed initially to a depth of 2.5 feet. Front-end loaders and smaller earth moving equipment will likely be used to excavate soil around buildings.

Perform Confirmation Sampling

Confirmation soil sampling will be conducted to determine if cleanup levels have been attained. If not, additional soil will be excavated until cleanup levels are met or an EPA-acceptable depth has been reached.

Import Clean Fill and Grade

The excavation will be backfilled with approximately 2,400 yd^3 of clean fill material. Sources of fill material include Spring Gulch Waste Rock Pile, which may require screening to achieve a suitable gradation for the backfill. The fill will be separated to an appropriate gradation of fine and coarse-grained material, hauled to the mill, end-dumped into the excavation, compacted, and graded.

Transport PCB Soils to EPA-Approved Off-Site Facilities for Treatment and/or Disposal

The excavated soil will be separated into soils containing PCBs greater than 50 mg/kg and those with PCBs less than or equal to 50 mg/kg. The greater than 50 mg/kg PCB-soils will be transported by truck-mounted roll-offs to the nearest off-Site treatment facility that accepts and treats PCB-affected soil.

The excavated soil with PCBs less than or equal to 50 mg/kg will be transported to the nearest off-Site facility that accepts but does not treat the PCB-affected soil. Soil samples will be collected and analyzed to identify contaminant concentrations prior to transport.

Regrade, Cover, Apply Amendments and Vegetate Mill Area as part of Mill Decommissioning

Those areas designated for forestry at the Mill Area will be regraded, covered with amended Spring Gulch waste rock, and revegetated as part of mill decommissioning. The cover shall be of a minimum 36-inch depth and consist of amended Spring Gulch waste rock which passes an 8-inch screen for grain size and is less than or equal to the 600 mg/kg molybdenum screening criterion for borrow material. Vegetation will include grasses, forbs, shrubs and trees. Those areas designated for commercial/industrial use will not require cover or capping as part of this CERCLA response action.

Monitor Plant Growth Performance to Asses if Molybdenum Uptake from Borrow Material to Plants Inhibit Vegetative Success or Poses Risk to Wildlife

Performance monitoring will be conducted to assess the success of plant growth on borrow material that will used as cover for the Mill Area. Such monitoring will include measuring concentrations of molybdenum in plant tissue co-located with media samples (cover material) to quantify oxide and sulfide species of molybdenum and degree of uptake by plants. Molybdenum uptake from borrow material to plants shall not be at levels such that inhibits attainment of revegetation success standards or exceeds risk-based concentrations for herbivorous native wildlife. Performance criteria will be developed using existing and new data from laboratory studies on plant uptake and toxicity using cover material as well as field monitoring results. The timeframe for developing the performance criteria is at the start of the remedial design and continuing through implementation and monitoring of the remedy. Examples of some parameters likely to require field monitoring on a 5-year basis include cover material molybdenum concentrations, plant molybdenum concentrations, and revegetation success.

Perform General Maintenance of the Mill Area, Including Water Quality Monitoring for All Wells, Seeps and Springs at the Mill Area

General maintenance of the Mill Area with monitoring will be continued during operation and after closure. This will consist of grading of roads, maintenance of structures, and water quality monitoring for all wells, seeps, and springs at the Mill Area.

12.2.2 Mine Site Area

The Selected Remedy includes the following subalternatives and timing of water treatment for the Mine Site Area:

- **Subalternative 3A** – Source containment by regrading and re-contouring waste rock piles to achieve a minimum interbench slope of 3H:1V, including partial to complete removal of waste rock to accommodate the slope requirement, followed by cover, amendment application and revegetation; surface water (seepage) interception, underground mine dewatering, and ground water extraction; water treatment;
- **Subalternative 3B** – Same as Subalternative 3A, except waste rock piles will be regraded and re-contoured to achieve a minimum interbench slope of 2H:1V;
- **Water Treatment** – The construction of a water treatment plant will commence at Year 0 Construction of the remedial action. Upon completion of construction, the water treatment plant will be operated to treat all contaminated water collected by the remedy.[81]

The major components of the response action are described below.

Regrade and Re-contour Waste Rock Piles to Achieve a Minimum Interbench Slope of 3H:1V, with Partial or Complete Removal of Waste Rock to Accommodate Slope Requirement; Cover, Apply Amendments and Vegetate

For Waste Rock Piles where 3H:1V Interbench Slopes are Determined by EPA to be Impracticable, Regrade and Re-contour Waste Rock Piles to Achieve a Minimum Interbench Slope of 2H:1V; Cover, Apply Amendments and Vegetate

[81] Water to be treated does not include the water and seepage collected by the NPDES Best Management Practices under NPDES Permit NM0022306. The NPDES water is currently sent to the mill and then to the tailing facility for disposal.

The design and remediation of the waste rock piles will be conducted in a phased approach, with the design and remediation of the first waste rock pile conducted as a pilot study. The first waste rock pile to be remediated will likely be the Goathill North Waste Rock Pile, as interim reclamation for mitigating instability of the pile was completed in 2005. However, active subsidence associated with ongoing mining may be a factor in determining which waste rock pile is best suited for the pilot study. EPA will make such determination during remedial design.

The pilot study will incorporate treatability studies to identify appropriate cover design specifications. However, the treatability studies will not delay actual remedial implementation, but be conducted concurrent with ongoing remediation of the waste rock piles. Treatability studies will be conducted on cover design parameters and physical properties of borrow. The studies will include, but are not limited to determining optimal cover and revegetation design specifications for achieving design performance criteria in reducing infiltration, promoting vegetative growth and protecting wildlife, minimizing erosion, and long-term slope maintenance. The studies will also include evaluation of types, application methods, and application rates of amendments.

Each waste rock pile will be regraded and re-contoured to achieve the minimum 3H:1V or minimum 2H:1V interbench slopes, then covered with amended Spring Gulch waste rock and revegetated. In conducting the earthwork, partial or complete removal of waste rock will also be performed to achieve required interbench slopes. Each rock pile re-contouring will be initially designed to a minimum interbench slope of 3H:1V, with slope breaks provided every 100 to 200 feet. If it is determined by EPA during remedial design that it is impracticable to achieve the 3H:1V minimum interbench slope for certain waste rock piles, then the re-contouring of those piles will be designed to a minimum interbench slope of 2H:1V, with slope break lengths provided approximately every 100 to 200 feet (*i.e.,* designed to achieve the shallowest slope practicable between 3H:1V and 2H:1V). Some partial removal of waste rock may be necessary to achieve interbench slopes shallower than the 3H:1V.

EPA recognizes that each of the mine site waste rock piles is unique. Consequently, during the remedial design phase, each waste rock pile will be evaluated independently to balance the relative value of a number of factors including, but not limited to: attainable slope stability and factor of safety, sustainable vegetation on steep slopes, water management, environmental protection, minimizing construction-related environmental impacts, compliance with ARARs, attainment of TBCs and safety – both worker and public.

Each of the mine site waste rock piles will be regraded to achieve a stable slope for constructing the store and release/evapotranspiration cover. After regrading, each waste rock pile will be covered to a 36-inch depth of amended cover material and revegetated (see typical cover profile, Figure 12-2). The cover material (waste rock) will be excavated from Spring Gulch Waste Rock Pile identified as non-acid generating black andesite and aplite. It will be screened to a maximum grain size of 8 inches and the 600 mg/kg molybdenum screening level criterion for borrow material and amended. The store and release/evapotranspiration cover system will be designed to reduce infiltration within the boundary of the cover to a level which eliminates or reduces the leaching and migration of inorganic COCs and acidity from waste rock to ground water at concentrations and quantities that have the potential to cause exceedances of the numeric New Mexico ground water standards, background levels, or EPA's Site-specific health-based criteria in ground water.

Water management features will be incorporated into the final design of each waste rock pile and may include, but not be limited to terraces, swales, ditches, and other features, as necessary. Both run-off and run-on water will be managed via these features to divert unimpacted water around the rock pile, or off of the waste rock pile to a natural drainage to avoid being contaminated. The cover will incorporate erosion control channels, swales, and benches for surface water run-on and run-off. The cover may also incorporate a geomorphic design intended to blend with the existing surrounding area if the performance standards for protecting ground water can be achieved.

Vegetation will include grasses, shrubs, forbs, and trees. Multiple applications of amendments may be required to promote vegetative growth once the cover is in place.

Prior to construction, the existing access roads will be maintained or widened. Depending on the haul route to be used, turn-outs may need to be constructed to allow for two-way traffic. Bulldozers, equipment operators, and possibly specialized equipment will be used to regrade the rock pile. Construction access to the waste rock pile will be required and maintained throughout regrade and cover placement. Following construction, disturbed areas around the rock pile will be reclaimed to pre-existing conditions and the waste rock pile slopes and covers will be maintained, including repair of damage to the remedy caused by erosion, in accordance with maintenance schedules to be developed during remedial design.

Regrade to Minimum 3H:1V Interbench Slopes

The waste rock piles were individually evaluated to identify possible regrading and re-contouring designs for achieving the minimum 3H:1V interbench slope, with partial or complete removal of waste rock if necessary to accommodate the slope requirement. The waste rock pile with a balanced-cut-fill within the in-place regraded rock pile is Goathill South. The rock piles that were selected for partial or complete removal because the interbench 3H:1V grades are not achievable with an in-place regrade include: Capulin, Goathill North, Sugar Shack West, Sugar Shack South, Middle, Sulphur Gulch South, and Sulphur Gulch North/Blind Gulch.

To achieve the 3H:1V interbench slope angles, varying amounts of waste rock will have to be removed from each pile as well as varying the footprint of the pile. The total surface area for grading and revegetation is approximately 420 acres. The total volume of material to cover the waste rock piles is estimated to be approximately 2.4 million yd^3 based on a 36-inch cover thickness.

The conceptual design for the regrading and re-contouring of the waste rock piles is discussed individually below. In the conceptual design each waste rock pile is re-contoured to a minimum or average interbench slope of 3H:1V to the underlying slope. In developing the conceptual design, a final interbench slope of 3H:1V was targeted, with slope break lengths provided approximately every 200 feet. However, the slopes and slope breaks may vary depending on the final detailed design.

Capulin Waste Rock Pile

The slope of Capulin Waste Rock Pile ranges from 3.7H:1V to 1.0H:1V. The existing disturbed area of the rock pile is 64.9 acres. The regraded pile will be expanded to have a regraded disturbance area of 84.4 acres, an increase of approximately 30 percent. The regraded area will extend over approximately 1,300 feet (1/4 mile) of an existing drainage. A conceptual layout of the regraded waste rock pile is shown on Figure 12-3. Regrading activities include partial removal of the waste rock pile. Removal will include excavation of the waste rock, haul truck loading to an on-site repository, and placement in the repository. The estimated volume of mine rock to be removed is approximately 1.5 million yd^3.

Water management diversions will accommodate the 100-year, 24-hour storm event of approximately 6 acre-feet (ac-ft) from approximately 62 acres of undisturbed forest above the waste rock pile, or an alternative design approved by the EPA during the remedial design phase.

The estimated volume of screened and amended cover material necessary to cover the waste rock pile is approximately 0.2 million yd^3. The underlying slope that will be exposed during the regrade has a slope that varies from 2.8H:1V to 1.8H:1V.

Goathill North Waste Rock Pile

The current slope of Goathill North Waste Rock Pile ranges from 5.1H:1V to 1.4H:1V after interim reclamation regrading. The existing disturbance area is 49.9 acres. Regrade activities will include partial removal of the rock pile. Partial removal will include excavation of the waste rock, haul truck loading to an on-site repository, and placement in the repository. The estimated volume of waste rock to be removed is approximately 2.8 million yd^3. A conceptual layout of the regraded waste rock pile is shown on Figure 12-4.

Water management diversions will accommodate the 100-year, 24-hour storm event of approximately 2 ac-ft from approximately 15 acres of undisturbed forest, or an alternative design approved by the EPA during the remedial design phase.

The estimated volume of screened and amended cover material necessary to cover the waste rock pile is approximately 0.1 million yd^3. The underlying slope that will be exposed has a slope of approximately 1.9H:1V and is approximately 22.2 acres in aerial extent.

Goathill South Waste Rock Pile

The slope of Goathill South Waste Rock Pile ranges from 1.9H:1V to 1.5H:1V. The existing disturbed area of the rock pile is 8.0 acres. The regraded pile will be expanded to have a regraded disturbance area of 9.8 acres, an increase of approximately 22 percent. Regrading activities will include a balanced-cut-fill within the rock pile. A conceptual layout of the regraded waste rock pile is shown on Figure 12-5.

Water management diversions will accommodate the 100-year, 24-hour storm event of approximately 1ac-ft from approximately 3 acres above the waste rock pile, or an alternative design approved by the EPA during the remedial design phase.

The estimated volume of screened and amended cover material necessary to cover the waste rock pile is approximately 0.01 million yd^3. The underlying slope that will be exposed during the regrade has a slope of approximately 1.8H:1V and is approximately 8.0 acres in aerial extent.

Sugar Shack West Waste Rock Pile

The current slope of Sugar Shack West Waste Rock Pile ranges from 1.7H:1V to 1.5H:1V. The existing disturbed area of the waste rock pile is 47.7 acres. The regraded pile will be expanded to have a regraded disturbance area of 57.2 acres, an increase of approximately 20 percent. Regrading activities will include partial or complete removal of the waste rock pile. Removal will include excavation of the waste rock, haul truck loading to an on-site repository, and placement in the repository. The estimated volume of mine rock to be removed is approximately 3.9 million yd^3. A conceptual layout of the regraded waste rock pile is shown on Figure 12-6.

Water management diversions will accommodate the 100-year, 24-hour storm event of approximately 5 ac-ft from approximately 27 acres above the waste rock pile, or an alternative design approved by the EPA during the remedial design phase. During regrading an existing drainage will be covered. A diversion channel will need to be constructed outside the new disturbance limits of the pile to control storm water.

The estimated volume of screened and amended cover material necessary to cover the rock pile is approximately 0.1 million yd^3. The underlying slope that will be exposed during the regrade has a slope of approximately 1.8H:1V and is approximately 38.4 acres in aerial extent.

Sugar Shack South Waste Rock Pile

The slope of Sugar Shack South Waste Rock Pile ranges from 2.1H:1V to 1.4H:1V. The existing disturbed area of the waste rock pile is 115.6 acres. The regrade will be constrained by underlying topography and constraints at the toe, including proximity to State Highway 38 and the Red River. Regrading activities will include partial or complete removal of the waste rock pile. Removal will include excavation of the waste rock, haul truck loading to an on-site repository, and placement in the repository. The estimated volume of mine rock to be removed is approximately 25.7 million yd^3. A conceptual layout of the regraded waste rock pile is shown on Figure 12-7.

Water management diversions will accommodate the 100-year, 24-hour storm event, or an alternative design approved by the EPA during the remedial design phase; however, it is anticipated that storm water run-on will be minimal above the waste rock pile. Maintaining the 8,720 and 8,920 ft. elevation benches for storm water management will not be feasible.

The estimated volume of screened and amended cover material necessary to cover the waste rock pile is approximately 0.2 million yd^3. The underlying slope that will be exposed during the regrade is approximately 38.5 acres in aerial extent.

Middle Waste Rock Pile

The slope of Middle Waste Rock Pile ranges from 1.4H:1V to 1.1H:1V. The existing disturbed area of the waste rock pile is 120.4 acres. A conceptual layout of the regraded waste rock pile is shown on Figure 12-8. Regrade of this rock pile would be constrained by underlying topography and constraints at the toe, including proximity to State Highway 38 and the Red River. Regrading activities will include partial or complete removal of the waste rock pile. Removal will include excavation of the waste rock, haul truck loading to an on-site repository, and placement in the repository. The estimated volume of mine rock to be removed is approximately 34.7 yd^3.

Water management diversions will accommodate the 100-year, 24-hour storm event of approximately 6 ac-ft from approximately 40 acres above the rock pile, or an alternative design approved by the EPA during the remedial design. Maintaining the 8,720 and 8,920 ft. elevation benches for storm water management will not be feasible.

The estimated volume of screened and amended cover material necessary to cover the waste rock pile is approximately 0.06 million yd^3. The underlying slope that will be exposed during the regrade is approximately 108.4 acres in aerial extent.

Sulphur Gulch South Waste Rock Pile

The slope of Sulphur Gulch South Waste Rock Pile ranges from 2.0H:1V to 1.6H:1V. The existing disturbance area is 156.5 acres. The regraded rock pile will be expanded to have a regraded disturbance area of 165.9 acres, an increase of 6 percent. A conceptual layout of the regraded rock pile is shown on Figure 12-9. The regrade will be constrained by underlying topography and constraints at the toe, including proximity to State Highway 38 and the Red River. Regrading activities will include partial or complete removal of the waste rock pile. Removal will include excavation of the waste rock, haul truck loading to an on-site repository, and placement in the repository. The estimated volume of mine rock to be removed is approximately 34.7 yd^3.

Water management diversions will accommodate the 100-year, 24-hour storm event of approximately 1 ac-ft from approximately 4 acres above the rock pile, or an alternative design approved by the EPA during the remedial design phase. Maintaining the 8,720 and 8,920 ft. elevation benches for storm water management will not be feasible.

The estimated volume of screened and amended cover material necessary to cover the waste rock pile is approximately 0.4 million yd^3. The underlying slope that will be exposed during the regrade has portions which are steeper than 1.9H:1V and is approximately 95.7 acres in aerial extent.

Sulphur Gulch North/Blind Gulch Waste Rock Piles

The slopes of Sulphur Gulch North and Blind Gulch waste rock piles range from 2.0H:1V to 1.4H:1V. The existing disturbance area is 129.7 acres. Regrading activities will include partial or complete removal of the waste rock pile. Removal will include excavation of the waste rock, haul truck loading to an on-site repository, and placement in the repository. The estimated volume of mine rock to be removed is approximately 12.7 million yd^3. A conceptual layout of the regraded waste rock pile is shown on Figure 12-10.

Water management diversions will accommodate the 100-year, 24-hour storm event of approximately 7 ac-ft from approximately 68 acres of undisturbed forest, or an alternative design approved by the EPA during the remedial design phase.

The estimated volume of screened and amended cover material necessary to cover the rock pile is approximately 0.9 million yd^3. The underlying slope that will be exposed during the regrade is steeper than 1.9H:1V and is approximately 40.0 acres in aerial extent.

Spring Gulch Waste Rock Pile

The Spring Gulch Waste Rock Pile is the preferred source of cover material. Once sufficient waste rock material has been removed for use as cover for the other waste rock piles, the remaining portion of the Spring Gulch Waste Rock Pile will be regraded and covered with appropriate cover material from Spring Gulch Waste Rock Pile, and revegetated.

The slope of Spring Gulch Waste Rock Pile ranges from approximately 2.0H:1V to 1.6H:1V. The existing disturbance area is 81.3 acres. Regrade activities will include partial or complete removal of the waste rock pile. Removal will include excavation of the waste rock, haul truck loading to an on-site repository, and placement in the repository. The estimated volume of mine rock to be removed is approximately 6.5 million yd^3, 3.9 million yd^3 of which will be removed for cover material. A conceptual layout of the regraded waste rock pile is shown on Figure 12-11.

Water management diversions will accommodate the 100-year, 24-hour storm event of approximately 47 ac-ft from approximately 460 acres of undisturbed forest, or an alternative design approved by the EPA during the remedial design phase.

The regraded Spring Gulch Waste Rock Pile not used for cover material (mixed volcanics) will be covered in the same manner as the other waste rock piles. The estimated volume of screened and amended cover material necessary to cover the rock pile is approximately 0.5 million yd^3. The entire regraded surface will be covered.

Regrade to Minimum 2H:1V Interbench Slopes

The 2H:1V regrade component of the Selected Remedy includes the same general components as the 3H:1V regrade except that waste rock is moved within and between the rock piles to achieve a minimum interbench slope of 2H:1V. Material removed from waste rock piles will be placed at either Spring Gulch or Sulphur Gulch North/Blind Gulch waste rock piles.

The waste rock piles that have an in-place regrade are Capulin, Goathill North, and Sugar Shack West. The rock piles having waste rock material moved to other rock piles include: Goathill South, Sugar Shack South, Middle, and Sulphur Gulch South. The waste rock piles that will receive additional waste rock material include Sulphur Gulch North/Blind Gulch and Spring Gulch. The total surface area for grading and revegetation is approximately 660 acres. The total volume of material to cover the rock piles is estimated to be approximately 3.8 million yd^3 based on a 36-inch cover thickness.

The conceptual design for regrade of each waste rock pile to minimum 2H:1V interbench slopes is discussed individually below. In developing the conceptual design, a final interbench slope of 2H:1V was targeted, with slope break lengths provided approximately every 200 feet. However, slopes and slope breaks may vary depending on the final detailed design.

Capulin Waste Rock Pile

The slope of Capulin Waste Rock Pile ranges from 3.1H:1V to 1.0H:1V. The existing disturbed footprint area of the waste rock pile is 64.9 acres. Under the 2H:1V slope regrade option, the regraded pile will be expanded to have a regraded disturbance area of 88.3 acres, an increase of 36 percent. The expanded pile will extend over approximately 850 feet of existing drainage. Regrading activities will include a balanced-cut-fill within the regraded rock pile. A conceptual layout of the regraded waste rock pile is shown on Figure 12-12.

Water management features would be similar to those described under the 3H:1V regrade design for Capulin Waste Rock Pile. The estimated volume of screened and amended cover material necessary to cover the rock pile is 0.2 million yd^3. The underlying slope that will be exposed during the regrade is approximately 15.9 acres in aerial extent.

Goathill North Waste Rock Pile

The current slope of Goathill North Waste Rock Pile ranges from 5.1H:1V to 1.4H:1V after interim reclamation. The existing disturbed footprint area of the rock pile is 49.9 acres. Regrading activities will include a balanced-cut-fill within the regraded rock pile to the minimum 2H:1V slope. A conceptual layout of the regraded waste rock pile is shown on Figure 12-13.

Water management features would be similar to those described under the 3H:1V regrade design for Goathill North Waste Rock Pile. The estimated volume of screened and amended cover material necessary to cover the rock pile is 0.2 million yd^3. The underlying slope that will be exposed during the regrade is steeper than 1.9H:1V and covers an area of approximately 15.9 acres.

Goathill South Waste Rock Pile

The slope of Goathill South Waste Rock Pile ranges from 1.9H:1V to 1.5H:1V. The existing disturbed footprint area of the rock pile is 8.0 acres. The regraded pile will be expanded to have a regraded disturbance area of 10.0 acres, an increase of 25 percent. Regrading activities will include a balanced-cut-fill within waste rock piles. The regrade will require removing material to Spring Gulch or Sulphur Gulch North/Blind Gulch waste rock piles. The estimated volume of mine rock to be removed is approximately 0.3 million yd^3. A conceptual layout of the regraded waste rock pile is shown on Figure 12-14.

Water management features would be similar to those described under the 3H:1V regrade design for Goathill South Waste Rock Pile. The estimated volume of screened and amended cover material necessary to cover the waste rock pile is 0.02 million yd^3. The underlying slope that is exposed during the regrade covers an area of approximately 6.0 acres.

Sugar Shack West Waste Rock Pile

The slope of Sugar Shack West Waste Rock Pile ranges from 1.7H:1V to 1.5H:1V. The existing disturbed footprint area of the rock pile is 47.7 acres. The regraded pile will be expanded to have a regraded disturbance area of 55.8 acres, an increase of 17 percent. Regrading activities will include a balanced-cut-fill within waste rock piles. A conceptual layout of the regraded rock pile is shown on Figure 12-15.

Water management features would be similar to those described under the 3H:1V regrade design for Sugar Shack West Waste Rock Pile. The estimated volume of screened and amended cover material necessary to cover the rock pile is 0.2 million yd^3. The underlying slope that is exposed during the regrade that is steeper than 1.9H:1V covers an area of approximately 11.6 acres.

Sugar Shack South Waste Rock Pile

The slope of Sugar Shack South Rock Pile ranges from 2.1H:1V to 1.4H:1V. The existing disturbed footprint area is 115.6 acres. The regraded pile will be expanded to have a regraded disturbance footprint of 124.8 acres, an increase of 8 percent. The regrade will be constrained by underlying topography and constraints at the toe, including the proximity of State Highway 38 and Red River. Regrading activities will include a balanced-cut-fill within waste rock piles. Regrading will require removing material to Spring Gulch or Sulphur Gulch North/Blind Gulch. The estimated volume of mine rock removed is approximately 7.3 million yd^3. A conceptual layout of the regraded waste rock pile is shown on Figure 12-16.

Water management features would be similar to those described under the 3H:1V regrade design for Sugar Shack South Waste Rock Pile. The estimated volume of screened and amended cover material necessary to cover the rock pile is 0.5 million yd^3. The underlying slope that will be exposed during the regrade covers an area of approximately 10.6 acres.

Middle Waste Rock Pile

The slope of the Middle Waste Rock Pile ranges from 1.4H:1V to 1.1H:1V. The existing disturbed footprint area is 120.4 acres. The regraded disturbance area will be expanded to have a regraded disturbance area of 130.0 acres, an increase of 8 percent. The regrade will be constrained by underlying topography and constraints at the toe, including the proximity of State Highway 38 and Red River. Regrading activities will include a balanced-cut-fill within the waste rock piles. Regrading will require removing material to Spring Gulch or Sulphur Gulch North/Blind Gulch. The estimated volume of mine rock to be removed is approximately 12.1 million yd^3. A conceptual layout of the regraded waste rock pile is shown in Figure 12-17.

Water management features would be similar to those described under the 3H:1V regrade design for Middle Waste Rock Pile. The estimated volume of screened and amended cover material necessary to cover the rock pile is 0.5 million yd^3. The underlying slope that would be exposed during the regrade that is steeper than 1.9H:1V covers an area of approximately 38.6 acres.

Sulphur Gulch South Waste Rock Pile

The slope of the Sulphur Gulch South Waste Rock Pile ranges from 2.0H:1V to 1.6H:1V. The existing disturbed footprint area is 156.5 acres. The regarded disturbance area will be expanded to have a regraded disturbance area of 162.8 acres, an increase of 4 percent. The regrade will be constrained by underlying topography and constraints at the toe, including the proximity to State Highway 38 and Red River. Regrading activities will include a balanced-cut-fill within the waste rock piles. Regrading will require removing material to Spring Gulch or Sulphur Gulch North/Blind Gulch waste rock piles. The estimated volume of mine rock to be removed is approximately 9.1 million yd^3. A conceptual layout of the regraded rock pile is shown in Figure 12-18.

Water management features would be similar to those described under the 3H:1V regrade design for Sulphur Gulch South Waste Rock Pile. The estimated volume of screened and amended cover material necessary to cover the rock pile is 0.8 million yd^3. The underlying slope that will be exposed during the regrade that is steeper than 1.9H:1V covers an area of approximately 22.7 acres.

Sulphur Gulch North/Blind Gulch Waste Rock Piles

The slopes of the Sulphur Gulch North/Blind Gulch waste rock piles range from 2.0H:1V to 1.4H:1V. The existing disturbed footprint area is 129.7 acres. Regrading activities will include a balanced-cut-fill within the waste rock piles. A conceptual layout of the regarded rock piles is shown on Figure 12-19.

Water management features would be similar to those described under the 3H:1V regrade design for Sulphur Gulch North/Blind Gulch waste rock piles. The estimated volume of screened and amended cover material necessary to cover the rock pile is 0.9 million cubic yards. The underlying slope that is exposed during the regrade steeper than 1.9H:1V covers an area of approximately 36.8 acres.

Sulphur Gulch North/Blind Gulch waste rock piles may be used as repositories for the placement of excess waste rock as described above. It is estimated that up to approximately 30.1 million yd^3 of additional waste rock will be placed onto the existing waste rock piles from the material removed from the other waste rock piles depending on which piles are regraded to 2H:1V interbench slopes. The waste rock piles with the additional fill will be regraded to a minimum interbench slope of 2H:1V to the underlying slope to the maximum extent practicable with slope break lengths provided approximately every 200 feet. The filled footprint will be expanded to 198.3 acres, an increase of 52 percent. The estimated volume of screened cover material necessary to cover the rock pile is 1.0 million yd^3. A conceptual layout of the regarded rock piles as repositories is shown on Figure 12-20.

Spring Gulch Waste Rock Pile

The slope of Spring Gulch Waste Rock Pile ranges from 2.0H:1V to 1.6H:1V. The existing disturbed footprint area is 81.3 acres. Regrading activities will include a balanced-cut-fill within the waste rock piles. Material will either remain in place or move to the Sulphur Gulch North/Blind Gulch waste rock piles. The estimated volume of the waste rock to be removed is 6.7 million yd^3; 5.4 million yd^3 of which will be removed for cover. The estimated volume of screened and amended cover material necessary to cover the rock pile is 0.5 million yd^3.

Spring Gulch Waste Rock Pile may be used as a repository for the placement of excess waste rock material. However, no storage would be required for the material removed from the other waste rock piles if they are regraded to 2H:1V interbench slopes. The rock pile with the additional fill will be graded to a minimum interbench slope of 2H:1V to the underlying slope to the maximum extent practicable with slope break lengths provided approximately every 200 feet. The estimated volume of screened cover material necessary to cover the rock pile is 0.6 million yd^3. A conceptual layout of the regraded waste rock pile is shown on Figure 12-21.

Construct and Utilize On-Site Repository(ies) for Waste Rock

The use of an on-site repository for waste rock will include: (1) placement and compaction of waste rock material, (2) grading of waste rock to achieve a stable slope for the construction of the cover, and (3) covering the graded surface with materials obtained from Spring Gulch Waste Rock Pile. The open pit is used as the on-site repository location for cost estimating purposes. However, EPA will determine the actual location of an on-site repository(ies) during remedial design. EPA will notify the public of the location of the repository(ies) once a determination has been made. Placement of waste rock material in an on-site repository will provide achievable in-place regrade for the waste rock piles that have waste rock material removed. It will also achieve stable slopes for construction of a cover. Partial or complete removal from the rock piles will include excavation of the waste rock, haul truck loading to an on-site repository, placement and compaction in the repository, and grading to achieve design slopes. The estimated maximum volume of waste rock from the nine individual waste rock piles to be moved to the repository is approximately 119 million yd^3, assuming all rock piles are regraded to 3H:1V interbench slopes.

The waste rock material within the repository will be graded to a minimum interbench design slope of 3H:1V, as practical, and covered with a 36-inch depth of cover material. The cover will incorporate erosion control channels, swales, and benches for surface water run-on and run-off. The borrow material to be used for the cover will be excavated from the Spring Gulch Waste Rock Pile identified as non-acid generating. It will be screened to a maximum grain size of 8 inches and the 600 mg/kg molybdenum screening criterion for borrow and amended. Multiple applications of amendments may be required to promote vegetative growth once the cover is in place. The estimate volume of screened cover material necessary to cover the waste rock is approximately 1.5 million yd^3.

Continue Controlled Access (Fencing, Gate, and Signage)

As the mine site covers approximately three square miles of mountainous land, the remedy will include access controls in specific areas of the mine site. Current access restrictions are in place for those areas with operating facilities (buildings, structures, etc.) and include fencing, gate, placement of signage and guarded entry points. These land use controls will continue during the remaining operational life of the mine. The fencing and signage will be maintained after closure.

Additional land use controls to restrict access to the open pit and subsidence area will be put in place at mine closure and maintained for the long term, possibly in perpetuity, to protect public health and safety. Physical barriers to restrict access will include a continuous wire fence and five-foot high berm to be placed around the entire open pit perimeter and signage. The stability of the pit walls will be monitored semiannually to identify potential failure or hazard areas which may adversely impact public health or safety. If any potential failure or hazard areas are identified, they will be mitigated.

Access to the subsidence area will also be restricted. Since it would be impracticable to fence off the subsidence area, signage will be used to warn people of the safety hazards.

Continue Operating Existing Seepage Interception and Ground Water Withdrawal Well Systems, Dewater Underground Mine, Pipe Water to Mill and Treat Water[82], pH Adjust Water Until Water Treatment Plant is Available to Treat Water.

The operation of the existing ground water withdrawal well system in front of the roadside waste rock piles and the seepage interception systems at Springs 13 and 39 as Best Management Practices under EPA NPDES Permit NM0022306 (USEPA 2006b) will continue under the direction and oversight of the NPDES Program (see Figure 12-22). The

[82] "Water Treatment" or to "treat water" at the mine site means: the use of chemical precipitation utilizing the high-density solids treatment process. This includes solids separation of the metal precipitated sludge with proper disposal before discharging the effluent.

withdrawal well system extracts ground water from the alluvial aquifer. The system includes three extraction wells: GWW-1, GWW-2, and GWW-3. The system extracts approximately 420 gpm of water, which is pumped to the mill and disposed of at the tailing facility.

The seepage interception systems at Springs 13 and 39 are to collect shallow alluvial seepage that forms aluminum hydroxide precipitate along the bank of the Red River. The systems are French drains that are 1.5 feet below the low water level of the river. The collected water flows by gravity to a concrete vault where it is pumped through a pipeline to the mill. The Spring 13 system is located near the mouth of Capulin Canyon. The drain is approximately 1,000 feet long and collects approximately 20 gpm of water. The Spring 39 system is located at the base of the Goathill Debris Fan. The system includes two adjacent drains approximately 400 feet in length that collect approximately 80 gpm of water. These two drain collection systems collect water at a rate of approximately 100 gpm.

Because of hydrologic connection between bedrock ground water and the Red River, the dewatering of the underground mine will continue in perpetuity to maintain the mine water level below the Red River, thus maintaining a hydraulic gradient in bedrock toward the mine. The underground mine collects colluvial and bedrock ground water which drains to the open pit, the subsidence area, old underground workings, and the decline, as well as storm water run-off directed to the open pit and subsidence area and seepage from Capulin and Goathill North waste rock piles. The underground mine is currently dewatered at an average rate of approximately 250 gpm. This water is pumped to the mill for use in milling operations along with make-up water from the Red River and water production wells.

The total flow rate of contaminated water collected by these systems is approximately 770 gpm [420 gpm + 100 gpm + 250 gpm = 770 gpm]. During milling periods, the 520 gpm of contaminated water from the ground water withdrawal well system and seepage interception systems is pumped to Sump 5000 located adjacent to the mill at the mill and mixed with tailing slurry for transport to the tailing facility. No pH adjustment of the acidic water is necessary at this time because the alkaline process of milling ore buffers the acidity of the contaminated water. The mixture of contaminated water and tailing slurry discharged to the tailing facility at the end of pipe meets the allowable discharge pH of between 6 and 9 specified in Ground Water Discharge Permit DP-933.

During non-milling periods, the acidic water is pumped to Sump 5000 at the mill, pH adjusted using hydrated lime and sent to the tailing facility for disposal. Since water is needed for operational maintenance of the pipeline during non-milling period, CMI uses this contaminated water for such purpose. CMI blends the contaminated water with sources of unimpacted water (which can exceed 1,000 gpm) that is collected from production wells and the Red River prior to conveyance through the pipeline. Table 1-1 shows the total volume of water sent to the tailing facility during milling and non-milling periods on a month-by-month basis for 2009. Periodic sampling of the discharge water at the end of pipe by NMED indicates an exceedance of New Mexico water quality standards for manganese and other constituents. The water conveyed through the pipeline is also used for partial dust suppression at the tailing facility. The majority of the water discharged into the tailing impoundments seeps through the tailing (as tailing seepage) to ground water and contributes to the contamination of ground water at the tailing facility.

The water collected by mine dewatering (250 gpm) will be conveyed to the water treatment plant for treatment as described in Section 12.1.2, above. The NPDES Program will determine whether the current disposal practices for the 520 gpm of water collected by the Best Management Practices will continue or be modified.

Continue to pH adjust water until the water treatment plant is available to treat all of this water.

Continue Collection and Conveyance of Waste Rock Pile Seepage to Subsidence Area on Interim Basis until Piping and Collection Systems Constructed, at which time Water will be Piped to Mill Area for Treatment;

Seepage from Capulin and Goathill North waste rock piles are currently being collected and managed. The Capulin Leachate Collection System collects an average of approximately 20 gpm of water derived from seepage from Capulin Waste Rock Pile and storm water. The collected water is pumped through the horizontal borehole to the Goathill Gulch drainage, and then is directed to the subsidence area. The Goathill North Waste Rock Pile toe drain collects seepage at a rate of approximately 10 gpm. This seepage is also directed to the subsidence area. The collection and conveyance of this seepage to the subsidence area will continue on an interim basis until construction of the piping and new seepage collection systems for Capulin and Goathill North waste rock leachate is completed, at which time water will be piped to the mill for treatment.

Install New Seepage Collection Systems near the Base of Capulin and Goathill North Waste Rock Piles to Enhance Seepage Capture, Pipe Seepage to Mill Area and Treat Water; Decommission Capulin Leachate Collection System

Two new interceptor drains will be installed in two drainages below the toe of the Capulin Waste Rock Pile during the rock pile regrade, and one new interceptor drain will be installed approximately 100 feet downstream of the existing toe drain at Goathill North Waste Rock Pile. These drains will enhance seepage capture from waste rock piles. The existing Capulin Leachate Collection System will be decommissioned, including catchments, sediment traps, and the pumpback pond. The drains will be designed to collect subsurface flow, and storm water flow will be directed over or around the systems. The drains will be keyed into competent bedrock by installing a grout curtain or other engineered barrier system to a depth of 50 feet on the downgradient side of the drains (Capulin Waste Rock Pile only). The drains will extend across the drainages and consist of a perforated pipe in a trench backfilled with gravel. For the conceptual design, the two Capulin Waste Rock Pile interceptor drains are assumed to be 100 feet in length, 20 feet deep, and 5 feet wide with an estimated combined seepage collection rate of 50 gpm for both drains. The collected seepage will drain by gravity through an HDPE pipe 8,000 feet in length routed down Capulin Canyon to the Spring 13 collection vault, then pumped to the water treatment facility (other routes for piping will be evaluated in the remedial design). The new Goathill North interceptor drain is assumed to be 50 feet in length, 30 feet deep and 5 feet wide. The estimated collection rate is 30 gpm for both the new drain and existing toe drain. The collected seepage will be drained by gravity through an HDPE pipe 12,000 feet in length and routed down Goathill Gulch to the Columbine pump station, then pumped to the water treatment facility (other routes for piping will be evaluated in the remedial design). A conceptual layout of the Mine Site Area remedial component is shown on Figure 12-22.

Install and Operate New Ground Water Extraction Well Systems in Lower Portion of Tributary Drainages, Pipe Water to Mill Area and Treat Water

New ground water extraction well systems will be constructed within the lower portion of all tributary drainages and operated. The first extraction well system will be located at the base of each of the roadside waste rock pile drainages. A second extraction well system will be constructed in the lower portion of Goathill Gulch near the head of the debris fan. A third extraction well system will be constructed in the lower portion of Slick Line Gulch between existing monitoring wells MMW-21 and MMW-48A. The forth extraction well system will be constructed in lower Capulin Canyon.

A new ground water extraction well system will be installed at the base of the roadside waste rock piles in pre-mine drainages to capture seepage from the waste rock piles before it enters the Red River alluvial aquifer. The wells will be designed to capture the estimated ground water flow in the colluvium and the upper 10 feet of the weathered portion of bedrock in the drainages. When contaminant concentrations in the alluvial aquifer are reduced to cleanup levels, approval will be sought from the EPA NPDES Program to phase out the three existing GWW extraction wells. For the conceptual design, EPA assumes that one well will sufficiently capture ground water flow in each of the four roadside waste rock pile drainages. The assumed pumping rates for the drainages are equivalent to the subwatershed mean annual yield estimates.

The conceptual design of the extraction well systems for the roadside waste rock pile drainages is described below. The actual pumping rates and number of wells will be determined during the remedial design.

- Lower Sulphur Gulch well (or wells if needed) will be approximately 100 feet deep with 50 feet of screen, and will pump at a rate of 110 gpm;
- Lower Sulphur Gulch West well will be approximately 100 feet deep with 50 feet of screen, but will pump at a rate of 10 gpm;
- Lower Middle Waste Rock Pile drainage well will be approximately 120 feet deep with 60 feet of screen, and will pump at a rate of 20 gpm;
- Lower Sugar Shack South Waste Rock Pile drainage well will be 130 feet deep with 70 feet of screen, and pump at a rate of 10 gpm;

The lower Sulphur Gulch well will be 8 inches in diameter; the other wells will be 6 inches in diameter. The extracted water will be pumped to an on-Site water treatment facility and treated.

A new ground water extraction well system will be installed in lower Goathill/Slick Line Gulch, located in lower Goathill Gulch near the head of the debris fan and in Slick Line Gulch between monitoring wells MMW-21 and MMW-48A. A conceptual layout of these extraction systems is shown on Figure 12-22. The purpose of the extraction wells is to capture mine-related ground water contamination within the drainages. For the conceptual design, EPA assumes that the wells in lower Goathill and Slick Line gulches will be screened from approximately 160 to 270 feet deep and 50 to 100 feet deep, respectively. The well screens will primarily intersect colluvium with the lower 10 feet of screen in the underlying bedrock. The well diameters will be 6 inches and the wells are assumed to produce 20 gpm. The extracted water will be pumped to an on-Site water treatment facility.

A new ground water extraction well system will be installed in lower Capulin Canyon to capture potential residual impacts from waste rock pile seepage that occurred before seepage collection was implemented in 1992. For the conceptual design, EPA assumes that one well will be approximately 70 feet deep with 20 feet of screen, and will pump at a rate of 50 gpm. The well casing diameter will be 6 inches. The extracted water will be pumped to an on-Site water treatment facility.

The conceptual total estimated flow of water to be collected and treated by these remedial systems is 220 gpm. The actual pumping rates and number of wells will be determined during remedial design.

Construct and Operate Water Treatment Plant at Year 0 Construction of the Remedial Action and Treat Water

Construction of a new water treatment plant at the mine site will begin at Year 0 Construction of the remedial action. Although an on-Site CERCLA response action does not require issuance of an NPDES permit for authorization to discharge to waters of the United States, due to the unique circumstances related to the on-going operations at the facility, EPA has decided to proceed with NPDES permitting for the water treatment plant effluent discharges to surface water. See Section 12.1.2 above. A pre-construction draft NPDES permit application will be developed in accordance with 40 C.F.R. Part 122. Once construction of the plant is completed and a final NPDES permit is issued by EPA, the water treatment plant will be operated to treat the water.

The conceptual total estimated flow of water to be collected by the remedial systems is approximately 1,070 gpm (Table 12-1). The estimated flow will be refined during remedial design. Of the 1,070 gpm of collected water, approximately 550 gpm will be treated at the water treatment plant. The other 520 gpm of estimated flow will be disposed in a manner to be determined by the NPDES regulatory authority if CMI is in compliance with NPDES Permit NM0022306. NPDES officials conducted a Site inspection the week of October 24, 2010 to assess CMI's compliance with the individual NPDES permit

(NM0022306) as well as the MSGP for storm water discharges. The results of that inspection are pending. If it is determined that CMI is not in compliance with Permit NM0022306 for disposal of the 520 gpm of contaminated water collected, CMI will be required to treat the 520 gpm of water as part of this CERCLA response action.

TABLE 12-1
CONCEPTUALIZED TOTAL ESTIMATED FLOWS FOR WATER TREATMENT

Remedial Component	Estimated Flow (gpm)
Mine Dewatering	250
NPDES BMP Ground Water Withdrawal Well System	420[1]
NPDES BMP Seepage Interception Systems at Springs 13 and 39	100[1]
Seepage Interception Systems at Base of Capulin and Goathill North Waste Rock Piles	80
Ground Water Extraction Well Systems in Lower Drainages	220
Total	1,070

[1] Method of water disposal to be determined by NPDES regulatory authority if CMI is in compliance with NPDES Permit NM0022306.

As stated in Section 12.1.2, the conceptual approach for water treatment is lime neutralization/chemical precipitation/HDS with secondary treatment (*i.e.,* reverse osmosis/ultrafiltration or other membrane/filtration technology) to achieve more stringent discharge limits, if required. The shakedown of primary and secondary treatment processes to be conducted as discussed in Section 12.1.2 may impact the conceptual approach. A conceptual process flow diagram for water treatment is depicted on Figure 12-23.

Conveyance of water (*i.e.,* pipelines, ditches, pumps, etc.) will be included with the water treatment and will use existing infrastructure. If the existing infrastructure is inadequate at the time water treatment begins, new or additional infrastructure will be required. A discharge point for the treated water has not been determined and will be evaluated during RD. The preliminary location for the treatment plant is at the mill.

The major equipment associated with the conceptual lime/neutralization/chemical precipitation/HDS treatment plant includes:

- Equalization basin
- Storage tanks
- Lime slurry system
- Lime reactor system
- Flocculent/polymer feed system
- Clarifier/thickener system
- Chemical feed system for pH adjustment
- Reverse osmosis
- Polishing systems
- Filter press system

Existing buildings and equipment may be used depending on the condition of the equipment at the time the treatment plant will be constructed. Sludge from the clarifier/ thickener bottoms will be pumped to a filter press for dewatering. A portion of the sludge will be recycled to the beginning of the treatment system, mixed with lime, and fed to the first reactor to assist in the chemical precipitation and formation of high density sludge. The sludge pumped to the filter press will be dewatered to an approximately 30 percent solids filter cake. The filter cake is expected to be nonhazardous and will be analyzed to ensure proper disposal.

An engineered repository will be constructed at the mine site for placement of water treatment residuals (sludge and filter cake). Suitable areas will be relatively flat, several acres in size, and accessible year round. Approximately 10 to 15 cells of approximately

7,500 yd^3 capacities will be needed. Maximum height of the downstream impoundment berms will be limited to less than 10 feet so that the cells are not considered jurisdictional dams under the Office of the State Engineer Rules and Regulations. Figure 12-24 shows a plan view of 10 sludge/filter cake cells. Figure 12-25 shows a typical cross section of cell.

The sludge and filter cake will be transported to the cells via dump trucks. The trucks will enter an active cell via an earth-fill access ramp. The cells will be lined with a geosynthetic liner overlain by a low density polyethylene geomembrane. Subgrade material will be well compacted sand, clay, and/or silt material. Cells that have reached design capacity will be covered. Storm water collection and diversion systems would be constructed to manage storm water run-on and run-off.

Water Level in Underground Mine will be Maintained at Elevation below Red River in Perpetuity

Dewatering of the underground mine will continue in perpetuity to maintain the mine water level below the Red River, thereby maintaining a hydraulic gradient in bedrock toward the mine. Currently, the underground mine is dewatered at a rate of approximately 250 gpm.

Temporary Well Drilling Restrictions will be Imposed by the New Mexico Office of the State Engineer

Temporary well drilling restrictions will be sought from the New Mexico Office of State Engineer to limit use of ground water at the mine site until ground water cleanup levels are attained. The restrictions will only apply to new requests for water well permits, not to existing water well permit holders.

Other government controls contemplated for the Selected Remedy after remedial construction is complete include local (village or county) ordinances, permits, and/or zoning to protect source control and water collection and treatment remedy components.

Provide Temporary Alternate Water Supply or Point-of-Use Treatment System until Attainment of Ground Water Cleanup Levels

Temporary actions will be taken to protect any persons using ground water as a drinking water supply in areas where Site-related contaminant levels in ground water exceed federal or New Mexico drinking water standards (MCLs) or EPA health-based criteria. Such action may be provision of an alternate water supply to the affected homes or businesses, or installation and maintenance of point-of-use treatment systems (*e.g.*, filter at tap) in the homes or businesses. The actions will continue until ground water cleanup levels have been attained. At this time, EPA is not aware of human exposure to ground water contamination above such standards or criteria at the Mine Site Area.

Continue Ground Water and Geotechnical Monitoring and General Site Maintenance

General maintenance of the mine site will be continued during operation and after closure. This will consist of grading of roads and maintenance of structures. Water quality monitoring for all wells, seeps, and springs in and along the mine site will also continue. Radionuclides (*e.g.*, uranium, thorium) will be added to the list of analytical parameters. Inclinometers installed at the waste rock piles will continue as part of the geotechnical monitoring of the rock piles.

Monitor Performance of Store and Release/Evapotranspiration Cover Systems to assess their Effectiveness at Reducing Infiltration to Levels that Allow Attainment of Ground Water Cleanup Levels

Performance monitoring will be conducted to assess if the store and release/evapotranspiration cover system has the capacity to limit net percolation by storing precipitation solely within the non-acid generating cover system for a period long enough for water to be removed by evaporation and transpiration and that any net percolation will not cause an exceedance of ground water standards.

A performance criterion will be developed during the remedial design phase for the store and release/evapotranspiration cover system to achieve the remedial action objectives for the Mine Site Area. This criterion will focus on reducing net percolation through the non-acid generating cover system to a level that would allow attainment of ground water remediation goals and be protective of ground water.

Monitor Plant Growth Performance to Asses if Molybdenum Uptake from Borrow Material to Plants Inhibit Vegetative Success or Poses Risk to Wildlife

Performance monitoring will be conducted to assess the success of plant growth on borrow material that will cover waste rock piles. Such monitoring will include measuring concentrations of molybdenum in plant tissue co-located with media samples (*e.g.,* soil, waste rock) to quantify oxide and sulfide species of molybdenum and degree of uptake by plants. Molybdenum uptake from borrow material to plants shall not be at levels such that inhibits attainment of revegetation success standards or exceeds risk-based concentrations for herbivorous native wildlife. Performance criteria will be developed using existing and new data from laboratory studies on plant uptake and toxicity using cover material as well as field monitoring results. The timeframe for developing the performance criteria is at the start of the remedial design and continuing through implementation and monitoring of the remedy. Examples of some parameters likely to require field monitoring on a 5-year basis include cover material molybdenum concentrations, plant molybdenum concentrations, and revegetation success.

Monitor Performance of Seepage Interception and Ground Water Extraction Well Systems to Assess Effectiveness at Achieving Ground Water Cleanup Levels

Performance monitoring will be conducted to assess the effectiveness of the seepage interception and ground water extraction well systems on attaining cleanup levels in alluvial, colluvial and bedrock ground water. Monitoring will include colluvial and bedrock ground water monitoring in all mine site tributary drainages. Monitoring will also include all seeps and springs in the Mine Site Area. The performance monitoring program will be developed during remedial design.

Perform Additional Molybdenum Characterization of Spring Gulch Waste Rock Pile to Assess Suitability as Borrow Material for Cover

Additional characterization will be performed on the spatial distribution, concentration and chemical form of molybdenum in the Spring Gulch Waste Rock Pile during the pre-design phase to verify the suitability of Spring Gulch waste rock as borrow material for cover.

12.2.3 Tailing Facility Area

The Selected Remedy includes the following alternative for the Tailing Facility Area:

- **Modified Alternative 3B** – Source containment by regrade, cover, and revegetation of tailing impoundments; upgrade seepage collection; piping of irrigation water in eastern diversion channel; continue ground water extraction with additional extraction southeast of Dam No. 1 (MW-4 and MW-17 Area); water treatment.

The major components of the response action are described in detail below.

Perform Ground Water Characterization in Bedrock Aquifer beneath and West of Tailing Impoundments, and in Bedrock and/or Alluvial Aquifer Downgradient of Dam No. 1

In light of the significant water loss known to be occurring at the tailing impoundments, additional ground water characterization will be performed in pre-design for the basal bedrock (volcanic) aquifer beneath and/or west of the western tailing impoundments, as well as in the volcanic aquifer and/or alluvial aquifer downgradient (south) of Dam No. 1, to evaluate the need for expanding the ground water component of the remedy. This additional characterization includes installing a well(s) to replace former temporary piezometer TPZ-5B and monitoring for radionuclides (*e.g.,* uranium, thorium). It may also include installation of other monitoring wells to fully characterize the deeper portion of the alluvial aquifer as well as other areas of the alluvial and/or volcanic aquifer if deemed necessary by EPA. If the characterization indicates concentrations above the remediation goal for molybdenum or other COCs, ground water extraction would be included to address these areas.

Cover and Revegetate Tailing Facility (and Remove Limited Soil at the Dry Maintenance Area at the Cessation of Tailing Deposition)

The tailing facility will be covered and revegetated for source containment. Consistent with conditions of the New Mexico Mining Permit TA001RE-96-1 and Ground Water Discharge Permit DP-933, as TBCs, a minimum 36-inch depth soil cover will be placed on the tailing facility, graded, and revegetated.[83] The cover type will be a store and release/evapotranspiration cover designed to reduce infiltration and percolation of water through the tailing material to ground water that would cause an exceedance of ground water quality standards. In limiting infiltration and percolation, the cover will also minimize oxidation and acid generation of the tailing. Tailing and water will no longer be placed at the tailing facility at closure; therefore, dewatering of the tailing will occur and seepage will decrease with time once the facility is covered.

A store and release/evapotranspiration cover system is an appropriate cover type for the climate conditions near Questa and the type of borrow materials that are locally available. It will also provide a condition that allows for the re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding areas, not conflicting with the MMD-approved post-mining land use.

[83] In November 2009, EPA approved a joint proposal by CMI and Chevron Technology Ventures for a concentrated photovoltaic (CPV) solar facility and cover depth pilot demonstration at the northeastern corner of the tailing facility. The pilot demonstration will be for a period of five years and include an evaluation of 1-, 2-, and 3-foot cover depths. In a joint letter with NMED and MMD, dated November 13, 2009, EPA agreed that if a 1-foot or 2-foot thick cover is demonstrated to be successful in the five-year pilot, the CERCLA remedy would be modified accordingly. A copy of the November 13, 2009 letter is included in Appendix C.

The estimated area to be covered is approximately 1,050 acres, which is shown on Figure 12-26. This will include the historic buried tailing adjacent to, but outside the current impoundments. The volume of cover material is estimated at 5.4 million yd^3. The source of the cover material will be the alluvial soils in the northern portion of the tailing facility. The alluvial soils from the northern tailing facility were used to construct the interim cover over the Dam No. 1 impoundment in the mid-1990s. The interim cover has revegetated since then and now supports several native species of vegetation similar to species outside of the tailing facility. The interim cover materials were not screened; therefore, screening of materials for the final cover is not necessary and simplifies construction and reduces costs. The vegetation is well established (*e.g.,* vegetation density, species constancy and uniformity).

The final cover will be revegetated with grasses and forbs and possibly woody shrubs. Revegetation will be designed to optimize the effectiveness of the cover to reduce infiltration and percolation through the underlying tailing to protect ground water, promote evapotranspiration from the cover system, and provide cover stability and protection from wind and water erosion. Revegetation will also be designed to screen out species that may take up metals at levels harmful to the plants as well as large herbivorous wildlife (e.g., deer and elk) that would graze on the plants. Species-specific evaluations will be performed during remedial design to assess the potential uptake and release of metals in vegetation through roots/soil interactions, organic material/live stems and leaf tissue, and fruit/seed pathways since containment of waste that would accumulate in living tissue and decomposing biomass may be an issue for several contaminants.

The likely procedure for placement of cover consists of several steps. The alluvial cover material will be excavated and hauled using scrapers. In trafficable areas, the scraper will be used to place the cover materials, which is the same method used for placing the interim cover. In areas where the tailing may be moist and would not support scraper traffic, scrapers will stockpile cover materials nearby, and dozers will be used to advance the material over the tailing.

Drainage of the cover will be accomplished by grading the final surface for positive drainage with slopes between 1 to 5 percent, in order to provide for long-term diversion of flow around and from the surface of the tailing impoundments. Run-off will be collected in ditches that direct the water to the large storm water diversion channels on the west and east sides of the tailing facility.

Although soil in the area outside the tailing impoundments does not require remediation based on protection of terrestrial ecological receptors, one location outside of the impoundment footprint with elevated molybdenum (above EPA's ecological soil remediation goal for molybdenum of 300 mg/kg) will be excavated and placed at the tailing facility prior to cover placement. This soil sample (TSS11-4) is located south of the Change House.

Contaminated soil will be removed initially to a depth of 2 feet. Confirmation soil sampling will be conducted to determine if cleanup levels have been obtained. If not, additional soil will be excavated until cleanup levels are met or an EPA acceptable depth has been reached. The extent of elevated molybdenum in soil at this location is considered to be small in comparison to the impoundment area to be covered. Assuming a 2-foot depth of excavation, the area of contaminated soil at this single location was estimated to be approximately 200 yd^3. The excavation will likely be accomplished using wheel-mounted front-end loaders. The excavated soil will be transported by truck to the tailing impoundments, placed, and graded prior to cover installation. Since there is no remedial action objective requiring a remediation goal to be achieved, no confirmation soil sampling will be conducted.

Replace the Lower 002 Seepage Barrier with Extraction Wells and Replace the Upper 003 Seepage Barrier with a Deeper Barrier; Treat Water

There are two seepage interception systems located at the tailing facility which have been operating since 1975. They currently collect approximately 550 gpm of water and seepage. The Outfall 002 seepage interception system is located south of Dam No. 1 and consists of a combination of shallow rock-filled drains, seepage barriers, and extraction wells. The Outfall 003 seepage interception system includes seepage barriers across the drainage on the eastern slope of Dam No. 4 and an extraction well, EW-1 (Figure 12-26). A detailed description of the Outfall 002 and Outfall 003 seepage interception systems is provided in Section 9.4.4, above.

These systems will be upgraded to reduce or eliminate seepage bypass. The upgrade to the Outfall 002 system includes installation of new ground water extraction wells across the Dam No. 1 arroyo just downgradient of the location of the existing lower 002 seepage barrier. The upgrade to the Outfall 003 system includes the replacement of the upper 003 seepage barrier with a new seepage barrier that extends approximately 30 feet below the existing barrier. Geotechnical data will be collected along the proposed barrier alignments to support design of the upgrade.

New extraction wells will be constructed at CMI's downgradient property boundary in the Dam No. 1 arroyo to reduce or eliminate off-site and downward migration of tailing seepage contaminants (primarily molybdenum and sulfate). It is estimated that four wells will be placed along a 250-foot wide transect across the Dam No. 1 arroyo, with each well pumping at 30 gpm. Each well will have a depth of approximately 100 feet, with a screened interval of 60 to 100 feet.

The new upper 003 seepage barrier is estimated to be 50-feet in length, and will be excavated to a depth of approximately 50 feet to collect seepage that may be migrating beneath the existing barrier. The barrier will be approximately 10 feet wide with a nominal 10-inch diameter perforated drain pipe in the bottom. The drain will be connected to the existing pipeline and the water will flow via gravity to the Outfall 002 manhole. The upgraded seepage barrier is estimated to produce 180 gpm, an increase of 120 gpm compared to the existing 003 seepage barrier. It is estimated that the existing and upgraded systems combined will produce 790 gpm of seepage and impacted ground water (Table 9-14).

Approximately 400 gpm of water is currently discharged to the Red River via Outfall 002 under the NPDES Best Management Practices. The disposal method for this 400 gpm of water will be determined by the EPA NPDES Program. The remaining 390 gpm of estimated water flow will be piped to the water treatment plant and treated as part of the CERCLA response action.

Pipe Unused Irrigation Water in the Eastern Diversion Channel to Prevent Infiltration through Historic Buried Tailing

Infiltration and water contact with the historic buried tailing northwest of the Change House will be reduced by constructing piping in the eastern diversion channel. Water in the diversion channel will be directed into the pipe and discharged south near Dam No. 1, thereby by-passing the area of historic buried tailing.

A concrete dam will be constructed in the bottom the diversion channel to prevent unused irrigation water from continuing to flow in the channel. The dam will extend across the channel and will be keyed into the bottom of the channel. The height of the dam will be approximately 1 foot above the channel bottom and the low height will not interfere with the channel's ability to convey storm water as originally designed. The dam will be constructed with a notch in the center where the pipe will be connected. Water behind the dam will enter the pipe and be conveyed approximately 6,000 feet past the historic buried tailing and discharged near Dam No. 1.

Install and Operate Ground Water Extraction Well System in Alluvial Aquifer Southeast of Dam No. 1 and Downgradient of Historic Buried Tailing; Treat Water

Ground water extraction will be performed southeast of Dam No. 1 to capture contamination in the alluvial aquifer. It is assumed that five extraction wells will be installed in the area of monitoring wells MW-4 and MW-17 along an east-west line, approximately 240 feet apart, to create a continuous zone of ground water capture over the 1,200 feet of potentially affected aquifer. For conceptual-level design, each well is assumed to be pumped at 10 gpm for a total extraction rate of 50 gpm. The depth to the water table in MW-17 ranges from 130 to 150 feet; therefore, the extraction wells will be installed to a depth of approximately 200 feet with 60-foot screens to extract ground water from the upper 60 feet of the alluvial aquifer. Boreholes for each well will be drilled 10 to 12 inches in diameter to accommodate 6-inch-diameter casings and screens, with 4-inch-diameter submersible pumps.

Source containment is included through the use of piping to bypass the unused irrigation water in the diversion channel, which addresses the source of infiltration that reaches the historic buried tailing.

Refurbish Existing Ion Exchange Plant and/or Construct New Water Treatment Plant at Year 0 Construction of the Remedial Action and Operate to Treat Water

Water treatment will be performed at the tailing facility as described in Section 12.1.2, above. The estimated total flow of water from the upgraded seepage collection systems (seepage barriers and extraction wells) and the five additional extraction wells to be located in the area of MW-4 and MW-17) will be 840 gpm, of which 400 gpm will be discharged to the Red River through the Outfall 002 (Table 9-14) as authorized under the NPDES permitting program. Following collection, the remaining water (approximately 440 gpm) will be treated at the existing ion exchange treatment plant and/or new treatment plant located south of Dam No. 4 and discharged via an NPDES-permitted outfall, rather than being pumped back to Dam No. 5A.

Piping associated with conveyance of water from the various collection and extraction systems at the tailing facility is included with this remedial component. Influent water to the treatment plant will include water collected from the Outfall 002 and Outfall 003 seepage barriers and extraction wells, which is currently pumped back to Dam No. 5, to capture tailing seepage from Dam No. 1 and Dam No. 4 impoundments.

Construction of a water treatment plant at the tailing facility will begin at the start of the remedial action (*i.e.,* Year 0 Construction). Once construction is complete, the water treatment plant will be tested and operated as specified in Section 12.1.2, above. NPDES authorization for discharging treated effluent will be required and a pre-construction draft NPDES permit application will be prepared. The existing ion exchange treatment plant is located south of Dam No. 4 and will be used for treatment of extracted ground water. A new treatment facility will also be constructed if necessary. Modifications may be necessary if contaminants in ground water, in addition to molybdenum, require removal (*e.g.,* uranium). Reverse osmosis will be included for additional treatment if needed. The extracted ground water will be adjusted to a low pH (3.5 to 4.0) using acid reagents. The water will then flow into the ion exchange column and move up-flow through four stages, subsequently overflowing through a resin trap and into a tank. Overflow from the tank will flow to a baffled launder where powdered lime will be added by one or two screw feeders connected to the lime storage silo to control the pH of the water to between pH 6.0 to 9.0 prior to it being discharged. A conceptual process flow diagram for water treatment at the tailing facility is depicted on Figure 12-27.

When the resin in the first stage of the column becomes loaded with molybdenum, the resin will require regeneration using a sodium hydroxide solution. The regenerated solution will require treatment prior to discharge. Precipitation using calcium chloride or evaporation may be needed. Conveyance of water (*i.e.,* pipelines, ditches, pumps, etc.) will be included with the water treatment and use existing infrastructure. If the existing infrastructure is not adequate at the time water treatment begins, EPA will require new or additional infrastructure. A discharge point for the treated water has not been determined and will be evaluated during the remedial design phase.

Either an evaporator will be installed in conjunction with the water treatment system or an evaporation pond constructed at the tailing facility for treatment of the reverse osmosis reject, if required. Suitable areas will be relatively flat, a few acres in size, and accessible year round. If a solid residual is generated during the treatment process, it will be disposed of at an appropriate location. Cover placement and limited excavation near the dry/maintenance area south of the Change House will be performed.

Temporary Well Drilling Restrictions will be Imposed by the New Mexico Office of the State Engineer

Temporary well drilling restrictions will be sought from the New Mexico Office of the State Engineer to limit use of ground water at the Tailing Facility Area until ground water cleanup levels are attained. The restriction will only apply to new requests for water well permits, not to existing water well permit holders.

Other government controls contemplated for the Selected Remedy after remedial construction is complete include local (village or county) ordinances, permits, and/or zoning to protect source control and water collection and treatment remedy components.

Provide Temporary Alternate Water Supply or Point-of-Use Treatment System until Attainment of Ground Water Cleanup Levels

Temporary actions will be taken to protect any persons using ground water as a drinking water supply in areas where Site-related contaminant levels in ground water exceed federal or New Mexico drinking water standards (MCLs) or EPA health-based criteria. Such action may be provision of an alternate water supply to the affected homes or businesses, or installation and maintenance of point-of-use treatment systems (*e.g.,* filter at tap) in the homes or businesses. The actions will continue until ground water cleanup levels have been attained.

At this time, EPA is not aware of human exposure to ground water contamination above such standards or criteria. The residences south of Dam No. 1, in the area of ground water contamination, are connected to the Village of Questa municipal water supply system. Molybdenum concentrations in ground water at the Red River State Fish Hatchery are just below the EPA health-based criterion of 0.08 mg/L for molybdenum. However, the trend in molybdenum concentrations over time has been increasing. If concentrations of molybdenum or other COCs increase to levels which exceed the health-based criterion, an alternate water supply will be provided, or a point-of-use treatment system will be installed, at the hatchery until ground water cleanup levels are attained. Currently, at the request of hatchery personnel, CMI provides bottled water to the facility.

Control Access to the Site, including use of an Exclusion Fence to Restrict Access by Deer and Elk; Provide Wildlife Drinkers

Access to the tailing facility will be controlled by fencing and signage for the remaining operating life of the facility to protect the public and wildlife. Limited fencing and restrictive entry to the tailing facility are currently in place to control access. However, the current three-wire barbwire fence surrounding the tailing facility is not effective in restricting access by deer and elk. Therefore, an exclusion fence (high fence) will be installed around the perimeter of the tailing facility to prevent deer and elk from gaining access to the tailing impoundments prior to closure of the facility and placement of final cover. The height of the fence will be determined during remedial design, but will be anywhere from 8 feet to 10 feet, as determined by EPA. The fence will also have one-way gates at intervals around its perimeter to allow animals to get out should they become trapped within the fenced area.

In combination with the exclusion fence, wildlife drinkers will be constructed along the western perimeter of the tailing facility on the eastern flank of the Guadalupe Mountains to replace the water supply (tailing ponds) that will be unavailable to the herds. The source of the wildlife drinking water will be supplied by precipitation capture, and the catchments will be sized to provide water continuously through drought conditions. EPA estimates a total of four drinkers will be constructed. However, the actual number of drinking facilities, as well as the design specifications, will be determined during remedial design based on field conditions and as approved by EPA, in consultation with the New Mexico Department of Game and Fish. In addition to being a water supply to the deer and elk, these drinkers may help control animal movements in terms of keeping them from moving around the fence to undesired or unanticipated locations (crop fields and highways).

Continue Tailing Dust Control Measures

CMI uses several different operational methods to control dust at the tailing facility. Tailing is deposited into small cells of approximately 100 acres in size and a water cover is used to the extent practicable. In addition, soil binders (*i.e.*, emulsion/tackifiers), soil cover, and straw mulch are used in areas where water cover cannot be maintained. Snow fencing is also used to disrupt the wind currents and reduce windblown dust. These dust control measures will continue for the remaining operating life of the facility.

Perform Air Monitoring

Air monitoring will be performed at the tailing facility. Currently, CMI conducts a voluntary air monitoring program (PM_{10} monitoring) at six air monitoring stations located along the perimeter of the CMI property boundary. This ongoing monitoring program will be reassessed and modified during the remedial design and incorporated into the remedy. Air monitoring will include PM_{10} and $PM_{2.5}$ monitoring, as well as chemical monitoring if deemed appropriate by EPA. Air monitoring stations will include those that are currently operated and any additional air monitoring stations to be located along the perimeter of the tailing facility and/or beyond the perimeter of the facility as required by EPA. A contingency plan for dust suppression will be developed and implemented in the event of mining-related exceedances of ambient air quality standards beyond the property boundary that threaten human health.

Monitor Water Quality at Red River State Fish Hatchery

NMED is monitoring water quality at the Red River State Fish Hatchery residential taps or other structures. A monitoring program will be implemented during the remedial action. It will be developed during the remedial design and shall include, at a minimum, analysis of molybdenum, sulfate, uranium, and other COCs.

Monitor Remedy Performance to Assess Effectiveness in Achieving Ground Water Cleanup Levels Southeast and Downgradient of Dam No. 1

Performance monitoring will be conducted downgradient of the historic tailing spill area (southeast of Dam No. 1) to assess the effectiveness that piping of irrigation water in the eastern diversion channel has on reducing COC concentrations in ground water to cleanup levels in the area of monitoring wells MW-4 and MW-17. The performance monitoring program will be developed during remedial design.

Monitor Remedy Performance to Assess Effectiveness in Achieving Ground Water Cleanup Levels Downgradient of Dam No. 4 and Dam No. 1 in the Alluvial and Bedrock Aquifers

Performance monitoring will be conducted downgradient (south and west) of Dam No. 4 and (south) Dam No. 1 to assess the effectiveness of the remedial actions on reducing COC concentrations in ground water to cleanup levels in the alluvial and basal bedrock aquifers. Monitoring will include all seeps and springs in these areas. The performance monitoring program will be developed during remedial design.

Monitor Performance of Store and Release/Evapotranspiration Cover System to Assess Effectiveness in Reducing Infiltration to Levels that allow Dewatering of Tailing Piles and Attainment of Ground Water Cleanup Levels

Performance monitoring will be conducted to assess if the store and release/ evapotranspiration cover system has the capacity to limit net percolation by storing precipitation solely within the non-acid generating cover system for a period long enough for water to be removed by evaporation and transpiration and that any net percolation will not cause an exceedance of ground water standards.

A performance criterion will be developed during the remedial design phase for the store and release/evapotranspiration cover system to achieve the remedial action objectives for the Tailing Facility Area. This criterion will focus on reducing net percolation through the non-acid generating cover system to a level that would allow attainment of ground water remediation goals and be protective of ground water.

Monitor Metals Uptake in Plant Tissue

Monitoring will be conducted to quantify and qualify metals uptake (including molybdenum uptake) by plants growing on the cover material at the tailing facility. Such monitoring will include measuring concentrations of metals in plant tissue co-located with media samples (*e.g.,* soil, tailing). Such monitoring will be performed at least once every five years for evaluation as part of the CERCLA five-year review. Metals uptake to plants shall not be at levels such that inhibits attainment of revegetation success standards, inhibit the success of the store and release/evapotranspiration cover, or exceeds risk-based concentrations for herbivorous native wildlife. Examples of some parameters likely to require field monitoring on a five-year basis include cover material molybdenum concentrations, plant molybdenum concentrations, and revegetation success.

Monitor Tailing Piles to Provide Early Detection of Acid Generation and Metals Leaching

An early detection monitoring program will be performed within and at the margins of the tailing piles to provide early detection of any potential acid generation and metal leaching. These monitoring programs will be developed during the remedial design.

Perform Monitoring and Maintenance of Tailing Dams

The collection of quarterly piezometer data and performance of annual inspections of the tailing facility dams to meet requirements of the New Mexico Office of the State Engineer will be part of the Selected Remedy until it is demonstrated that the tailing dams have been dewatered.

Continue Ground Water Monitoring and General Site Maintenance

Ground water monitoring and general site maintenance will continue. However, the monitoring program will be reassessed during the remedial design and modified if required by EPA. The ground water monitoring program will, at a minimum, be consistent with the monitoring requirements of Ground Water Discharge Permit DP-933 and include all wells at the Tailing Facility Area. The ground water monitoring program may include additional monitoring wells if deemed appropriate by EPA. Seeps and springs will also be monitored. Radionuclides (*e.g.,* uranium, thorium) will be added to the list of analytical parameters to be monitored. General maintenance of the tailing facility will be continued during operation and after closure. This will consist of grading of roads and maintenance of structures, including the dams, as appropriate.

12.2.4 Red River and Riparian and South of Tailing Facility Area

The Selected Remedy includes the following alternative for the Red River, Riparian, and South of Tailing Facility Area:

- **Subalternative 3B** – Removal of Soil and Tailing Spill Deposits and On-Site Disposal

The major components of the response action are described in detail below. Response actions to address contamination in the Red River are being conducted as part of the Mine Site Area component of the Selected Remedy.

Excavate Soil Contaminated with Molybdenum South of Tailing Facility and Tailing Spill Deposits along the Red River Riparian Corridor, including Large Tailing Pile at Lower Dump Sump

Tailing spill deposits will be excavated to a depth where tailing is no longer visible. The estimated total area containing tailing spill deposits is approximately 3 acres. The volume of tailing spill deposits requiring excavation is estimated to be 3,800 yd^3, the majority of which is located at the Lower Dump Sump. For the smaller individual tailing deposit locations, excavation will be conducted by hand (*i.e.,* using a shovel). For larger areas, excavation will include the use of a frontend loader. Due to the location of the tailing deposits along the Red River riparian corridor, site-to-site relocation (*i.e.,* mobilization and demobilization) may be required in order to move and setup between deposit locations.

For the area south of the tailing facility, approximately 8 acres will be excavated and backfilled with clean alluvial soil. The area requiring excavation is depicted on Figure 12-29. Contaminated soil will be removed initially to a depth of approximately 2 feet. Confirmation soil sampling will be conducted to determine if cleanup levels have been attained. If not, additional soil will be excavated until cleanup levels are met or an EPA acceptable depth has been reached. Based on an excavation depth of 2 feet, the estimated volume of soil requiring excavation is approximately 26,000 yd^3.

Administrative coordination with private landowners will be performed to obtain the necessary access approvals for the area south of the tailing facility, and with federal land management agencies (*e.g.,* U.S. Forest Service) and land owners along the riparian corridor. Coordination will also be performed with the New Mexico Department of Game and Fish during design and construction to establish and implement best management practices for ensuring minimal physical damage or destruction of native riparian vegetation by dewatering and soil removal activities.

Dewater Soil in Area South of the Tailing Facility and Stabilize Excavated Soil

Removal of contaminated soil will require site preparation prior to construction because of the shallow water table and boggy nature of the area. The area may have to be dewatered using shallow trenches.

Due to the wet nature of the excavated soil, dewatering will be performed. Excavation may be performed with a dragline and soil stockpiled in a temporary bermed area lined with a geosynthetic liner and allowed to dewater. Soil stabilizers may be added to the excavated material to aid in handling, loading, and transport.

Transport and Dispose Excavated Soil and Tailing at the Tailing Facility

The excavated and dewatered soil/tailing will be transported and placed in an impoundment at the tailing facility. On-site disposal at the tailing facility must occur prior to cover placement at the facility.

Backfill Excavation with Alluvial Soil

The source of fill material is the alluvial borrow area in the northern portion of the tailing facility. The alluvial fill will be appropriately screened prior to transport to the area south of the tailing facility where it will be placed and revegetated.

The tailing spill excavations will also be backfilled with clean alluvial soil and revegetated, if needed.

Any woody riparian vegetation that is removed or damaged during construction activities will be replaced at a ratio that will restore the native riparian area to pre-impacted and pre-construction conditions.

Perform Physical, Chemical and Biological Monitoring of Red River to Assess Effectiveness of Response Actions at Mine Site Area on Improving Red River Surface Water Quality and Protecting Aquatic Life

The physical, chemical and biological characteristics of the Red River will be monitored periodically (at least once every five years) to assess the effectiveness of response actions to be performed at the Mine Site Area on improving Red River surface water quality and protecting aquatic life.

12.2.5 Eagle Rock Lake

The Selected Remedy includes the following alternative for Eagle Rock Lake:

- **Subalternative 3B** – Inlet Storm Water Controls; Dredge Sediment and On-Site Disposal

The major components of the response action are described in detail below. Coordination will be performed with the U.S. Forest Service and New Mexico Department of Game and Fish on all remedial design and construction activities for Eagle Rock Lake. . In light of the ongoing plans to re-construct the dam at Cabresto Lake, also located within the Questa Ranger District, the remedial actions at Eagle Rock Lake will be timed and coordinated with the Ranger District, if at all possible, such that one of the lakes remains available to the public for recreational use. These two lakes provide the only flat water fishing opportunities easily accessible to local residents and visitors alike.

Install Inlet Controls to Manage Storm Water Entering the Lake

Inlet controls will be installed to manage storm water entering the lake. Engineering controls will be included on the inlet structure to the lake to reduce the sediment load from entering the lake during storm events or other high-flow conditions that entrain sediment in the river. Flows into Eagle Rock Lake range from approximately 100 to 400 gpm. Storm events generate a considerable sediment load in the river that originates from drainages upstream of the mine site, and controls on the inlet will be designed to close the headgate if the sediment load increases. Closing the headgate will be accomplished through the use of specific conductance and turbidity probes that monitor the river water and close the headgate if prescribed values are exceeded.

The source of water for the lake is a headgate that diverts water from Red River. The headgate is located approximately 300 feet east (upstream) of the lake inlet (Figure 12-30). The headgate consists of a 24-inch-diameter slide gate that is manually operated. The headgate is fastened to a concrete diversion structure on the north side of the river. The existing headgate will be replaced with a new slide gate with an electronic actuator and motor to operate the gate. The electronic actuator operates on 110 volts. The nearest electrical power source is a light pole that is approximately 600 feet west of the headgate. If this power source is utilized, an electrical cable will likely be installed from the light pole to the headgate and connected to the motor through an aboveground electrical control box.

Specific conductance and turbidity probes will be installed in a stilling well near the headgate to continuously monitor the river water. If values that are indicative of high sediment load in the river are reached, the headgate will be activated and closed to prevent the sediment-laden water from entering the lake.

Specific conductance values of the river near Eagle Rock Lake generally range from 200 to 300 microSiemens per centimeter (µS/cm). Sampling of the river during storms reveals that the specific conductance can increase from 400 µS/cm to as much as 700 µS/cm. The turbidity of the river water is another measure of the sediment load that will be used in combination with the specific conductance. Review of the historical turbidity values of the river near the lake shows that the turbidity generally ranges from 5 to 20 nephelometric turbidity units (NTUs) during typical low-flow conditions. The turbidity of the river water during storm events was measured to be as high as 300 NTU. Based on the available measurements, a specific conductance greater than 400 µS/cm and/or turbidity greater than 30 NTU are indicative of high sediment load in the river and are selected as preliminary "trigger" values to activate and close the headgate to prevent sediment-laden water from entering the lake. Final trigger values will be determined in the remedial design phase.

Dredge and Dewater Sediment

Dredging and dewatering of lake-bottom sediment will be performed. Two types of dredging are available: (1) hydraulic dredging from a barge, or (2) drainage of the lake to allow the sediments to dewater, followed by excavation of the sediment. Hydraulic dredging is selected because it will have less impact to the lake and recreational use of the lake. Additionally, this type of dredging will be quicker than draining and excavating sediment, since the sediment may take several months to naturally dry to a point where it can be excavated.

Hydraulic dredging to remove the sediment will be performed from a barge. The depth of sediment dredging will be approximately three feet. The sediment will be pumped to a staging area near the lake. The staging area will need to be of sufficient size to temporarily impound the dredged sediment. A temporary berm will be constructed around the staging area to contain the sediment. The sediment will then be mechanically dewatered by a hopper in the staging area to facilitate drying. Excess water will be temporarily impounded then allowed to flow back into the lake. Sediment will be allowed to dry in the staging area until an appropriate moisture is reached that will allow for haulage and disposal.

Coordination will be performed with the New Mexico Department of Game and Fish and the Red River State Fish Hatchery prior to the start of dredging activities for possible fish salvage and/or opportunities for potential enhancements to fish habitat.

Transport and Dispose Excavated Sediment at an Appropriate On-Site Facility

Once dewatered, the dredged sediment will be transported to and disposed of in an appropriate on-Site facility. Approximately 15,000 yd^3 of dewatered sediment, based on a 3-foot depth of dredging over the 3-acre lake, will be disposed. Cells similar to the ones to be constructed at the mine site for the water treatment plant filter cake and sludge will be used to contain this sediment. It is estimated that each cell would contain approximately 7,500 yd^3. Therefore, two cells would be needed for the sediment.

Perform Physical, Chemical and Biological Monitoring to Assess Long-Term Effectiveness of Eagle Rock Lake Remediation

Physical, chemical and biological monitoring will be performed to assess the long-term effectiveness of the sediment remediation and inlet storm water controls at Eagle Rock Lake to reduce levels of contamination in lake sediment and protect the benthic macroinvertebrate population. Monitoring will include macroinvertebrate diversity and abundance. It will also include monitoring the continuing performance and integrity of the inlet storm water controls in preventing contamination from entering the lake during storm and other high-flow events.

12.2.6 Community Protective Measures

A Community Protective Measures Plan will be developed and implemented as part of the Selected Remedy. These measures may include providing community health information, or responding to concerns raised by local residents or business owners. They may also include sampling private water wells at the request of a resident. Although EPA has no evidence to suggest that medical monitoring is needed for the Questa community, it may be appropriate to perform some form of medical surveillance or monitoring during construction of the remedy, especially given the length of time estimated for completion of construction activities (25-28 years).

EPA believes medical surveillance is the jurisdiction of the State of New Mexico and, therefore, will discuss such a program with the New Mexico Department of Health's Regional Public Health Office in Taos and Environmental Health Epidemiology Bureau during remedial design about conducting or overseeing medical monitoring for the Questa community. EPA will also seek the Agency for Toxic Substances and Disease Registry (ATSDR) involvement and support in any state-led monitoring program for Questa. These federal and state agencies have the necessary expertise and resources to perform such activities.

12.2.7 Green Remediation Strategy

Consistent with EPA's 2010 Superfund Green Remediation Strategy and EPA Region 6's 2009 Clean and Green Policy, the Selected Remedy will be implemented in a manner that promotes green remediation efforts and reduces the environmental footprint of the cleanup to the maximum extent possible, while adhering to NCP requirements and related statutes. Green remediation practices will be developed during remedial design and updated throughout the performance of the Selected Remedy to ensure that green remediation technologies and practices are considered and implemented where practicable and available. The Selected Remedy will be designed and constructed to conserve natural resources, minimize waste generation and reduce energy consumption to the maximum extent possible. Green house gases and air emissions from activities such as operation of heavy machinery and transportation of routine vehicles and haul trucks will be reduced by applying the most appropriate advanced technologies and sound field practices. This may include selection of fuel efficient and alternative vehicles, diesel vehicle emission controls such as engine exhaust filters, engine idle reduction plans, and use of truck staging areas. It may also include the use of biodiesel to power heavy field equipment, instead of conventional diesel that emits a mixture of air pollutants. Minimizing diesel emissions reduces the risk to residents and workers in the vicinity of the cleanup area.

Green remediation strategies developed at the Site will also focus on the use of renewable sources of energy as one way to reduce greenhouse gas emissions and fossil fuel energy consumption in Site operations. Water treatment plants will have to be operated at the mine site and tailing facility for decades; the mine site water treatment plant to be operated possibly in perpetuity. In light of the renewable energy project (1-megawatt concentrated photovoltaic solar facility) being constructed at the tailing facility by Chevron Technology Ventures as a 5-year pilot demonstration, EPA will encourage CMI to use such renewable energy to power its water treatment plant if successful. CMI has also indicated an interest in exploring potential renewable energy options at the mine site, which may be used to operate the water treatment facility at the mine site. Other options that may be explored include securing energy from other renewable resources such as green power purchases from electric service providers or purchase of renewable energy certificates. EPA will seek to maximize use of renewable energy in implementing the Selected Remedy, with a goal of using 100 percent of renewable energy to power Site operations. However, such goal will not take priority over meeting established cleanup goals and objectives.

Green remediation strategies may also focus on actions that minimize further harm to the area, protect land resources or ecosystems at or near the Site, minimize impacts to water quality and water resources, and foster the return of areas to ecological, economic, social, or other uses. Site remediation may use significant amounts of raw materials and sometimes generates its own hazardous and non-hazardous wastes, including debris and materials that often are shipped off-Site. Green remediation strategies may include ways to reduce materials consumption and waste generation, use recycled and local materials and spent products, and purchase environmentally preferred products.

12.3 Summary of Estimated Remedy Costs

A summary of the estimated costs for each of the five areas being addressed by the Selected Remedy as well as the estimated total cost of the Selected Remedy is presented in Table 12-2, below. Detailed cost-estimate summaries for each of the five areas and water treatment at the mine site and tailing facility are provided in Tables 12-3 to 12-9. The cost estimate summary tables for water treatment reflect cost estimates for starting at Year 0 Construction.

The information in the cost estimate summary tables is based on the best available information regarding the anticipated scope of the remedial alternatives and subalternatives chosen as part of the Selected Remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during any additional pre-design characterization of ground water, pilot or treatability studies, or the engineering design of the Selected Remedy. Major changes may be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Difference, or a ROD amendment. These cost estimates are order-of-magnitude engineering cost estimates that are expected to be within +50 to -30 percent of the actual project costs.

12.3.1 Cost Elements

Cost elements are associated with capital (construction), operation and maintenance (O&M) costs, and periodic costs. The cost assumptions for construction of the remedial action are that all capital costs are assumed to occur in Year 0 (base year 2008), with a few exceptions. Earthwork activities associated with the waste rock piles for the Mine Site Area alternatives are assumed to take place in phases over multiple years. Earthwork activities associated with covering the tailing impoundments for the Tailing Facility Area alternatives are also assumed to take place in phases over a 6-year timeframe (Year 0 to

Year 5). Water treatment includes construction of a water treatment plant and repository in Year 0, Year 10, Year 20, and Year 30. O&M costs are estimated mostly on an annual basis. O&M costs occur over the entire period of analysis and are identified for both the remedial action and long-term O&M phases.

TABLE 12-2
COST ESTIMATE SUMMARY FOR SELECTED REMEDY

Preferred Alternative Description	Cost in Current Dollars ($)			Present Value Cost ($)
	Capital	O&M	Total	
Mill Area – Alternative 3	2,176,000	923,000	3,099,000	2,549,000
Mine Site Area – Subalternatives 3A and 3B	600,351,000 to 231,448,000	68,772,000 to 71,720,000	669,123,000 to 303,168,000	309,982,000 to 114,421,000
Mine Site Area – Water Treatment (Year 0 Construction)	20,263,000	41,063,000	61,326,000	34,541,000
Tailing Facility Area – Modified Subalternative 3B[1]	29,649,000	18,547,000	48,196,000	33,758,000
Tailing Facility Area – Water Treatment (Year 0 Construction)	22,076,000	73,027,000	95,103,000	51,989,000
Red River, Riparian, South of Tailing Facility Area – Subalternative 3B	3,442,000	412,000	3,854,000	3,591,000
Eagle Rock Lake – Subalternative 3B	1,352,000	504,000	1,856,000	1,538,000
Total Cost	679,309,000 to 310,406,000	203,248,000 to 206,196,000	882,557,000 to 516,602,000	437,948,000 to 242,387,000

1. Cost Estimate includes $606,000 (construction cost) for ground water extraction southeast of Dam No. 1 (from Alternative 4) and $629,000 for the exclusion fence around perimeter of tailing facility and drinkers for wildlife.

12.3.2 Present Worth Analysis

A present worth, or present value, analysis is a method used to evaluate expenditures that occur over different time periods. This standard methodology allows for a cost comparison of different remedial alternatives, which may have capital and O&M costs that are incurred in different time periods, on the basis of a single cost figure for each alternative.

Only capital costs that occur in future years (*i.e.,* after Year 0) are subject to a net present value analysis. All other capital costs do not include a net present value analysis. Future costs involving construction related to replacing remedy components (*e.g.,* new water treatment plant) are considered to be periodic costs that are subject to a net present value analysis and sensitive to the discount rate, as are O&M costs.

12.3.3 Period of Analysis

Generally, a 30-year period of analysis was used to calculate a present value for each alternative, although several alternatives used a shorter period. The Mine Site Area period of analysis was extended to cover the duration of rock pile earthmoving activities (*e.g.,* 28 years) plus 30 years O&M, totaling 58 years. Because the water treatment components have the potential to incur multiple high replacement costs in the future, a 100-year period of analysis was initially performed in addition to the 30-year period of analysis in the FS. The results of the 100-year period of analysis showed that adding additional O&M (including periodic replacement of the water treatment system every 30 years) resulted in a negligible increase of approximately 5 percent of the 30-year period of analysis. Therefore, only a 30-year period of analysis is estimated for O&M.

12.3.4 Discount Rate

A real discount rate was applied to expenditures that occur beyond the base year (2008) over the period of analysis. The real discount rate consists of the difference between the rate of inflation and the nominal discount rate. All costs for the alternatives during the period of analysis are related to a common base year, which allows the cost of final remedial action to be compared on the basis of a single figure representing the amount of money that, if invested in the base year, should be sufficient to cover the costs associated with the remedial action over its planned life. The only exception to this is with the Site-wide water treatment alternative, which is a component of an alternative and is not used for comparison of cost to other alternatives. Based on the NCP and EPA Guidance (USEPA 2000a), a real discount rate of 7 percent was used in developing the present worth (present value) cost estimates for the remedial alternatives.

12.4 Expected Outcomes of the Selected Remedy

The expected outcomes of the Selected Remedy in terms of resulting land and ground water uses, the cleanup levels and the risk reduction achieved as a result of the response action, and the anticipated community impacts are discussed below for each of the five areas.

12.4.1 Mill Area

The Mill Area is expected to continue as an operating milling facility for an indefinite period of time. After milling operations cease, the reasonably anticipated future land use is primarily low-occupancy industrial and commercial use. Currently, and until the PCB cleanup is complete, workers are protected through worker health and safety and communication hazard programs, which are monitored and enforced by MSHA. The recreational visitor/trespasser is protected by continuing access restrictions both during and after milling.

The estimated time for cleanup is 1.5 years. The results of the HHRA indicate that existing conditions at the Mill Area pose an excess lifetime cancer risk of 2×10^{-4} from incidental ingestion, dermal contact, and inhalation due primarily from exposure to PCBs. The final cleanup level for PCBs at the Mill Area is depicted on Table 12-10. In removal and off-

Site treatment and disposal of high concentrations (greater than or equal to 25 mg/kg) of PCBs, the Selected Remedy will reduce risk to the future commercial or industrial worker to an approximate 1 x 10^{-5} excess cancer risk level.

Although the EPA BERA did not include the Mill Area because of a lack of habitat for terrestrial receptors, a remediation goal of 300 mg/kg for molybdenum in soil was developed for the Mine Site Area based on site-specific toxicity testing to protect herbivorous wildlife and plants. Since concentrations of molybdenum in soil at the Mill Area exceed the remediation goal of 300 mg/kg, the Selected Remedy is expected to protect herbivorous wildlife and plants from exposure to molybdenum in soil (through uptake of molybdenum in plants) for those portions of the Mill with a post-mining land use designation of forestry. The forestry-designated areas will be covered by a 36-inch thick cover of amended Spring Gulch waste rock and vegetated.

12.4.2 Mine Site Area

The mine site is expected to continue as an operating mining facility for an indefinite period of time. After the termination of mining, long-term management of mining waste will be performed through the use of engineering controls. Perpetual mine dewatering and treatment will also be performed. EPA expects that certain areas of the mine site will be used for light industry after mining and the remaining portion of the mine site has an MMD-approved post-mining land use of forestry.

EPA expects the Selected Remedy to reduce the risk to current and future recreational visitors or trespassers by remediation of contaminated surface water (mine site catchments and seeps and springs from waste rock piles and along the Red River). The results of the HHRA indicate that surface water at mine site catchments and seeps and springs poses a risk to recreational visitors/trespassers from incidental ingestion and dermal contact. Total non-cancer health hazards (HIs) ranging from 4 to 53 exceed EPA's target HI of 1, primarily from exposure to beryllium (1), cadmium (2), and manganese (50). Final cleanup levels for these human health chemicals of concern (COCs) in Mine Site Area surface water are summarized in Table 12-11. The implementation of seepage collection systems and piping of seepage to the mill for treatment will reduce exposure to these COCs.

EPA expects the Selected Remedy to reduce the human health risk from exposure to contaminated ground water through source containment, seepage collection and ground water extraction and treatment. The results of the HHRA indicate that conditions at the mine site pose an excess lifetime cancer risk ranging up to 4×10^{-3} for future residents and 2×10^{-3} for on-site commercial and industrial workers from ingestion of contaminated ground water drawn from rural domestic wells or industrial wells. These risks exceed EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6} as well as NMED's target risk level of 1×10^{-5}. They are exclusively from exposure to arsenic, which appears to be related to high natural background levels for the alluvial aquifer, but also to mining activities for colluvial and bedrock ground water. The HHRA results also indicate that ground water used for drinking poses non-cancer health hazards, with Hazard Indices (HIs) ranging up to 1,474 for future residents and 324 for on-site commercial or industrial workers, depending on the target organ. HIs exceed EPA's target HI of 1 and are associated with metals and other inorganic chemicals.

EPA expects the Selected Remedy to attain ground water cleanup levels at the mine site within approximately 10 to 30 years and perhaps longer, depending on the location of the ground water.[84] EPA expects cleanup levels to be achieved in the alluvial aquifer within 10 years. The length of time to achieve cleanup levels in colluvial and bedrock ground water cannot now be estimated as it depends on the effectiveness of source containment and reduction of infiltration and acid-rock drainage.

Final cleanup levels for human health COCs in Mine Site Area ground water are depicted on Table 12-12. The cleanup levels include federal and New Mexico drinking water standards (MCLs), New Mexico water quality standards, EPA health-based criteria, and background levels. Background levels were estimated as part of the USGS Baseline

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[84] In the area of Spring 13, if the contamination in alluvial ground water is not mining related, but rather from natural sources, ground water cleanup levels will not be attained.

Investigation for colluvial and bedrock ground water (*i.e.,* pre-mining baseline water quality) and as part of the RI for the alluvial aquifer. These background levels are cleanup levels for some COCs. For the alluvial aquifer, the background levels are the cleanup levels only for the northern portion of the aquifer along the mine site. The cleanup levels for the middle and southern portion of the alluvial aquifer are the federal and New Mexico standards and EPA health-based criteria. EPA policy is generally to clean up to background levels, if such levels exceed standards or health-based criteria.[72] Under New Mexico Water Quality Act regulations, the numeric standard for a specific constituent does not have to be achieved if that constituent is present in natural background concentrations above the numeric standard [§ 20.6.2.4101B NMAC]. Depending on the background levels estimated by the USGS for individual drainages at the mine site, colluvial and bedrock ground water remediated to background levels in certain drainages may be unsuitable for drinking water as highly mineralized rock and natural scar formation has resulted in some background concentrations exceeding standards or health-based criteria.

The timeframe to establish engineering controls (source containment) at all of the waste rock piles includes the 25 to 28 years for regrade, cover and revegetation, and a few additional years to establish vegetation. Successful source containment is expected to reduce acid rock drainage and metals leaching to colluvial and bedrock ground water within tributary drainages, Red River alluvial ground water, and Red River surface water. Source containment combined with ground water remediation and seepage collection within the drainages and at seeps and springs along the Red River and near the base of waste rock piles are expected to allow ground water cleanup levels to be achieved and maintained throughout the alluvial aquifer and bedrock and colluvial ground water bearing zones.

The Selected Remedy will require perpetual mine dewatering, operation of some ground water extraction wells, and water treatment for long-term protection of ground water, as well as Red River surface water through a hydrologic connection to ground water.

The Selected Remedy will include temporary well drilling restrictions to be established by the New Mexico Office of the State Engineer, to protect humans from consuming contaminated ground water until ground water cleanup levels are attained.

The Selected Remedy will reduce the migration of contaminated ground water to Red River surface water, thereby improving water quality in the river and the overall protection of trout (survival and growth measures) at and downstream of the mine site reach. The results of the BERA indicate that long-term (chronic) exposure to elevated concentrations of primarily aluminum, and to a some extent copper and zinc, in Red River surface water at and downstream of Spring 13, and to a lesser degree at Spring 39 and other seeps and springs along the Red River may cause adverse effects to exposed trout. The Hazard Quotient (HQ) for aluminum concentrations in surface water (2) and seeps/springs (31), based on trout toxicity reference values, exceeded EPA's threshold value of 1. Whole body residue-based HQs for large brown trout exceeded the threshold value of 1 for copper (2-5) and zinc (5-14) and the 7-day laboratory toxicity tests (serial dilution tests) showed Spring 13 and Spring 39 to be toxic to trout at very low dilutions. Final cleanup levels are established for total aluminum (chronic and acute) in Red River surface water to protect trout. The cleanup levels as well as the methodology for evaluating achievement of the cleanup levels are summarized on Table 12-13. The cleanup levels will be applied in areas near and downstream of Spring 13 and Spring 39. They will take into account storm events in the Red River Valley and the related changes caused by those storm events to surface water quality, including adverse impacts in chemistry and toxicity from scar tributary drainages along the Red River. The timeframe for achieving the cleanup levels for aluminum in Red River surface water is expected to be similar to the timeframe (10 years) for cleaning up the Red River alluvial aquifer.

EPA expects the Selected Remedy to be protective of herbivorous native wildlife and plants that potentially could be exposed to molybdenum in Spring Gulch waste rock; the selected borrow material for covering waste rock. The molybdenum suitability criterion for screening borrow material and successful plant growth performance-based remediation goal were developed to ensure protectiveness from molybdenum toxicity. The criterion and performance-based remediation goal are summarized in Table 12-14.

The anticipated environmental and ecological benefits are the improved water quality and fish populations (primarily brown trout) of the Red River along and downstream of the mine site reach and the return of the mine site to a condition that will lead to a sustainable ecosystem and support the post-mining land use of forestry (except in designated use areas).

Implementation of the Selected Remedy, in combination with efforts by the U.S. Forest Service to remediate abandoned mines located upriver from the Site, the TMDL program to regulate aluminum loadings to the Red River, and the federal and state natural resource trustee agencies to restore natural resources within the Red River Watershed, are expected to improve environmental and ecological conditions within the entire Red River Watershed.

Restoring the Red River Watershed, including aquatic life in the Red River is also anticipated to have positive socio-economic and community revitalization impacts for the town of Red River and the Village of Questa such as for recreational purposes (*e.g.,* camping and fishing).

12.4.3 Tailing Facility Area

The tailing facility is expected to continue as an operating facility for an indefinite period of time. During this operating period, workers are protected through health and safety and hazard communication programs currently implemented by CMI and monitored and enforced by MSHA. EPA expects the Selected Remedy to protect the recreational visitor/trespasser and terrestrial wildlife by restricting access through the use of fencing and signage, including an exclusion (high) fence and drinkers for deer, elk and other wildlife, until decommissioning and closure of the facility and placement of final cover. After termination of mining, EPA expects the Tailing Facility Area to be available for wildlife habitat, light industry (such as renewable energy projects) and residential use. EPA also expects the Selected Remedy to protect current and potential future users of ground water for drinking water through temporary well drilling restrictions and alternate water supply.

EPA anticipates that installation of the engineering controls (cover and revegetation) will be completed in about 6 years after permanent cessation of tailing disposal operations. By use of engineering controls, the Selected Remedy reduces risk posed to the recreational visitor or trespasser from exposure to molybdenum in tailing pond sediment. The results of the HHRA indicate that existing conditions at the tailing facility pose a non-cancer health hazard to the recreational visitor or trespasser from incidental contact and ingestion of molybdenum in tailing pond sediment (HI of 2). The final cleanup level for molybdenum in tailing pond sediment is depicted on Table 12-15.

The use of engineering controls also reduces the risk to herbivorous native wildlife (deer and elk) from exposure to molybdenum in tailing, and in plants via uptake and bioaccumulation. Chronic exposure to elevated molybdenum concentrations may cause adverse affects (molybdenosis) to these animals. A calculated HQ of approximately 4 for deer and elk exceeds EPA's threshold value of 1, based on the Site-specific toxicity reference value of 41 mg/kg and exposure point concentration of 184 mg/kg (geometric mean) for tailing. The final cleanup levels for molybdenum in tailing are summarized in Table 12-16. Since no federal or state ARARs exist for this medium, the cleanup levels were determined through the BERA.

The results of the EPA BERA indicate that benthic macorinvertebrates are neither abundant nor diverse in the tailing pond sediments, likely due to poor water and sediment quality. The BERA also indicates low potential for adverse effects to birds (wren, kingfisher) from exposure to the tailing pond sediment via the food web model. This risk is further minimized when considering limited suitable habitat and limited food source.

As a result of the Selected Remedy, EPA expects that ground water will be remediated to established cleanup levels in approximately 15 years after placement of final cover for source containment. In the interim period, the temporary well drilling restrictions to be imposed by the New Mexico Office of the State Engineer and provision of alternate water supply or placement of point-of-use treatment systems, as needed, will protect current users of ground water drawn from private or industrial water wells or springs for drinking water until cleanup levels are met.

The results of the HHRA indicate that existing conditions at the Tailing Facility Area pose an excess lifetime cancer risk ranging up to 6.04×10^{-4} from ingestion of contaminated ground water. The cancer risk is related exclusively to arsenic, but does not appear to be mining related. The HHRA results also indicate non-cancer health hazards (HIs ranging up to 80) from ingestion of ground water. The risk is due primarily from exposure to metals. However, only risks associated with molybdenum exposure significantly exceeds background risk. The HHRA did not identify uranium as contributing appreciably to risk, but concentrations of uranium are related to mining activities and exceed the New Mexico MCL of 0.03 mg/L, an identified ARAR. Other chemicals that exceed New Mexico water quality standards in ground water at the Tailing Facility Area are fluoride, iron, manganese, sulfate, and total dissolved solid. Therefore, these chemicals also are COCs for the Tailing Facility Area ground water. Although sulfate itself is not a hazardous constituent under CERCLA, it is a precursor to the formation of sulfuric acid; sulfuric acid is a hazardous constituent and a major component of acid rock drainage. Final cleanup levels for COCs in ground water at the Tailing Facility Area are presented in Table 12-16. The final cleanup levels for ground water include federal or New Mexico drinking water standards (MCLs), New Mexico water quality standards, and EPA health-based criteria, which are all ARARs and TBCs. Attainment of these ground water cleanup levels are expected to restore ground water to its beneficial use as drinking water.

The anticipated socio-economic and community revitalization impacts are the potential use of the tailing facility for light industry and park, recreational and athletic field uses. CMI is currently constructing a renewable energy facility (1-megawatt solar energy facility using concentrated photo-voltaic technology) as a 5-year pilot demonstration at the northern portion of the tailing facility. The pilot solar facility is expected to be completed and operational by 2011. Should the pilot project be successful and implemented as a long-term source of renewable energy, it would be expected to provide a positive impact to the local community in terms of job creations, reduction in energy costs to consumers, and valuable reuse of contaminated lands. The development of park, recreational and athletic fields would also be beneficial to the local community from a socio-economic standpoint.

The anticipated environmental and ecological benefit is protection of large herbivorous native wildlife herds (deer/elk) whose home range is the adjacent Guadalupe Mountains and surrounding areas.

12.4.4 Red River and Riparian and South of Tailing Facility Area

Implementation of the Selected Remedy is expected to allow the land in the area south of the tailing facility to be available for unrestricted use in two years. Achievement of cleanup levels is expected to reduce risk to wildlife (deer, elk, and other terrestrial wildlife) and livestock (cattle, sheep) from exposure to molybdenum in soil and via plant uptake that could result in molybdenosis. Implementation of the Selected Remedy will also protect birds within the riparian corridor by reducing exposure to “hot spot” concentrations of molybdenum in tailing spills through removal.

The results of the EPA BERA indicate that conditions in the area south of the tailing facility may cause adverse affects (molybdenosis) to sensitive receptors such as herbivorous native wildlife (mule deer, Rocky Mountain elk), birds and non-grazing mammals (represented by western kingbird), and livestock (cattle, sheep) from exposure to elevated molybdenum concentrations in surface soil, and in some cases terrestrial plants through uptake and bioaccumulation. Calculated HQs for livestock (11), deer/elk (3), and birds representing other terrestrial wildlife, (2) are above EPA’s threshold value of 1 and warrant response action. Although the BERA indicated risk from exposure to soil in the Red River riparian corridor did not warrant a response action (HQ less than 1), “hot spots” of elevated molybdenum concentrations in localized tailing spills are above the toxicity reference value of 54 mg/kg for birds and other terrestrial wildlife, therefore, are also addressed by the Selected Remedy. Final cleanup levels for the COC (molybdenum) at the Red River and Riparian and South of Tailing Facility Area, as well as the basis for the cleanup levels are presented in Table 12-16. Since no federal or state ARARs exist for molybdenum in soil, the cleanup levels were determined through a Site-specific risk analysis in the BERA.

Anticipated benefits include addressing environmental justice concerns associated with the welfare of local ranchers who have lost livestock that grazed in the pastures south of the tailing facility.

Anticipated environmental and ecological benefits include protection of herbivorous native wildlife herds (deer and elk) whose home range is the Guadalupe Mountains and surrounding areas (see Section 6.0 above).

The anticipated socio-economic and environmental benefits to restoration of the Red River ecosystem are discussed under Mine Site Area, Section 12.4.2 above.

12.4.5 Eagle Rock Lake

Implementation of the Selected Remedy is expected to allow Eagle Rock Lake to be available for unrestricted use in two years. The risk of adverse affects to the benthic macroinvertebrate population from exposure to metals in sediment is expected to be reduced upon achieving cleanup levels. The contaminated sediment will be removed down to a dredged depth of three feet and the inlet storm water controls will reduce the volume of sediment entering the lake. This response action will allow cleanup levels for COCs in sediment to be achieved.

The results of the EPA BERA indicate that existing conditions at Eagle Rock Lake may cause adverse affects to the benthic macroinvertebrate populations (aquatic insects and other invertebrates) due to exposure to elevated concentrations of several metals. The highest HQs estimated for zinc (14), copper (8), and nickel (6) in sediment. HQs for these metals are above EPA's threshold value of 1 and also substantially above reference HQs from upper Fawn Lake (reference lake located upriver of the mine site). Other metals in Eagle Rock Lake sediment which posed some risk (HQ greater than 1) include aluminum, arsenic, cadmium, lead, manganese, molybdenum, selenium, and silver. Of those, HQs for Eagle Rock Lake sediments exceeded those of upper Fawn Lake for aluminum, arsenic, cadmium, manganese, and selenium. In several cases, the Eagle Rock Lake HQs were only marginally higher than those of upper Fawn Lake (molybdenum and selenium) and, therefore, risks due to exposure to those metals are assumed approximately equal to the reference area. Analysis of macroinvertebrate tissue also show that concentrations of aluminum, copper, nickel and zinc are above reference levels for tissue collected from upper Fawn Lake. Additionally, the surface of the sediment of Eagle Rock Lake is covered with a semi-gelatinous 'floc' (assumed to be comprised of primarily aluminum hydroxide) that degrades the microhabitat utilized by the benthic macroinvertebrate populations. Aluminum, copper and zinc concentrations in fish tissue samples (white suckers) from Eagle Rock Lake are significantly above levels in fish tissue from upper Fawn Lake, with copper and zinc levels posing some risk. No assessment of risk for aluminum could be made because no toxicity reference values were available at the time of the assessment. .

In summary, aluminum (for consideration of floc formation), cadmium, copper, manganese, nickel, and zinc are sediment COCs for Eagle Rock Lake. The final cleanup levels for these COCs in sediment at Eagle Rock Lake for protection of benthic macroinvertebrate populations are presented in Table 12-17. Since no federal or state ARARs exist for sediment, the cleanup levels were determined through literature review in the BERA.

The results of the BERA also indicate that risk to trout from exposure to aluminum in Eagle Rock Lake surface water was low, but potentially significant. Therefore, aluminum in surface water is a COC. However, because the lake is managed as a put-in-take fishery for hatchery-reared rainbow trout, long-term (chronic) exposure is unlikely for stocked trout; brown trout are uncommon in the lake; and white suckers are generally less sensitive to metals exposure.

Remediation of Eagle Rock Lake will impact the local community for a period of approximately two years. Recreational use (fishing) would be lost during dredging and for a period of time after dredging until clarity of the water improves, suspended sediment settles, and the lake is restocked with rainbow trout.

The anticipated environmental and ecological benefit is the re-establishment of healthy benthic macroinvertebrate populations that will provide an adequate food source for fish.

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13.0 STATUTORY DETERMINATIONS

Under CERCLA § 121 and the NCP at 40 C.F.R. § 300.430(f)(5)(ii), EPA must select a remedy that is protective of human health and the environment, complies with ARARs (unless a statutory waiver is justified), is cost effective, and utilizes permanent solutions, 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 requirements.

13.1 Protection of Human Health and the Environment

The protectiveness of the Selected Remedy is discussed for each of the five areas to be remediated.

13.1.1 Mill Area

The Selected Remedy for the Mill Area will be protective of human health and the environment. The soil removal will reduce concentrations of PCBs to levels that are considered protective for low occupancy (commercial/industrial) land use and the cancer risk to within EPA's acceptable risk range. The off-Site treatment and disposal addresses PCBs as a principal threat waste. The placement of a 36-inch thick cover of amended Spring Gulch waste rock that meets EPA's molybdenum suitability criterion for screening borrow in areas designated for forestry (as an approved post-mining land use) will protect wildlife and plants from molybdenum toxicity through plant uptake and the food web.

The reasonably anticipated land uses for the Mill Area at this time are commercial or industrial and forestry. If EPA determines that such land uses have changed or are anticipated to change to a high occupancy land use (*e.g.,* residential), the Selected Remedy would not be protective for the Mill Area and EPA would require additional response actions.

13.1.2 Mine Site Area

The Selected Remedy for the Mine Site Area will be protective of human health and the environment. Active ground water remediation using upgraded extraction and collection systems and treatment of all contaminated water will reduce risk to people that use ground water drawn from wells for drinking. Upgrading the seepage collection systems at the base of waste rock piles and decommission the Capulin catchments and pumpback system will protect the potential future recreational visitor/trespasser. The control of exposure to mining waste by engineering controls, access restrictions, and perpetual mine dewatering and water treatment will protect human health and wildlife. Temporary well drilling restrictions on new wells will limit ground water use until cleanup levels are attained for ground water.

The regrading and re-contouring of waste rock piles to interbench slopes ranging from 3H:1V to 2H:1V with waste rock removal will provide stability and the appropriate grade for placement of the store and release/evapotranspiration cover systems. The cover systems will reduce acid rock drainage and metals leaching to ground water, thus allowing ground water cleanup levels to be maintained. The use of the molybdenum suitability criterion for screening borrow material and establishing the successful plant growth performance-based remediation goal will protect herbivorous wildlife and plants from molybdenum toxicity in Spring Gulch borrow through uptake in plants and via the food web.

Source containment, ground water remediation, seepage interception systems at seeps and spring, and perpetual mine dewatering will protect aquatic life (trout) in the Red River by reducing inputs of acidic, metals-laden ground water to the Red River at zones of ground water upwelling.

13.1.3 Tailing Facility Area

The Selected Remedy for the Tailing Facility Area will be protective of human health and the environment through active ground water remediation, engineering controls, and temporary well drilling restrictions to limit ground water use. It will be protective for the remaining operating life of the facility and after permanent cessation of tailing disposal operations. During tailing disposal operations, the continued use of fencing and signage protects the potential recreational visitor or trespasser and wildlife.

Active ground water remediation will reduce the risk to current or potential future users of alluvial ground water drawn from wells for consumption (drinking). Ground water remediation includes water treatment for collected tailing facility water, as well as the mine site water during the interim period before water treatment is available at the mine site. The temporary provision of an alternate water supply or installation and maintenance of a point-of-use treatment system (*e.g.,* filter at tap), as needed, will protect people that use ground water for drinking in areas known to have ground water contamination in the alluvial or basal bedrock aquifers. These provisions will ensure protection for the interim period until ground water cleanup levels are achieved. Monitoring of the Red River State Fish Hatchery drinking water supply will be performed to assess the need for such provisions as concentrations of molybdenum in the water supply are close to, but below, the health-based cleanup level. CMI currently provides bottled water to hatchery personnel at their request. Temporary well drilling restrictions will also prevent exposure by restricting the installation of new wells in areas of ground water contamination.

Active ground water remediation for the basal bedrock aquifer will not be conducted as part of the Selected Remedy due to limited current and potential future use of the ground water. Although there was fairly widespread support from the community to do so, it would be at significant additional expense. Instead, engineering controls for source containment will be used to achieve ground water cleanup levels in the bedrock aquifer. After source containment measures are implemented, ground water quality within the basal bedrock aquifer is anticipated to improve slowly by attenuation and dilution in areas where it is currently impacted.

The combination of engineering controls, access restrictions and institutional controls will protect human health and ecological receptors by controlling exposure to mining waste following permanent cessation of tailing disposal operations. Engineering controls for source containment (cover) will reduce infiltration of precipitation and tailing seepage to ground water, thereby allowing ground water cleanup levels to be maintained in the long term. The cover will also provide a physical barrier for controlling exposure to tailing and tailing pond sediment by the recreational visitor or trespasser or commercial/industrial worker, as well as plants and animals. The cover will protect wildlife and plants from molybdenum toxicity through uptake in plants and via the food web. Temporary institutional controls (well drilling restrictions) will limit the use of ground water until cleanup levels are achieved.

13.1.4 Red River and Riparian and South of Tailing Facility Area

The Selected Remedy for the Red River, Riparian, and South of Tailing Facility Area will be protective of human health and the environment. The removal and on-Site disposal of molybdenum-contaminated soil in the riparian area south of the tailing facility will protect large herbivorous wildlife (mule deer/Rocky Mountain elk) and livestock (cattle, sheep) that are sensitive to molybdenum toxicity and may contract molybdenosis. The removal will also protect avian wildlife (birds).

The removal of isolated “hot spot” concentrations of molybdenum in tailing spills along the Red River riparian corridor will protect birds from molybdenum toxicity.

13.1.5 Eagle Rock Lake

The Selected Remedy for Eagle Rock Lake will be protective of human health and the environment. The removal of contaminated sediment to a dredged depth of three feet and installation of inlet storm water controls at the headgate will reduce the concentrations of metals in the existing sediment and the rate of sedimentation and metals accumulation from Red River surface water during storm events. These actions will allow the establishment and long-term protection of new benthic macroinvertebrate populations in Eagle Rock Lake sediment.

13.2 Compliance with Applicable or Relevant and Appropriate Requirements

The NCP at 40 C.F.R. § 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.

In addition to ARARs, non-promulgated advisories, proposed standards, criteria, guidance or policy documents developed by the federal or state government, or other information referred to as To Be Considered (TBC) materials may also be used in conjunction with, or in lieu of, ARARs to achieve an acceptable level of risk at a site. Although not legally binding, TBCs may be used when determining protective cleanup levels or response actions where no ARARs exist, or where ARARS alone would not be sufficiently protective of human health and the environment. Because TBCs are not ARARs, their identification and attainment are not mandatory.

13.2.1 Types of ARARs

ARARs that govern actions at CERCLA sites fall into the following three broad categories based on the chemical contaminants present, site characteristics, and the remedial alternatives proposed for cleanup: [85]

- Chemical-Specific ARARs – Chemical-specific ARARs include those environmental laws and regulations that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specific chemicals. These requirements generally set health- or risk-based concentration limits or discharge limits for specific chemicals by media. When applied to site-specific conditions, these result in the establishment of numerical values that determine the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. Chemical-specific ARARs are triggered by the specific chemical contaminants found at a particular site. If a chemical has more than one such requirement that is an ARAR, the most stringent generally should be complied with.
- Location-Specific ARARs – Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations (*e.g.,* floodplains, wetlands, historic places, and sensitive ecosystems or habitats).
- Action-Specific ARARs – Action-specific ARARs are restrictions that define acceptable treatment and disposal procedures for hazardous substances. These

[85] CERCLA Compliance with Other Laws Manual, Parts I and II, OSWER Directive 9234.1-01 and -02

ARARs generally set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities related to management of hazardous substances, pollutants, or contaminants. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be achieved (*e.g.*, emission standards for incinerators, underground storage tank regulations, or land disposal restrictions).

13.2.2 CERCLA Waiver Criteria for ARARs

The NCP requires compliance with ARARs during and at completion of remedial actions. However, there are certain circumstances when ARARs may be waived. CERCLA § 121(d) allows the selection of a remedial alternative that will not attain ARARs if any of six conditions for a waiver of ARARs exists. The following five conditions may apply to the Site:

- Interim Measures – The remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed;
- Greater Risk to Human Health and the Environment – Compliance with such requirement at the site will result in greater risk to human health and the environment than alternative options;
- Technical Impracticability – Compliance with such requirement is technically impracticable from an engineering perspective;
- Equivalent Standard of Performance – The remedial action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criterion, or limitation, through use of another method or approach;

- Inconsistent Application of State Requirements – With respect to a state standard, requirement, criterion, or limitation the state has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criterion or limitation in similar circumstances at other remedial actions.

No ARAR waivers are being invoked at this time.

13.2.3 Final Determination of ARARs and TBCs

EPA made the final determination of ARARs and TBCs in coordination and consultation with NMED, the lead state agency supporting EPA in the CERCLA process. Consultation between NMED and other New Mexico regulatory agencies, including EMNRD, was also part of the ARAR analysis. The preliminary ARARs identification process was initiated during scoping and planning of the RI/FS and continued during the FS phase. CMI provided comments and recommendations for the ARARs and TBCs analysis. The preliminary ARARs as well as CMI comments and recommendations are presented in Section 2 of the FS Report.

EPA's final determination of ARARs and TBCs is presented on Tables 13-1 through 13-4. Each ARAR or groups of related ARARs are identified by a specific statutory or regulatory citation, the environmental medium which is regulated (if appropriate), a synopsis of the requirement, the action to be taken to attain the requirement and a classification describing whether the ARAR is applicable or relevant and appropriate for each of the five areas being addressed by the Selected Remedy.

Several ARARs identified on Tables 13-1 through 13-3 are identical or nearly identical requirements in both federal and New Mexico law, such as the requirements of the Clean Water Act and the New Mexico Water Quality Act. The New Mexico requirements that are federally authorized must generally be equivalent to or more stringent than their federal counterparts. Therefore, and in accordance with the preamble to the NCP, the citations are made to the New Mexico provisions as the appropriate standards, but treatment of the provisions as federal requirements.

For those New Mexico requirements that are not federally delegated, but have a federal counterpart, a comparison of the requirements has been made and the more stringent of the two are identified as the ARAR.

This ROD constitutes EPA's formal identification and detailed description of ARARs and TBCs for the Selected Remedy. This ARARs and TBCs analysis is based on CERCLA § 121(d), 42 U.S.C. § 9621(d), EPA's CERCLA Compliance with Other Laws Manual, Parts I and II – OSWER Directive 9234.1-01 and -02, various CERCLA ARARs Fact Sheets issued by EPA as OSWER Directives, the NCP, EPA's Abandoned Mine Site Characterization and Cleanup Handbook (USEPA 910-B-00-001), and the preliminary ARARs identification process conducted during the FS.

A summary of key statutes and regulations identified as ARARs for the Selected Remedy as well as certain TBCs are discussed in the following sections under these categories:

- Hazardous and Solid Waste Management
- Mining Waste Management
- Management and Disposal of Polychlorinated Biphenyls
- Ground Water Quality
- Surface Water Quality
- Air Quality
- Other Requirements
- To Be Considered

13.2.4 Hazardous and Solid Waste Management

Hazardous and solid wastes are regulated under the federal Resource Conservation and Recovery Act (RCRA). RCRA hazardous wastes are regulated by Subtitle C and RCRA nonhazardous solid wastes are regulated by Subtitle D. The mining-related wastes at the Site are primarily the acid generating and potentially acid generating waste rock and tailing waste. For the purposes of this ROD, EPA has determined that these mining wastes are not RCRA hazardous waste, in accordance with the Mining Waste ("Bevill") Exclusion set forth in 40 C.F.R. § 261.4(b)(7) and described below.

Mining Waste ("Bevill") Exclusion: In 40 C.F.R. § 261.4(b)(7), solid waste from the extraction, beneficiation and processing of ores and minerals is excluded from the definition of hazardous waste and therefore, is not subject to Subtitle C requirements.

New Mexico Hazardous Waste Act and Regulations: The State of New Mexico is authorized to administer a hazardous waste program in lieu of the federal RCRA Subtitle C program. The New Mexico Hazardous Waste regulations at § 20.4.1 NMAC adopt by reference the federal regulations and are equivalent to, consistent with, and no less stringent than the federal hazardous waste program. These regulations set standards for the identification of hazardous wastes and include provisions for hazardous waste generation, treatment, storage and disposal. Although EPA expects that regulated hazardous waste will not be generated at the Site, the requirement to characterize solid wastes that are generated to determine whether they are hazardous is an applicable requirement. Should regulated hazardous waste be generated as part of remedial activities, it will be managed in accordance with the New Mexico hazardous waste regulations and sent off Site for treatment and disposal.

New Mexico Solid Waste Act and Regulations: The RCRA Subtitle D program is administered in New Mexico pursuant to §§ 20.9.2 and 20.9.4 NMAC which define the siting, design, operational, closure and post-closure requirements for solid waste management facilities. These requirements prohibit the dumping of non-hazardous, non-mine related solid waste on the Site, and provide relevant and appropriate requirements for landfills, such as the on-Site construction and demolition landfills as well as impoundments for water treatment sludge or other special wastes. These regulations explicitly do not apply to waste from extraction, beneficiation or processing of ores and minerals, including the overburden from mining of molybdenum (*i.e.,* waste rock and tailing).

13.2.5 Mining Waste Management

SMCRA governs activities associated with coal exploration and mining. Because the standards promulgated under SMCRA are intended for active coal mines, they will not be applicable to CERCLA actions at the Site. However, the standards set forth at 30 C.F.R. Parts 816 and 817 governing surface mining activities and underground mining activities, respectively, would be relevant and appropriate requirements at the Site because SMCRA regulations address circumstances that are similar and establish performance objectives that are consistent with the remedial action objectives established in this ROD, such as reducing the migration of acidity and metals from sulfide-bearing waste rock to ground and surface water.

SMCRA would be an ARAR for activities (e.g., revegetation) that are not regulated under other federal environmental laws. In some cases, however, CERCLA requirements for achieving a protective remedy may be more stringent than SMCRA standards. For example, revegetation needs at the Site may exceed the SMCRA performance standard for revegetation, especially considering the need for effective cover systems to meet New Mexico Water Quality Act requirements for protecting ground water at any place of withdrawal for present or reasonably foreseeable future use.

Under SMCRA, New Mexico is authorized to administer the federal coal mining program in the State. The New Mexico coal mining regulations have been approved by the Office of Surface Mining and implemented in lieu of the federal program. Therefore, the New Mexico coal mining regulations are relevant and appropriate requirements to the Site.

New Mexico Mining Act and Regulations – Coal Mining: The New Mexico Mining Act coal mining regulations at § 19.8.20 NMAC include various requirements and standards for topsoil supplements and amendments, diversion and conveyance of overland flows, discharge control measures for sedimentation ponds, impoundments, dams, diversions and embankments, and avoidance of drainage from acid- and toxic-forming materials and mines to ground water. Requirements are established for disposal of excess spoils, including durable rock fills (*e.g.,* valley fills such as waste rock piles), that specify stability (factor of safety) and, slope gradient and surface water diversion channel size. For durable rock fills, requirements include a minimum static factor of safety of 1.5 and earthquake (pseudo-static) factor of safety of 1.1 (§ 19.8.20.2034.F NMAC) and a outslope of the fill that does not exceed a 2H:1V slope. The director of the state agency administering the program (EMNRD) may require a flatter slope (see Mining Permit Conditions under TBCs, below). There are also requirements and standards for cover and revegetation of acid- and toxic-forming materials. The director may specify thicker amounts of cover to protect against adverse effects on plant growth, erosion, and acid-forming seeps (see Mining Permit Conditions under TBCs). Revegetation requirements specify that all land affected by mining shall be revegetated to provide a diverse, effective and permanent vegetative cover and include standards for measuring vegetative success.

The Selected Remedy will comply with these ARARs. The cover and vegetation systems of the Selected Remedy will be designed and constructed to optimize vegetative growth (including multiple applications of amendments) and provide adequate protection to wildlife and plants from exposure to metals via uptake in plants. Monitoring of vegetative success will be part of the Selected Remedy.

New Mexico Mining Act and Regulations – Non-Coal Mining: The New Mexico Mining Act non-coal mining regulations are not prescriptive in the management of mining waste, but provide some requirements at §§ 19.10.5 and .6 NMAC that are applicable. At § 19.10.5.507 NMAC reclamation is required to a condition that allows for the re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding areas following closure, unless it conflicts with the approved post-mining land use. This ARAR also provides for a waiver for an open pit or other waste unit, if the open pit or waste unit meets all applicable federal and state laws, regulations, and standards for air, surface water, and ground water protection following closure and will not pose a current or hazard to public health or safety. The non-coal mining requirements specify that final slopes and drainage configurations must be compatible with a self-sustaining ecosystem or approved post-mining land use.

The Selected Remedy will comply with these applicable requirements through the regrade of waste rock piles to achieve a range of minimum interbench slopes from 3H:1V to 2H:1V, placement of 36-inch thick cover of non-acid generating and amended Spring Gulch waste rock, and revegetation. The Selected Remedy will also comply with these requirements through the placement of the 36-inch thick soil cover and revegetation at the tailing facility. The suitability criterion for screening borrow material and a successful plant growth performance-based remediation goal are TBCs to be used in combination with these ARARs to ensure successful vegetative growth. Monitoring and maintenance requirements and standards established in the Mining Permit Conditions for the revegetation are also TBC materials for ensuring the long-term effectiveness of the remedy.

13.2.6 Management and Disposal of Polychlorinated Biphenyls

Toxic Substances Control Act (TSCA) and Regulations: The TSCA regulations at 40 C.F.R. Part 761 set forth requirements governing the management and disposal of polychlorinated biphenyls (PCBs). The substantive requirements of 40 C.F.R. Part 761, Subparts D (storage and disposal) and O (sampling), are ARARs for locations at the Mill Area that contain PCBs. These requirements also include incineration requirements. The Selected Remedy will comply with the TSCA requirements through removal of contaminated soil and off-Site treatment (incineration) and disposal.

13.2.7 Ground Water Quality

Safe Drinking Water Act and Regulations: The SDWA National Primary Drinking Water regulations at 40 C.F.R. Part 141 have been adopted by New Mexico (see below). 40 C.F.R. Part 141 specifies maximum contaminant levels (MCLs) and MCL goals (MCLGs) for select chemicals in drinking water. Primary drinking water regulations are applicable only for drinking water at the tap; however, MCLs and non-zero MCLGs are relevant and appropriate if ground water is a current or potential source of drinking water. At the Site the MCLs and MCLGs are relevant and appropriate.

New Mexico Wastewater and Water Supply Facilities: In § 20.7.10.100 NMAC, New Mexico has adopted EPA regulations set forth at 40 C.F.R. Part 141 for MCLs, action levels for lead and copper, and MCLGs for public drinking water supply systems. These regulations are relevant and appropriate at the Site. The New Mexico MCLs, action levels, and MCLGs are listed in Tables 13-5, 13-6, and 13-7.

New Mexico Water Quality Act and Regulations: The WQCC regulations set forth at § 20.6.2 NMAC establish water quality standards and regulations to protect ground water and to prevent or abate water pollution. The various standards are summarized in Tables 13-8, 13-9, and 13-10. Ground water in New Mexico is subject to protection if it has concentrations of 10,000 mg/L or less of total dissolved solids. The determination of a discharge's effect on ground water is measured at any place of withdrawal of water for present or reasonably foreseeable future use. Contaminant-specific standards for ground water are established at § 20.6.2.3103 NMAC.

The WQCC regulations at §§ 20.6.2.4100 through .4115 NMAC require pollution abatement of subsurface water so that all ground water in New Mexico which has a background concentration of 10,000 mg/L or less total dissolved solids is either remediated or protected for use as domestic and agricultural water supply, and to remediate or protect those segments of surface water which are gaining because of subsurface water inflow.

Ground water pollution at any place of withdrawal for present or reasonably foreseeable future use, where total dissolved solid concentrations are 10,000 mg/L or less shall be abated to meet water quality standards.

In a preliminary evaluation of seven criteria established by the WQCC[86] for place of withdrawal of ground water at the Site in 2010, NMED concluded that the Site, including the aquifers beneath the Site, has been used as a place of withdrawal of water for past and present use and will be a place of withdrawal for reasonably foreseeable future use.[87] NMED concluded that it is foreseeable that wells will be placed on or in the vicinity of the Site in the future for drinking, industrial or agricultural purposes. This conclusion was based on the following criteria: (1) Site geology and hydrology, (2) the quality of water prior to any mining-related discharge, (3) past and current land use in the vicinity, (4) future land use in the vicinity, (5) past and current water use in the vicinity, (6) potential future water use in the vicinity, and (7) population trends in the vicinity. A copy of NMED's place of withdrawal evaluation is part of the Administrative Record file for the Site.

13.2.8 Surface Water Quality

Clean Water Act – Basic Prohibition: Clean Water Act requirements set forth at 33 U.S.C. § 1311(a) provides that the discharge of a pollutant from a point source to waters of the United States without a permit issued under the Clean Water Act is unlawful.

New Mexico Water Quality Act and Regulations: The New Mexico WQCC has established water quality standards and regulations in §§ 20.6.2.2101 and .4103 NMAC for the protection of surface water and to prevent or abate water pollution. These standards must be complied with for the protection of the waters of the State of New Mexico should they be more stringent or lower numerically than EPA's MCLs and non-zero MCLGs

[86] New Mexico Water Quality Control Commission Decision and Order on Remand: *In the Matter of Appeal of Supplemental Discharge Permit for Closure (DP-1341) for Phelps Dodge Tyrone, Inc.*; WQCC 03-12A and 03-13A; February 4, 2009

[87] New Mexico Environment Department Preliminary Evaluation of Criteria for Place of Withdrawal of Water at the Chevron Mining Incorporated Questa Mine, September 27, 2010

drinking water standards. The New Mexico standards also apply for constituents that have no federal standard. General requirements at § 20.6.2.2101 NMAC include limits on biochemical oxygen demand, oxygen demand, settleable solids, fecal coliform and pH in effluent (Table 13-8). At § 20.6.2.4103 NMAC surface water pollution shall be abated to conform to the water quality standards established in Standards for Interstate and Intrastate Streams in New Mexico. § 20.6.4 NMAC.

Standards for Interstate and Intrastate Surface Waters: Sections 20.6.4.12, .122, and .900 NMAC establish general requirements for compliance to meet water quality standards, water quality designated uses and criteria for a specific stream segment (Rio Grande Basin), and water quality standards necessary to protect those designated uses and criteria and an antidegradation policy. The numeric standards of §§ 20.6.4.122 and .900 NMAC are provided in Tables 13-11 and 13-12.

13.2.9 Air Quality

New Mexico Air Quality Control Act and Regulations: Air quality regulations set forth in § 20.2 NMAC are applicable if remedial activities involve specific sources of air pollutants. They establish ambient air quality standards, performance standards for such sources of pollutants, and specific monitoring methods. New Mexico ambient air quality numeric standards of §§ 20.2.3.109, .110, and .111 NMAC for particulates, sulfur compounds and other air contaminants are provided in Table 13-13. The regulations at §§ 20.2.60 and .61 NMAC contain restrictions on open burning, smoke, and other visible emissions.

13.2.10 Other Requirements

The following federal and state requirements are other location-specific ARARs for the Site that will be complied with if applicable:

- Clean Water Act Dredge and Fill Requirements, which address discharges of dredged or fill material and work in or affecting navigable waters.
- Endangered Species Act
- Migratory Bird Treaty Act
- Bald Eagle Protection Act
- National Historic Preservation Act
- Archaeological and Historic Preservation Act
- Executive Order 11988 – Protection of Floodplains
- Executive Order 11990 – Protection of Wetlands
- New Mexico Cultural Properties Act
- New Mexico Prehistoric and Historic Sites Preservation Act
- New Mexico Wildlife Conservation Act

13.2.11 To-Be-Considered (TBC)

A complete list of TBCs is presented in Table 13-4. They include the following:

Clean Air Act and Regulations – National Ambient Air Quality Standards (NAAQS): The Clean Air Act regulations set forth in 40 C.F.R. § 50.6 are TBCs for soil removal and tailing disposal operations which may generate fugitive emissions. The regulations establish standards for particulate matter less than or equal to 10 microns in size (PM_{10}) and less than or equal to 2.5 microns in size ($PM_{2.5}$). The PM10 standard is 150 micrograms of particles per cubic feet of air ($\mu g/m^3$) over a 24-hour period. The $PM_{2.5}$ standard is 35 $\mu g/m^3$ over a 24-hour period.

New Mexico Water Quality Act – Ground Water Permit Conditions: Specific conditions and requirements set forth in New Mexico permits DP-933 (tailing facility) and DP-1055 (mine site) are TBCs.

- Ground Water Discharge Permit DP-933: This permit regulates discharges of pollutants from the tailing facility into ground water and surface water. An approved closure plan for reclamation of the tailing facility after cessation of operations is incorporated into the permit which includes conditions for surface regrading, 36-inch soil cover, and revegetation. The vegetated soil cover is to perform as an effective store and release/evapotranspiration cover to reduce infiltration to a level which does not cause exceedances of ground water standards.

- Ground Water Discharge Permit DP-1055: This permit regulates discharges of pollutants from the mine site into ground water and surface water. An approved closure plan for reclamation of the mine site after termination of mining is incorporated into the permit and includes conditions for regrading waste rock dumps to 3H:1V interbench slopes, unless the underlying slope is steeper than 3H:1V, then the waste rock dumps can be regraded to slopes no steeper than 2H:1V, to the maximum extent practicable. Conditions also include covering the waste rock dumps with 36 inches of growth medium and revegetating the cover to establish an effective store and release/evapotranspiration cover system that will reduce infiltration to the maximum extent practicable. Dewatering of the underground mine must be conducted for 100 years, and abatement of ground water contamination and seepage collection must be conducted within each tributary drainage basin at the toe of each waste rock pile.

New Mexico Mining Act – Mining Permit Conditions: Specific conditions set forth in the New Mexico Mining Permit TA001RE issued pursuant to the New Mexico Mining Act and § 19.10 NMAC are TBCs.

- Mining Permit TA001RE: This permit sets forth conditions for reclamation of both the mine and tailing facility at closure. In general, the permit imposes conditions for the Site that include, but are not limited to, a post-mining land use designation, surface regrading, building demolition, waste rock pile and tailing impoundment regrade and cover placement, leachate collection, water treatment and disposal, ground water and surface water monitoring, drainage plan, revegetation, road closure, pit reclamation and a contingency plan. The thickness of the cover required for both the mine site and tailing facility is 36 inches. The slope angle required for the waste rock pile regrade is a minimum 3H:1V interbench slope, unless the underlying bedrock slope is steeper than 3H:1V, then the waste rock dump can be regraded to no less than a 2H:1V slope. Approved closeout plans that are incorporated into the permit provide conditions for reclamation and closure of the tailing facility (Permit Revision 96-1) and the mine site (Permit Revision 96-2).

New Mexico Environment Department Preliminary Evaluation for Place of Withdrawal of Water at Chevron Mining Inc. Questa Mine

As noted above, NMED has performed a preliminary evaluation of place of withdrawal at the Site according to the criteria for determining place of withdrawal set forth in *Phelps Dodge Tyrone* (NMED 2010). This evaluation is a TBC.

National Secondary Drinking Water Regulations: The National Secondary Drinking Water regulations of 40 C.F.R. Part 143 contain non-enforceable guidelines for drinking water for public drinking water systems. The secondary maximum contaminant levels (SMCLs) are drinking water standards developed to protect the aesthetic quality of drinking water. Because ground water is a current or potential source of drinking water, SMCLs are TBCs. New Mexico has adopted 40 C.F.R. Part 143 (see § 20.7.10.101 NMAC); thus, SMCLs are TBCs for the Site. New Mexico SMCLs are presented on Table 13-14.

Clean Water Act – Total Maxim Daily Load: The Total Maximum Daily Load (TMDL) provisions of CWA § 303(d), 33 U.S.C. § 1313(d) and 40 C.F.R. § 130.7 require states to identify impaired waters and establish TMDLs for those watersheds (NMED 2006). This requirement is being implemented by NMED. TMDLs are based on the calculation of the maximum amount of a pollutant that a water body can receive and still maintain the water quality standards and an allocation of that amount to the pollutants' sources; both point and nonpoint (see Section 4.4.4). An acute aluminum TMDL was developed for specific reaches of the Red River in 2006. The acute aluminum TMDL is a TBC.

EPA Health-Based Criteria Established for Ground Water Cleanup Levels: Health-based criteria developed for COCs are used for ground water cleanup levels in the absence of ARARs or where New Mexico water quality standards are less protective for drinking water use. The health-based criteria are based on EPA Non-Cancer Oral Reference Doses (RfDs) contained in EPA's Integrated Risk Information System (IRIS). A Site-specific health-based criterion developed in the HHRA for molybdenum (0.08 mg/L) is used as a cleanup level. The EPA Region 6 health-based screening level criterion for vanadium pentoxide (0.33 mg/L) in tap water is used as a cleanup level for vanadium. These criteria will be used to protect current and potential future uses of ground water as drinking water.

EPA Office of Solid Waste and Emergency Response White Paper: "The Use of Soil Amendments for Remediation, Revitalization, and Reuse," EPA 542-R-07-013, December, 2007. This White Paper provides guidelines in the use of soil amendments and application rates for the Spring Gulch waste rock and other borrow materials to be used at the Site for store and release/evapotranspiration cover systems.

13.3 Cost Effectiveness

The Selected Remedy is cost effective because the remedy's cost are proportional to its overall effectiveness [see 40 C.F.R. § 300.430(f)(1)(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, or as appropriate, waive ARARs). Overall effectiveness was evaluated by assessing the following three of the five balancing criteria: long-term effectiveness and permanence, reduction in toxicity, mobility, or volume through treatment, and short-term effectiveness. The overall effectiveness of each alternative was then compared to each alternative's costs to determine cost effectiveness.

To the extent that the estimated cost of the Selected Remedy exceeds the costs of other alternatives, the additional cost is reasonably related to the additional benefits in long-term effectiveness and permanence and reduction of toxicity, mobility or volume of the contaminants through the treatment to be used.

With respect to the short-term effectiveness of the Selected Remedy, including consideration of risk involved to workers and the community as the remedy is being implemented, the use of proper safety precautions can adequately address short-term impacts and risk.

A detailed discussion of the cost-effectiveness determination is presented below for each area being addressed by the Selected Remedy.

13.3.1 Mill Area

The Selected Remedy for the Mill Area is the only alternative to be developed for a commercial/industrial land use setting. It is also the least expensive of the alternatives that achieve the threshold criteria, with the exception of the Limited Action alternative. The Selected Remedy is more effective and permanent in the long term compared to the Limited Action alternative and it reduces the toxicity and mobility of PCB concentrations greater than 25 mg/kg. The Limited Action leaves PCB concentrations greater than 25 mg/kg in place.

Based on this comparative assessment, the overall effectiveness of the Selected Remedy was determined to be proportional to its cost and hence represents a reasonable value for the money to be spent.

13.3.2 Mine Site Area

The cost-effectiveness determination for the Selected Remedy at the Mine Site Area focuses primarily on the significance of costs associated with source containment for the waste rock piles and water treatment.

13.3.2.1 Source Containment for Waste Rock Piles

The estimated cost for remediating the waste rock piles represents a range of costs defined by the two balance-cut-fill, partial/complete removal, and regrade components. The costs, which range from $310.0 million for the 3H:1V slope regrade to $114.4 million for the 2H:1V slope regrade (present value), are large. The estimated cost for either of the two regrade components is also much greater than the estimated cost of the Limited Action alternative ($8.5 million, present value), the only other alternative that meets the threshold criteria. However, the Limited Action alternative would not provide long-term protection and would only be partially effective as it does not include source containment for the waste rock piles.

The costs of the 3H:1V and 2H:1V slope regrade options are large because of the massive size of many of the rock piles (volumes range from less than 1 million to over 50 million yd^3 for each pile). To achieve the 3H:1V interbench slopes for all the waste rock piles, a large volume of waste rock (totaling approximately 122 million yd^3) would be removed from the rock piles and deposited in an on-site waste rock repository(ies): for some rock piles nearly all of the waste rock would be removed. This contributes significantly to the overall cost of achieving the 3H:1V slope regrade, which is an estimated $196 million (present value) increase in cost over the cost to achieve the 2H:1V slope regrade.

An assessment of cost effectiveness for the Selected Remedy when considering the waste rock pile regrades is as follows:

- Long-Term Effectiveness and Permanence: Overall, the 3H:1V slope regrade provides a higher level of effectiveness and permanence in the long term as the shallower slope would increase the stability of the waste rock piles and cover. The 3H:1V slope regrade would also be more suitable for promoting successful vegetation and, therefore, the store and release/evapotranspiration cover system would be more effective for reducing infiltration, acid rock drainage and metals leaching to ground water and surface water. There is some uncertainty as to how effective such a cover will be on slopes as steep as 2H:1V.

- Reduction of Toxicity, Mobility, or Volume through Treatment: Because the waste rock represents high volume, low-level threat waste, engineering controls rather than treatment are used for the Selected Remedy in accordance with NCP §300.430(a)(1)(iii)(B). Therefore, there is no reduction of toxicity, mobility, or volume of the waste rock through treatment. There is reduction of the toxicity, mobility, and volume of contamination in surface water and ground water through treatment.

- Short-Term Effectiveness: The extensive earthmoving activities which are required for both of these remedial components present risks to workers, the community and the environment. However, the 2H:1V regrade component would require less earthmoving work and hence potentially fewer accidents would occur compared to the 3H:1V regrade component. The 2H:1V regrade component would be slightly more effective in the short term.

When considering each slope regrade component of the Selected Remedy individually (*i.e.,* all of the waste rock piles are regraded to either 3H:1V slopes or 2H:1V slopes), the relationship between overall effectiveness and cost are proportional for each component. The cost of the 3H:1V slope regrade is significantly higher than the cost of the 2H:1V regrade (approximately $196 million present value), but the overall effectiveness of the 3H:1V slope regrade is anticipated to be significantly higher than the overall effectiveness of the 2H:1V regrade.

When considering each slope regrade component together, the cost of the Selected Remedy will actually be somewhere between the range of costs defined by these two regrade components,[88] as some waste rock piles will likely not be regraded to the 3H:1V interbench slope. Additionally, by using the "tool box" approach to design the remedy on a rock pile-by-rock pile basis, each waste rock pile will be regraded in the most effective and practicable manner possible given the characteristics of the rock pile and other key factors previously discussed herein. Therefore, the relationship between the effectiveness afforded by the "tool box" approach and its associated costs are reasonable in comparison to the higher costs estimated to achieve the 3H:1V slope regrade for every rock pile.

13.3.2.2 Water Treatment

The cost-effectiveness determination for the Selected Remedy is also affected by the approach taken for water treatment. The timing of water treatment, which affects the total present value cost, is chosen for the start of the remedial action (*i.e.,* Year 0 Construction).

Water treatment is needed at both the mine site and tailing facility as the current disposal practice is to discharge all contaminated water untreated to the unlined tailing impoundments, where over 75 percent of the water ultimately seeps downward into the underlying ground water, thereby causing exceedances of New Mexico water quality standards and EPA's health-based criteria for COCs in ground water. Water treatment results in the reduction of toxicity, mobility, and volume of contaminants in ground water and surface water. The relationship between the effectiveness afforded by water treatment from the start of the remedial action and its costs are reasonable compared to the other water treatment options and timeframes evaluated. It is noted that an evaluation will be performed during RD to determine efficiencies in treatment system processes, location(s), and sizing that could result in significant cost savings for construction and O&M of the

[88] Further refinement of the cost estimate from the range provided is not possible for this ROD as actual interbench slopes, volume of waste rock to be removed, and other factors for each pile will be determined during RD.

water treatment systems and reduce ongoing O&M and treatment residuals disposal with respect to these systems.

13.3.3 Tailing Facility Area

The Selected Remedy for the Tailing Facility Area (source containment; ground water extraction and upgraded seepage collection and treatment; and piping water in diversion channel) is more effective and permanent in the long term than any of the other alternatives with the exception of the alternative that includes ground water extraction in the basal bedrock (volcanic) aquifer (Alternative 4). However, the cost of implementing Alternative 4 with water treatment starting at Year 0 Construction increases the cost by approximately $83 million (present value) over the Selected Remedy because of the significant volume of water that would have to be collected from the volcanic aquifer and treated.

Because engineering controls are used instead of treatment for the high volume, low-level threat mining waste (tailing) consistent with 40 C.F.R. § 300.430(a)(1)(iii)(B), there is no reduction of the toxicity, mobility, or volume of the tailing waste through treatment for any of the alternatives. There is a reduction of the toxicity, mobility, and volume of contaminants in ground water through water treatment for the Selected Remedy and Alternative 4.

The Selected Remedy is more effective in the short term than Alternative 4, but less effective than the other alternatives. All of the alternatives present some potential risks to workers, the community and the environment.

The Selected Remedy for the Tailing Facility Area provides the best overall effectiveness of all alternatives proportional to its cost and hence represents a reasonable value for the money to be spent.

13.3.4 Red River and Riparian and South of Tailing Facility Area

The Selected Remedy for the Red River, Riparian, and South of the Tailing Facility Area (removal of soil and tailing spill deposits and on-Site disposal) is more effective and permanent in the long-term than all of the other alternatives with the exception of the removal and off-Site disposal alternative. However, off-Site disposal represents an increase in cost of approximately $2.5 million (present value) over on-Site disposal. There is no reduction in the toxicity, mobility, or volume through treatment for any of the alternatives and the most effective in the short-term is capping of soil and tailing spill deposits.

The Selected Remedy for the Red River, Riparian, and South of the Tailing Facility Area was determined to provide the best overall effectiveness of all alternatives proportional to its costs and hence represents a reasonable value for the money to be spent.

13.3.5 Eagle Rock Lake

The Selected Remedy for Eagle Rock Lake (inlet storm water controls, dredge sediments and on-Site disposal) is equally as effective and permanent in the long term compared to other alternatives that meet the threshold criteria. However, the alternatives for in-lake capping of sediment and backfilling the lake combined with the construction of new lake are more effective in the short term. There is no reduction in the toxicity, mobility, or volume through treatment for any alternative. The estimated costs of the alternatives which meet the threshold criteria are fairly similar. The on-Site disposal of sediment reduces the cost approximately $0.9 million (present value) compared to the cost for off-Site disposal, but provides a similar level of effectiveness.

Based on this comparative assessment, all of the alternatives that achieve the threshold criteria are cost-effective. The Selected Remedy for Eagle Rock Lake is less costly than the off-Site disposal alternative and represents a reasonable value for the money to be spent.

13.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

EPA has 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 Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined 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 State and community acceptance.

13.5 Preference for Treatment as a Principal Element

EPA has determined that the treatment of PCB-contaminated soil and contaminated ground water and surface water satisfies the statutory preference for the selection of a remedy that involves treatment as a principal element.

By treating the Mill Area soil with high concentrations of PCBs (greater than 25 mg/kg) at an approved off-Site treatment and disposal facility, the source material constituting a principal threat waste at the Site is treated.

Treatment of contaminated ground water and surface water (seepage) collected by the remedial systems at the Mine Site Area and Tailing Facility Area is a major component of the Selected Remedy. Water treatment will commence at the start of the remedial action (Year 0 Construction), rather than allowing the ongoing practice of discharging contaminated water to the unlined tailing impoundments. Water balance and loading analyses for the tailing facility indicate that over 75 percent of the water delivered to the impoundments is unaccounted for and, therefore, assumed to leach through the tailing (as tailing seepage) to ground water underlying the tailing facility. Tailing seepage continues to contaminate the alluvial and basal bedrock aquifers.

13.6 Five-Year Review Requirements

CERCLA § 121(c) and the NCP at 40 C.F.R. § 300.430(f)(5)(iii)(C) provide the statutory and legal bases for conducting five-year reviews of a remedy. Because the Selected Remedy includes engineering controls for the majority of the mining waste (*e.g.,* waste rock and tailing), it results in hazardous substances, pollutants, or contaminants remaining on Site above levels that allow for unlimited use and unrestricted exposure. Therefore, a statutory review will be conducted no less often than each five years after the start of the remedy to ensure that it is, or will be, protective of human health and the environment.

The five-year reviews will include an evaluation of current and potential future land uses at the Site. The reviews will also include an evaluation of the appropriate operation and maintenance that will need to be performed to protect the integrity of the Selected Remedy from such land uses.

The five-year reviews will also include an evaluation of the effectiveness of existing government controls (well drilling restrictions) as well as need for future government controls (e.g., ordinances or zoning restrictions by the local government) that are contemplated in this ROD for protecting the integrity of the remedy after remedial construction activities are completed.

14.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The Selected Remedy contains limited significant changes from the Preferred Alternative in the Proposed Plan. They are described below.

- **Cover at the Mill Area** – The Preferred Alternative specified that a 6-inch thick cover of amended Spring Gulch waste rock would be placed at areas designated for commercial/industrial use and up to 36 inches of cover would be placed in areas designated for forestry, consistent with the cover depth requirement set forth in the New Mexico mining permit TA001RE-96-2. After further consideration, EPA has decided that cover or capping of soil in the area designated for commercial or industrial use is not necessary for protecting human health, as PCB contamination in soil will be removed to levels that are considered protective for the commercial or industrial worker.

  Therefore, the 6-inch cover has been removed from the Selected Remedy. A 36-inch thick cover of amended Spring Gulch waste rock will be placed in the areas designated for forestry at mill decommissioning. This is consistent with the cover depth requirement set forth in New Mexico mining permit TA001RE-96-2.

- **Storm Water Management** – The Preferred Alternative specified that contaminated storm water at the mine site would be collected, conveyed, and treated rather than allowing it to infiltrate into the subsurface and contaminate ground water, which is the current practice of storm water management. After consultation with NPDES program personnel, EPA has decided to defer management of NPDES-regulated storm water to the NPDES program, rather than include it with the CERCLA response action.

Storm water discharges on the Site are regulated in part by EPA's Multi-Sector General Permit for Storm Water Discharges Associated with Industrial Activity and CMI's Storm Water Pollution Prevention Plan (SWPPP). The SWPPP provides that contaminated storm water collected from the waste rock piles is directed through conveyance channels and other drainage features to the open pit, subsidence area, catchments, closed basins and ditches at the mine site where it evaporates or infiltrates. Thus, storm water runoff from the waste rock piles may discharge into the subsurface and contaminate ground water.

In NMED's current Discharge Permits, CMI is directed to come up with other means of discharging storm water other than what is currently being done and that it will be disallowed in future permits to keep discharging impacted water to the subsidence zone and the open pit where it has the potential to further contaminate ground water above New Mexico water quality standards. NMED is currently involved with the renewal and modification process for the mine site Discharge Permit 1055 and CMI has been notified that it will have to collect, convey, and treat all storm water that comes into contact with mining waste and is contaminated at levels exceeding water quality standards.

- **Water Treatment** – The Preferred Alternative specified water treatment at both the Mine Site Area and Tailing Facility Area starting at Year 0 Construction. This is unchanged for the Selected Remedy. The water treatment technologies specified in the Preferred Alternative also remain the same for the Selected Remedy. However, as these treatment technologies were developed in a conceptual approach, there are significant Site-specific complexities that preclude final determination of these concepts within this ROD but can be addressed during the subsequent remedial design (RD) (see Section 12.1.2). It is also possible during RD to determine efficiencies in treatment system processes, locations, and sizing that result in cost savings for construction and O&M of the water treatment systems and reduce ongoing O&M and treatment residuals disposal with respect to these systems. These potential efficiencies have not been fully vetted.

Thus, EPA has determined that a performance-based approach is appropriate for water treatment for the Mine Site Area and Tailing Facility Area (see Section 12.1.2) and that the discharge of treated water will be regulated through NPDES permitting.

- **Institutional Controls** – The Preferred Alternative included institutional controls consisting of both proprietary controls recorded by CMI in 2009 to restrict certain land and resource uses at its property and government controls to temporarily restrict well drilling activities until ground water remediation is complete. For the mine site, including the mill and the tailing facility, CMI's proprietary controls are intended to prohibit residential uses (except for park, recreational or athletic field uses at the tailing facility), as well as ground and surface water uses and certain construction activities.

  After consideration of these proprietary controls, EPA has determined that they are not necessary to ensure that the Selected Remedy is protective of human health and the environment and, therefore, they are not included as part of the remedy. The government controls to be established by the New Mexico Office of the State Engineer for temporarily restricting well drilling to limit ground water use are necessary to ensure protectiveness and, therefore, will continue to be part of the Selected Remedy. Other government controls and enforcement tools with institutional control components can enhance remedy protectiveness, *e.g.,* local (village or county) ordinances, permits, and/or zoning to protect source control and water collection and treatment remedy components. Enforcement tools with institutional control components may also enhance protectiveness, *e.g.,* requirements in a consent decree or unilateral administrative order for CMI to restrict exposure to contaminated media before and during implementation of the remedial action and protect source control and water collection and treatment components after mining operations cease. A consent decree or unilateral administrative order might also include provisions requiring EPA and NMED notification prior to a property transfer (USEPA 2000b). Other enforcement tools with institutional control components are the New Mexico ground water discharge permits DP-1055 and DP-933, which require similar notification.

The basis for this determination is discussed below.

- **Mill Area** – In the Mill Area, potential human health risks are associated with exposure to PCB- and molybdenum-contaminated soil. The Selected Remedy will remove the contaminated soil to levels that will be protective of human health under an industrial or commercial land use scenario. Enforcement tools with institutional control components will ensure that use of the Mill Area prior to and during remediation is protective of human health. The placement of the cover and revegetation after decommissioning and closure of the mill facility will protect the environment.

  Based on the history of the site being used for industrial purposes and because it is a likely location for long-term water treatment operations and other activities associated with the Selected Remedy, EPA considers the reasonably anticipated future land uses following closure to be industrial and commercial. Forestry is also an expected future land use as it is one of the MMD-approved post-mining land uses, the other being long-term water management. Therefore, proprietary institutional controls to restrict residential land use are not necessary. Ground and surface water restrictions are also unnecessary because no mining-related ground or surface water contamination was found in the Mill Area. Government controls are contemplated after remediation solely to ensure the long-term integrity of source control remedy components under the anticipated land use scenarios.

- **Mine Site Area** – In the Mine Site Area, potential human health risks are associated with exposure to contaminated ground water, as well as contaminated surface water in mine site catchments and seeps and springs at waste rock piles and along the Red River. The Selected Remedy will restore contaminated ground water over time to MCLs, New Mexico water quality standards, or EPA health-based criteria at all areas of the mine site to protect future residents and future commercial or industrial on-site workers that may use the ground water for drinking water. This will be done by ground water extraction and seepage interception systems, source containment and water treatment. In the interim period until ground water remediation is completed, temporary well drilling restrictions to be imposed by the New Mexico Office of the State Engineer will be used to limit ground water use. The Selected Remedy also includes remediation of surface water by collection and piping of seeps and springs to the Mill Area for treatment and the decommissioning of the mine site catchments to protect recreational visitors and trespassers. Access restrictions[89] (fencing and signage) are currently in place at certain locations of the mine site and will be maintained after cessation of mining. These actions address the human health risks associated with the mine site. Additionally, enforcement tools with institutional control components will ensure that use of the Mine Site Area prior to and during remediation is protective of human health.

The amended and revegetated covers to be constructed on the waste rock piles for limiting water infiltration and acid rock drainage will need to be maintained for the long term. However, EPA does not anticipate human activity that would compromise the integrity of the cover systems. Residential dwellings are less likely to be built on the rock piles because of the rubblized nature of the waste rock, and even if dwellings are built on the flatter portions of the regraded piles, they would be unlikely to compromise the effectiveness of the three-foot thick cover. Non-motorized recreational uses such as cross-country skiing, hiking and hunting are not expected to compromise the cover system. Motorized recreational uses such as ATV use and, to a lesser extent, snowmobiles may impact the cover systems by

[89] Access restrictions such as fencing and signage are not institutional controls.

creating ruts and erosional features, especially before establishment of the vegetative community (including trees). Therefore, government controls such as local ordinances or zoning restrictions by the local government combined with appropriate signage are contemplated after remedial construction is complete to protect the integrity of the cover systems under the anticipated land-use scenarios.

The Selected Remedy does not directly address the open pit or subsidence area. The open pit did not warrant response actions based on risk assessment and the subsidence area was not investigated because of safety concerns associated with conducting sampling in unstable terrain. However, these areas currently pose safety hazards and will likely continue to do so after cessation of mining. The conditions of the open pit may be further modified by future mining and/or as a repository for waste rock under this CERCLA action. The subsidence area and open pit are also open conduits to ground water. CMI has received a waiver from MMD under Mining Permit TA001RE-96-2 for reclaiming the open pit (see Section 2.4.1.2, above). Conditions of the pit waiver include restricting access and maintaining institutional controls to protect public safety. Physical barriers to restrict access include a continuous wire fence and five-foot high berm to be placed around the pit perimeter and signage. CMI must also monitor the stability of the pit walls semiannually to identify potential failure areas which may adversely impact public health or safety and propose measures to mitigate such potential hazards. Once CMI meets all permit requirements with regards to reclamation of the Site under TA001RE (12 year minimum, post reclamation), MMD would fully release CMI from its responsibilities under the New Mexico Mining Act, including those for the open pit and subsidence areas.

Although EPA anticipates the future land use in the higher elevations of the mine site to be limited to the recreational visitor or trespasser, the physical barriers to be used to restrict access to the open pit and monitoring and mitigation of potential safety hazards associated with the pit walls will nevertheless need to be maintained or performed in the long term to protect public health and safety. Access to the subsidence area should also be restricted. Although it may be impracticable to fence off the subsidence area, signage would be appropriate to warn people of the safety hazards. Since the open pit and subsidence area also have an established connection to the underground mine workings and thus ground water, limiting the ability for public access to these otherwise un-remediated and un-reclaimed areas is also appropriate to protect ground water. Therefore, the continued long-term maintenance of the land-use control measures and pit wall monitoring required by MMD for the open pit and the signage along the perimeter of the subsidence area are included as part of the Selected Remedy and will be maintained in perpetuity unless EPA determines during subsequent reviews that the features no longer pose risks to public health and safety or to ground water.

In light of these response actions, the proprietary controls (Deed of Conservation Easement and Declarations of Restrictive Covenants) established by CMI for restricting residential use and ground and surface water uses at the mine site are not necessary components of the Selected Remedy for ensuring protectiveness.

Notwithstanding the government controls and enforcement tools, the integrity the source control measures and access restrictions will need to be monitored and maintained at the mine site to ensure the protectiveness of the Selected Remedy for the long term, and perhaps in perpetuity. If the anticipated land uses change, further CERCLA response actions may be necessary to ensure protectiveness.

- **Tailing Facility Area** – In the Tailing Facility Area, human health risks are associated with consumption of contaminated ground water and incidental ingestion and dermal contact of contaminated tailing pond sediment. The Selected Remedy will restore contaminated ground water over time to MCLs, New Mexico water quality standards, and EPA health-based criteria in the Tailing Facility Area. This will be done through ground water extraction and seepage interception systems combined with source containment and water treatment. In the interim period until ground water remediation is complete, an alternate water supply or point-of-use treatment system (*e.g.,* filter at tap) will be provided for affected homes or businesses. Government controls will also be imposed by the New Mexico Office of the State Engineer for temporarily restricting well drilling during this interim period. The Selected Remedy also includes the regrade and cover of the tailing impoundments after permanent cessation of tailing disposal operations. The tailing ponds will be drained and the tailing sediment covered as part of the response action. The cover will protect human health by prevent exposure to tailing sediment. It will also protect wildlife by preventing exposure to molybdenum in tailing and in plants that take up and bioaccumulate molybdenum and other metals. Enforcement tools with institutional control components will ensure that the use of the tailing facility prior to and during remediation is protective of human health.

  The anticipated future land uses at the tailing facility are light industrial, commercial, residential, and recreational. Wildlife habitat is also an anticipated land use as it is the current MMD-approved post-mining land use. The proprietary controls established by CMI allow light industrial, commercial and certain residential uses (park, recreational and athletic field uses) following decommissioning and closure of the facility. The Selected Remedy will be protective of these land uses. The integrity of the cover will need to be monitored and maintained in the long term and likely in perpetuity. Government controls such as local ordinances or zoning restrictions are contemplated after remedial construction is complete to ensure the long-term integrity of the source control remedy components under the anticipated land-use scenarios.

In light of these response actions, the existing proprietary controls recorded by CMI for the tailing facility are not necessary to ensure the protectiveness of the Selected Remedy.

- **EPA Health-Based Criterion for Molybdenum** – The health-based criterion of 0.05 mg/L for molybdenum in ground water established in the EPA HHRA (CDM 2009a) as a preliminary remediation goal and presented in the Proposed Plan was revised to 0.08 mg/L as the final cleanup level for molybdenum. The 0.05 mg/L value was based on the EPA IRIS reference dose (RfD) of 0.005 mg/kg-day and a daily consumption rate of 1.5 liters of water. After a further literature review, the 0.08 mg/L value was selected based on the daily consumption rate of 1 liter of water in the EPA Child Factors Exposure Handbook published in 2008.

- **Exclusion Fence and Wildlife Drinkers at Tailing Facility** – The Preferred Alternative specified controlled access to the tailing facility by fencing and signage to protect the public and wildlife. However, the existing three-wire barbwire fence surrounding the facility is not effective in restricting access by deer and elk. Based on EPA's BERA, large herbivorous wildlife such as deer and elk are at risk from exposure to tailing through metals uptake and bioaccumulation in plants. Therefore, an exclusion fence (high fence) will be installed around the perimeter of the tailing facility to prevent deer and elk and other wildlife from gaining access to the tailing impoundments prior to closure of the facility and placement of final cover. Additionally, in combination with the exclusion fence, wildlife drinkers will be constructed between the western perimeter of the fence and the Guadalupe Mountains to provide a water source for the deer and elk. The drinkers will be sourced by precipitation catchments of a type to be determined during remedial design. EPA estimates a total of four wildlife drinkers will be constructed.

- **Additional Characterization of Spring Gulch Waste Rock** – Additional characterization of molybdenum concentrations, spatial distribution, and chemical form (oxide and sulfide forms) in the Spring Gulch Waste Rock Pile was added to the Selected Remedy. The Spring Gulch waste rock will likely be the selected borrow material to be used as cover for the other mine site waste rock piles. There are concerns that the concentration of molybdenum in the Spring Gulch waste rock could pose a threat to wildlife and plants through the uptake of molybdenum in plants. To address these concerns, EPA has developed a molybdenum suitability criterion for screening Spring Gulch borrow and a successful plant growth performance-based remediation goal. A limited number of samples were collected and analyzed for chemistry during the RI/FS and as part of past state-directed studies. Further characterization is therefore warranted in the pre-design phase of the Selected Remedy.

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PART 3
RESPONSIVENESS SUMMARY

1.0 INTRODUCTION

As required by CERCLA § 117 and the NCP at 40 C.F.R. §§ 300.430(f)(3)(i)(F) and 300.430(f)(5)(iii)(B), the Responsiveness Summary provides information about the views of the public, the State of New Mexico and the federal and State natural resources trustee agencies regarding both EPA's Preferred Alternative and other remedial alternatives presented in the December 2009 Proposed Plan as well as general concerns about the Site. Comments expressing these views and concerns were submitted in writing to EPA during the Public Comment Period, which was held from January 6, 2010 through March 31, 2010, or expressed orally at one of the three public meetings held by EPA. The Responsiveness Summary also presents EPA's response to each comment. The summary further documents, in the record, how comments were integrated into EPA's decision-making process.

EPA received 237 comments from over 100 individuals, several environmental groups and 5 federal and State of New Mexico agencies or departments. The commenters included Chevron Mining Inc (CMI), the New Mexico Energy Minerals and Natural Resources Department (EMNRD) and Department of Game and Fish (NMDGF), and the U.S. Forest Service. The comments have been organized into three general categories: Public Comments, State of New Mexico Comments and Natural Resources Trustee Agency Comments. Because of numerous duplicate and similar-issue comments, EPA has further organized the public comments into several categories and consolidated as well as paraphrased the comments when possible. In consolidating the comments, EPA thoroughly reviewed every comment submitted to ensure that the summary comments captured every stakeholder concern.

The categories of public comments are as follows:

- CERCLA Process
- Preferred Alternative
  - General Comments
  - Mill Area
  - Mine Site Area
  - Tailing Facility Area
  - Red River and Riparian and South of Tailing Facility Area
  - Eagle Rock Lake
- Institutional Controls
- Community Issues and Involvement
- Red River State Fish Hatchery
- Remedial Investigation
- Human Health and the Environment
- Preliminary Remediation Goals
- Applicable or Relevant and Appropriate Requirements
- Five-Year Solar Facility and Cover Depth Pilot Study
- Red River Watershed Restoration
- Natural Resources
- Financial Assurance
- Enforcement
- Timing of Remedial Activities
- Other

EPA received separate comments from several individual stakeholder groups on the topic of closure of the tailing facility; primarily requesting mitigation of further releases of contaminants from the facility to ground water. In addition, there were over 100 residents that signed a cover letter concurring with Amigos Bravos comments on EPA's Proposed Plan, one of which was immediate closure of the tailing facility. This topic is only presented once below, along with several other related comments.

A majority of the federal and New Mexico regulatory agencies and departments, the Village of Questa, environmental groups, as well as a significant number of community members that submitted comments on the Proposed Plan have complimented EPA on the work it performed over the past 10 years. The U.S. Fish and Wildlife Service and New Mexico Ecological Services Field Office in Albuquerque, New Mexico, collectively agree that EPA's preferred alternatives appear to be appropriate and adequately protect trust resources. NMDGF supports EPA's alternatives for all areas of the Site. The Village of Questa and the Mayor are very accepting of EPA's cleanup plan and feel that it is a good plan for the Village. The Red River Restoration Group (R3G) commends EPA and its team on the entire 10-year effort, but urges EPA to implement the plan in an expeditious manner. The R3G further states that regulators and technical participants need to "quit talking and start doing remediation." The Northern New Mexico Group of the Sierra Club broadly supports the cleanup plan and the River Network supports the overall approach to controlling acid mine drainage by source containment and collection and treatment of contaminated water. Amigos Bravos also commends EPA for taking many of its concerns into account in developing the cleanup plan and for choosing source containment and water controls and treatment for both the mine site and tailing facility. One commenter commends EPA, NMED, and the other stakeholders for the rigorous investigations of the environmental problems associated with the Site and the quality of the science used during the study.

2.0 STATE OF NEW MEXICO COMMENTS AND EPA RESPONSES

2.1 New Mexico Energy, Minerals, and Natural Resources Department

Comment 1: EPA's preferred alternative for the Mill Area is Alternative 3 – Soil Removal (High Concentrations of PCBs greater than 25 mg/kg) and Off-Site Treatment and Disposal (Low Occupancy/Commercial/Industrial). According to the Plan, approximately 2,400 cubic yards of soil with total polychlorinated biphenyls (PCB) concentrations above the Toxic Substances Control Act (TSCA) cleanup level of 25 mg/kg for low occupancy/ commercial/ industrial use would be excavated from an area covering about 0.6 acres, and transported off-Site for treatment and/or disposal at EPA-approved facilities. The depth of excavation is estimated at 2.5 feet. Confirmation soil sampling would be performed to determine if cleanup levels have been attained. If not, additional soil would be excavated until cleanup levels are met or an EPA-acceptable depth has been reached. The excavation would be backfilled with clean fill (Spring Gulch rock pile material) and graded. Low occupancy use cleanup standards were selected for this alternative based on the current industrial use of the Mill Area, and the approved post-mining land use of forestry and water management under the New Mexico Mining Act Permit TA001RE-96-2. As part of mill decommissioning, the Mill Area would be covered with 6 inches of amended Spring Gulch waste rock and revegetated to allow for the development of a self-sustaining forest ecosystem comparable to the surrounding region.

EPA needs to clarify the depth of cover for the Mill Area. The description of the post-mining land use as forestry and water management requiring a 3-foot cover is inconsistent with the suggestion that a 6-inch cover will be used to cover the Mill Area in the preferred remedy. At a minimum, an 18-inch cover should be required for any anticipated future use in order to protect any underlying contaminated materials from common anthropogenic (human caused) or wildlife activity.

It is, therefore, recommended that the ROD require a 3-foot cover over the entire Mill Area unless otherwise justified as part of the remedial design or other identified post-mining land use.

Response 1 (29): *The Selected Remedy for the Mill Area specifies that the cover depth will be 36 inches for areas designated as forestry. This is consistent with mining permit TA001RE-96-2. The 36-inch cover depth is considered protective of vegetation that may take up molybdenum from Mill Area soil or herbivorous native wildlife that may graze in the area.*

The Selected Remedy does not specify a cover for the area to be designated for commercial or industrial use since PCBs will be removed to a level considered protective of human health. Therefore, other than backfilling and regrading the excavation, additional cover or capping of residual PCB or molybdenum contamination is not necessary for protecting the future commercial or industrial worker. Although this is inconsistent with permit TA001RE, EPA's CERCLA response action does not, in any way, limit MMD's authority under its New Mexico Mining Act and regulations to require CMI to meet cover depth or any other requirements set forth in permit TA001RE.

Comment 2: Currently, the post mining land use for the Mill Area is designated as "forestry," and the NM Mining and Minerals Division (MMD) permit (No. TA001RE) requires three feet of suitable cover material to reestablish a self-sustaining forest community. It is likely that some portion of the Mill Area will be redesignated as "light-industrial" to accommodate water treatment facilities. The 6-inch cover thickness called for in EPA's Proposed Plan alternatives, for light-industrial areas, is insufficient to meet the current requirements of the permit. The ROD should allow for the process of modifying the MMD permit to coincide with the ROD, as well as some flexibility for the negotiation of a suitable cover thickness, between MMD, EPA, and CMI as plans for the Mill Area become more well-defined.

Response 2: *As stated in the previous response, the six-inch cover depth specified in the Proposed Plan for areas to be designated for commercial/industrial use is not necessary to protect human health and, therefore, has been removed from the Selected Remedy. A 36-inch amended and revegetated cover is required for those areas that will be designated for forestry to protect herbivorous native wildlife or vegetation from the high concentrations of molybdenum in the soil at the Mill Area. This is consistent with mining permit TA001RE-96-2.*

The exclusion of a cover (or cap) for the area to be designated for commercial/industrial use in this CERCLA response action does not limit, in any way, MMD's authority to require cover for such area under the New Mexico Mining Act and regulations.

Comment 3: In MMD's view, the rock piles represent the greatest challenges to reclamation at the mine, both from the standpoint of regrading to long term stable surfaces, as well as the establishment of a productive vegetative community. It is likely that a series of preliminary efforts will be required to find a prescriptive remedy that will satisfactorily address these challenges.

Response 3: *EPA agrees with MMD's comment.*

Comment 4: Spring Gulch waste rock is considered by MMD to be of marginal quality as a cover material. MMD is concerned that elevated levels of molybdenum in this material may be bio-available to the extent the molybdenum accumulation in plant tissues may produce long-term negative impacts in the creation of a self-sustaining ecosystem. Some study effort should include measures of molybdenum uptake by plants with co-located media samples to quantify oxide and sulfide species of molybdenum. As you may be aware, a Wildlife Impact Study Report (URS, November 22, 2004), showed potential for molybdenum to bio-accumulate in plant tissues sampled from shallow-covered tailings at the Questa tailings facility.

Response 4: *EPA agrees and has included such measures as part of the Selected Remedy for the Mill Area and Mine Site Area.*

Comment 5: MMD supports EPA's commitment to conduct future treatability studies as the remedial design is developed. MMD encourages an early start along this learning curve, and supports any efforts that EPA can take to hasten early-stage reclamation and remediation of some rock slopes to serve as learning tools for later efforts. MMD recommends that treatability studies should incorporate variable amendment types, rates and application methods, as well as re-grading strategies that promise more stable slope configurations, such as geomorphic re-grading designs.

Response 5: *EPA agrees with the use of treatability tests in conducting the remedial design and remedial action for the waste rock piles. However, as stated in the ROD, these additional tests will not delay the remediation of the waste rock piles but be used concurrently as part of a phased approach for remediation, beginning with a pilot study on one or two waste rock piles. EPA recognizes that completing an evaluation of optimal vegetative growth and performance during testing may take several years. But while such testing is ongoing during the first pilot study(ies), design and construction work will continue on the next phase of remediation for the waste rock piles. It is unfortunate that the previous 10-year vegetation test plot studies conducted by CMI were so limited in scope and design (including application of amendments). A broader range of tests with multiple amendments, application rates and methods would have been useful.*

EPA also agrees that geomorphic re-grading designs warrant consideration and will be evaluated during remedial design. However, geomorphic designs will not be used if such designs require sacrificing cover performance in limiting infiltration and net percolation in waste rock as source control for the remediation and protection of ground water.

Comment 6: The pilot solar panel facility and associated cover thickness study promises to provide useful information to compare to the currently planned three (3) feet of cover by the MMD permit (TA001RE). However, surface drainage and final cover slope are not discussed. EPA should include specifications about grading practices and slope construction for the tailing cover to encourage positive drainage from the tailing. Based on performance of reclaimed tailings at other mine sites, we anticipate that any design with less than 1 percent overall slope may suffer from post-construction differential settling that leads to ponding and unpredictable drainage patterns or erosion. The remedy should call for overall elevation gradients across the tailings surface to exceed 1 percent and incorporate a more natural drainage pattern with some minimum drainage density, laid in a hierarchical or dendritic pattern to incorporate features of a natural functioning geomorphic design.

Response 6: *EPA agrees with MMD's comment that overall elevation gradients across the tailings surface should exceed 1 percent. The Selected Remedy specifies that the final tailing facility surface will be graded to slopes between 1 to 5 percent in order to provide for long-term diversion of flow around and from the surface of the tailing impoundments. With regards to the other suggestions by MMD on drainage patterns, EPA believes it is more appropriate to develop these details during remedial design. The details mentioned in the comment above are typical (or minimal) design requirements of a cover system for waste left in place.*

2.2 New Mexico Department of Game and Fish

Comment 7: For the mine site, Preferred Alternative 3B comprises source containment by re-grading the rock piles to achieve a 2:1 slope, covering them with soil and native vegetation and constructing a new treatment system to collect and treat contaminated mine waters. This alternative is preferable to 3A because of the reduced area of surface disturbance, both in terms of the rock pile footprint and the potential need for an on-site repository, as well as improved feasibility. Existing test plots have shown that the covered rock pile surfaces can hold a 2:1 slope with even minimal vegetation. We urge the EPA, when conducting the engineering studies necessary to support this action, to remain flexible toward the use of "geomorphic" options using variable slope/cover thickness combinations, as has been proposed in the past by CMI.

Response 7: *EPA agrees. All options will be considered during the remedial design for the waste rock piles. However, the geomorphic design will not be used if it sacrifices other aspects of the cover design for adequately reducing infiltration and net percolation through the waste rock piles for remediating and protecting ground water.*

Comment 8: Due to the poor performance of existing revegetation test plots at the mine site, the New Mexico Department of Game and Fish strongly supports the implementation of revised test plots as part of the selected action, incorporating soil amendments, as described in EPA's Proposed Cleanup Plan on page 110-111.

Response 8: *EPA agrees. See response to Comment 5 above.*

Comment 9: The RI Report documents surface water in the mine site seepage catchments with hazard quotients greater than one for several metals. The catchments were not included for detailed evaluation of ecological risk because they will not contain trout. However, the most likely receptors for ingestion of seepage catchment water are terrestrial and flying wildlife, which may use the impoundments for drinking. The proposed clean-up plan states that the preferred alternative will protect recreational visitors/trespassers from direct contact with seepage and seepage catchments through the use of fencing and piping. The conclusion of low ecological risk should be contingent on maintenance of effective wildlife exclusion measures at any catchments that remain after implementation of the selected action.

Response 9: *EPA did not evaluate terrestrial receptors because the catchments and impoundments are small, in many cases intermittent, and after a "first use" the receptor would never go back because better quality water (ponds and river) is available. Also, the catchments are not very suitable or attractive to most wildlife when filled with water (e.g.,* *lack of cover along the banks). Additionally, for ecological receptors, EPA was concerned about population effects, and these small, intermittent and isolated occurrences would not have population effects (e.g., birds, raccoons). This is especially true because most of the catchments only contain water intermittently. Therefore, frequent or long-duration exposures would be unlikely.*

Trout was evaluated because it is the primary receptor in the Red River where these water bodies could discharge to. Therefore, trout is the most likely receptor to be impacted. Although these catchments are not known to discharge to the river, if they did regularly, fish in the Red River could suffer individual and possibly population-level effects at least on a local basis.

The mine site seepage catchments near the base of the Capulin and Goathill North waste rock piles will be removed as part of the Selected Remedy. The management of storm water at the mine site is conducted pursuant to the NPDES Multi-Section General Permit for Storm Water Associated with Industrial Activity (MSGP). It is not regulated by CERCLA and, therefore, the Selected Remedy does not address storm water catchments at the mine site. However, as previously stated, the intermittent occurrence of water in these catchments, frequent or long-term exposure by ecological receptors is unlikely.

Comment 10: In regards to the approved solar energy and cover depth pilot demonstrations at the tailing facility, the New Mexico Department of Game and Fish is not opposed to this use of the facility, however, we believe that a one-foot cover depth should not be considered because it may not be feasible to maintain it in the long term, even if it is deemed "successful" in a short term evaluation period. Five years is not a sufficient period to judge either vegetation success or uptake of molybdenum and other contaminants from the underlying tailing material.

Response 10: *In a joint letter to CMI, dated November 13, 2009, EPA, NMED and MMD have agreed to consider the five-year demonstration of alternate cover depths of 1, 2 and 3 feet, but require that such demonstration be successful at protecting human health and the* *environment, as well as surface water and ground water resources, for it to be considered as part of any CERCLA response action or final closure under NMED's and MMD's permitting programs (see Appendix B of this ROD). EPA, NMED and MMD also agreed that if the pilot demonstrates, through data collection and monitoring, that a 1- or 2-foot cover depth can meet the agencies defined measures of success, including the uptake of molybdenum, then EPA will modify the remedy and NMED and MMD will support a request to modify the mining permit (TA001RE) and ground water discharge permit (DP-933). If, as the New Mexico Department of Game and Fish indicate, that such time period is insufficient to judge these measures, it may be necessary to extend the pilot demonstration. Additionally, in the event that the five-year cover depth pilot demonstration is successful and a 1- or 2-foot cover is used as part of the remedy for the tailing facility, the CERCLA five-year reviews to be conducted for the Site will allow EPA to continue evaluating potential metals uptake (including molybdenum) in plants growing at the tailing facility well beyond the initial five-year timeframe for the pilot demonstration. EPA has included the monitoring of metals uptake in plant tissue as part of the remedy for the Tailing Facility Area. If it is determined that the cover depth is not protective (e.g., molybdenum uptake in plants is at a level that may be harmful to the plants or wildlife), additional response actions will be required.*

Comment 11: EPA's RI indicated that the tailing pond surface water impoundments have both water and sediment contamination which may present a hazard to wildlife (most notable sediment contamination). As mentioned above regarding mine site catchments, these impoundments are used by terrestrial and flying animals for drinking and by waterfowl for migration rest stops and nesting. It is likely that waterfowl ingest contaminants while eating plant and invertebrate material, as well as directly through drinking water. Although the impoundments are not considered "suitable aquatic habitat," presumably because they will be eliminated following the completion of mining activity, they do present a risk to wildlife now and for the short-to medium-term future.

Response 11: *In the Baseline Ecological Risk Assessment (BERA) EPA estimated risk to waterfowl below levels which require a response action. However, the risk estimated to* *large herbivorous animals (deer and elk) from exposure to tailing was significant. EPA has included the use of an exclusion fence (high fence) and wildlife drinkers as part of the Selected Remedy for the Tailing Facility Area to protect such animals until closure of the facility and placement of the final cover.*

Comment 12: The spring which supplies drinking water to the New Mexico Department of Game and Fish Red River Hatchery exceeds the EPA selected preliminary remediation goal for molybdenum concentration, due to contamination from a ground water plume originating at the mine tailings. While there is no applicable state standard, and the exceedance is not large in magnitude, it has been persistent and may reasonably be expected to persist in the future (J. Marcoline, NMED, personal comm.). The New Mexico Department of Game and Fish requests that CMI provide and maintain either an alternative drinking water source, or a means of purifying the water, in order to protect the health of our hatchery employees and their families. In addition, there should be ongoing monitoring of the spring water, which is also used for hatchery operations, as well as an analysis of the molybdenum content of the fish reared in the spring water and potential impacts to the public from eating these fish.

Response 12: *Although the levels of molybdenum in the tap water at the Red River State Fish Hatchery are currently below EPA's health-based cleanup level, CMI currently provides bottled water to the hatchery as an alternate source of drinking water in light of concerns raised by hatchery personnel. In early 2010, EPA, NMED and CMI meet with the New Mexico Department of Game and Fish and hatchery personnel to discuss the protective level (preliminary remedial goal) to be set by EPA for molybdenum in ground water. In EPA's Baseline Human Health Risk Assessment (HHRA), EPA had developed a protective level of 0.05 mg/L for molybdenum in ground water based on EPA's Integrated Risk Information System (IRIS) reference dose (RfD) of 0.005 mg/kg-day and a daily consumption rate of 1.5 liter of water. After further evaluation, a revised protective level of 0.08 mg/L for molybdenum was developed by EPA based on a daily consumption rate of 1 liter of water established in the updated EPA Child Factors Exposure Handbook published in 2008. The new protective level (0.08 mg/L) is the cleanup level selected by*

EPA in the ROD for molybdenum in ground water. The concentration of molybdenum in tap water at the hatchery is below this cleanup level, but the trend in concentrations over time has been increasing. Therefore, EPA will continue to closely monitor water quality at the hatchery.

Additionally, EPA has included as part of the Selected Remedy the provision of a temporary alternate water supply or point-of-use treatment system until ground water remediation is completed. EPA has also included monitoring of ground water at all wells, seeps and springs as part of the Selected Remedy for the Tailing Facility Area. This includes the seeps and springs in the area of the hatchery.

Comment 13: During removal of contaminated soil from the Red River riparian zone and south of the tailings facility, best management practices should be applied to minimize physical damage or indirect kill by dewatering of native riparian vegetation. Any woody riparian vegetation which is removed or damaged should be replaced at a 2:1 ratio. The New Mexico Department of Game and Fish also requests advance coordination regarding tailing spill cleanup, as this action could have major effects on our angler constituents.

Response 13: *Removal of soil south of the tailing facility will require dewatering of the soil because ground water is very close to the ground surface. However, EPA will make every effort to minimize the physical damage to vegetation and other aspects of the environment. As stated in Section 12.2.7 of the ROD, remediation will be conducted consistent with EPA's 2010 Superfund Green Remediation Strategy and EPA Region 6's 2009 Clean and Green Policy to reduce the environmental footprint of the cleanup to the maximum extent possible. Remedial activities will be carried out in a manner that, to the extent possible, includes (1) minimizing further harm to the area, (2) protecting ecosystems at or near the Site, and (3) fostering the return of impacted areas to ecological uses, as appropriate. The revegetation measures to be implemented after soil removal will be developed during remedial design. Any woody riparian vegetation that is removed or damaged during construction activities will be replaced at a ratio that will restore the native riparian area to pre-impacted and pre-construction conditions.*

As was done during the RI/FS, EPA will continue coordination with stakeholders, including the New Mexico Department of Game and Fish, during the Remedial Design and Remedial Action phases of the project. EPA welcomes the New Mexico Department of Game and Fish's input and participation in the cleanup process, especially for the work along the Red River riparian corridor.

Comment 14: Regarding Eagle Rock lake, please coordinate with the New Mexico Department of Game and Fish – Fisheries Division (505-476-8055) regarding dredging of the lake, as this could have major effects on our angler constituents and may require fish salvage. We also request additional consultation on potential enhancements to fish habitat which might be incorporated during the construction operations.

Response 14: *EPA agrees to coordinate with the New Mexico Department of Game and Fish – Fisheries Division during all planning and implementation of dredging and fish salvage operations at Eagle Rock Lake. EPA recognizes the need to salvage the fish in Eagle Rock Lake prior to dredging. EPA will also evaluate opportunities to potentially enhance fish habitat if they are presented during the cleanup.*

Comment 15: If the spring which supplies drinking water to the New Mexico Department of Game and Fish Red River Hatchery at any time exceeds the EPA selected remediation goal for molybdenum, the Department requests that CMI provide and maintain either an alternative drinking water source, or a means of purifying the water, in order to protect the health of our hatchery employees and their families.

Response 15: *EPA agrees. See response to Comment No. 12 above.*

3.0 NATURAL RESOURCE TRUSTEE AGENCY COMMENTS AND EPA RESPONSES

3.1 U.S. Department of Agriculture – Forest Service

Comment 16: In reviewing EPA's Proposed Cleanup Plan, we noted the remediation work that will occur at Eagle Rock Lake. As noted in the Plan, the Lake and the surrounding area are on National Forest System (NFS) land. As you may also know, the President's authorities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) are delegated to a variety of federal agencies through Executive Orders 12580 and 13016. The majority of CERCLA authorities are delegated to EPA. However, there are some CERCLA authorities delegated to federal land management agencies such as the Forest Service and the Bureau of Land Management (BLM). These federal land management agencies have the authority to implement and oversee CERCLA work that occurs on land under their jurisdiction. The federal land management agencies have this authority where, as here, the response action is not an emergency and the site is not on the National Priorities List. We know that Eagle Rock Lake is a relatively small component of the overall remedy, but we wanted to at least raise this issue with you now. Relatively soon after the ROD, we would expect EPA, NMED and Chevron to move toward implementation of the remedy. The implementation could occur through an administrative order or a consent decree. When the parties begin to develop an order or decree, we ask that the Forest Service be included as a party to the document.

Response 16: *The CERCLA authority delegated to the U.S. Forest Service and other federal land management agencies to conduct a remedial action and issue administrative orders is conditional. Executive Order 12580, 61 Fed. Reg. 45871 (August 30, 1996),* *provides that such authority may not be exercised where EPA is the lead federal agency "for the conduct or oversight of a response action." EPA determines whether it is the lead agency, consistent with Executive Order 12580 and the NCP. Memorandum of Understanding Among the Environmental Protection Agency, United States Coast Guard, Department of Commerce, Department of the Interior, Department of Agriculture, Department of Defense, Department of Energy, and Department of Justice Concerning the Exercise of Authority Under Section 106 of the Comprehensive Environmental Response, Compensation, and Liability Act, Section IV B at 6. (Feb. 10, 1998). Since EPA has provided the Remedial Project Manager to plan and implement response actions at the Site under the NCP, it is the lead federal agency. 40 C.F.R § 300.5 (definition of "lead agency").*

Decisions relating to entering into a consent decree with a PRP or, if an agreement cannot be reached, issuing a unilateral administrative order to a PRP to perform the remedial action will be made during the RD/RA phase which is the next step in the CERCLA process following issuance of the ROD. If an agreement is reached between EPA and the PRP by which the PRP agrees to perform the remedial action, DOJ will commence an action under CERCLA § 106(a) by filing a complaint in federal court in which the United States is named as the plaintiff and the PRP is named as the defendant. Neither EPA nor any other federal agency will be named as a party in the complaint or the consent decree.

EPA will continue to consult with DOA, DOI, the federal natural resources trustees, other appropriate federal agencies and New Mexico agencies to ensure that human health and the environment are protected during the RD/RA phase.

Comment 17: Page 22 of EPA's Proposed Plan indentifies metals contamination in Eagle Rock Lake bottom sediments. It is further stated that the "source of the metals contamination is sediment carried by the Red River, which enters the lake in suspension… during periods of high flow." We assume that EPA, through the remedial investigation, has made a connection between the historical leaks in the tailings pipeline (1966 to 1991) as described on page 5 of the Plan, and the contaminated sediment in Eagle Rock Lake. As such, we would recommend that this connection of tailings spills from the pipeline and ultimate deposition of these contaminated materials into Eagle Rock Lake be clarified as part of the description of Eagle Rock Lake.

Response 17: *EPA has included a discussion of the extent of contamination at Eagle Rock Lake, as well as the findings of the U.S. Geological Survey's (USGS's) study of Eagle Rock Lake in the ROD. USGS conducted geochemical studies of sediment from Eagle Rock Lake to evaluate the effect on the lake by CMI's mining operation. USGS found a pattern of increasing concentrations of several medals, including molybdenum, in Eagle Rock Lake sediment from about the early 1960s based on analysis of a sediment core. USGS concluded from the study that "loss of mill tailings from pipeline breaks is most likely responsible for some of the spikes in trace element concentrations in the Eagle Rock Lake core. See USGS Questa Baseline and Pre-Mining Ground Water Quality Investigation 8: Lake Sediment Geochemical Record from 1960 to 2002, Eagle Rock Lake and Fawn Lakes, Taos County, New Mexico.*

Comment 18: As was pointed out in the presentation on February 23, 2010 by EPA personnel and stated on page 47 of the Proposed Plan, Eagle Rock Lake is a popular recreation site of the local community and is stocked by the New Mexico Department of Game and Fish as a put and take fishery, as well as many other summer events. In addition, the lake is the site of the annual "Fish Fiesta" – an event sponsored by the U.S. Forest Service, U.S. Department of Agriculture's (DOA's) Bureau of Land Management (BLM), and the town of Taos as an education effort to familiarize local youth with aquatic environments and introduce them to fishing as a recreational activity. This event typically serves several hundred youths and their parents.

As final plans and engineering design are initiated for the remedial actions at Eagle Rock Lake, we request that up front coordination by EPA and NMED be conducted with the U.S. Forest Service and New Mexico Department of Game and Fish to address the following closure logistics and salvaging existing fish:

- Timing and length of lake closure;
- Necessary security measures (road closures, fencing, etc.) required to implement the remedial actions and protect the public;
- Impact to existing infrastructure at the lake (parking lot surfacing, trails, picnic tables, etc.) that may occur during dredging and de-watering of contaminated sediment;
- Coordination with the U.S. Forest Service and New Mexico Department of Game and Fish to salvage resident fish prior to dredging; and
- Replace or repair existing recreational infrastructure needed to return the lake to an operational condition for our Forest visitors.

Perhaps EPA and NMED would also be interested in participating in an upcoming Fish Fiesta (prior to implementation) to communicate to the local public the objectives of the remedial actions and enhanced conditions of the lake that will result.

Response 18: *EPA agrees to early and continued communication and coordination of all Eagle Rock Lake cleanup activities with the U.S. Forest Service, as well as the New Mexico Department of Game and Fish. EPA has specified such communication and coordination in this ROD.*

Comment 19: Another concern of the actions proposed at Eagle Rock relates to ongoing plans to re-construct the dam at Cabresto Lake, also located on the Questa Ranger District. These two lakes provide the only flat water fishing opportunities easily accessible to local residents and visitors alike. We request the remedial actions at Eagle Rock Lake be timed and coordinated with the Ranger District such that one of the lakes remains available to the public for recreational use if at all possible.

Response 19: *EPA agrees and has indicated such coordination in the ROD.*

Comment 20: Page 78 of the Proposed Plan outlines in greater details the alternatives evaluated by EPA for Eagle Rock Lake. In addition to the dredging of lake sediments discussed above, another element of the remedy described involve engineering controls at the inlet structure to reduce future sediment load from entering the lake. These controls are described conceptually as being design to automatically close the head gate when either the specific conductivity or turbidity of the river increases to values indicative of high sediment load in the river.

Recognizing that design and final engineering of these controls are not complete, we request EPA consider the following comments related to the proposed Engineering Controls:

- The need for a power supply (i.e. self contained or line power);
- The need for routine future maintenance and calibration of the proposed instrumentation;
- The need for security measures at the head gate to prevent theft or vandalism of the instruments; and
- The economic impact to the U.S. Forest Service of future maintenance, upkeep, and likely replacement of instrumentation should these be expected to be borne by the U.S. Forest Service.

Any engineering controls installed as a part of this remedy should include future funding from the responsible party for maintenance and repair to ensure the longevity of the remedy.

Response 20: *Once the ROD is issued, EPA will begin formal negotiations with CMI, the responsible party, for it to conduct or pay for the cleanup of the Site. If CMI conducts the cleanup, it will be expected to perform or fund maintenance and repair on the engineering controls for the inlet structure.*

Comment 21: Page 80 of the Proposed Cleanup Plan describes two types of dredging operations considered suitable for proposed remedial actions at Eagle Rock Lake: (1) hydraulic dredging from a barge, or (2) drainage of the lake to allow the sediments to dewater, followed by excavation. We offer the following comments:

Hydraulic dredging usually introduces quite a lot of additional water into the sediment making it more "runny" and difficult to dewater and haul. There is very limited storage area in the vicinity of the lake. With long time frames to dewater sediments needed and limited storage area available, the actual work at Eagle Rock Lake will likely be extended in time. This concern is stated above – with respect to the recreational value and level of use of this lake by Forest visitors.

Draining the lake might be difficult as this pond was dug out for gravel, implying there might be a fairly rapid inflow of water from the surrounding alluvium and adjacent Red River. The water would have to be pumped continuously during excavation resulting in highly turbid, sediment laden water that could not be discharged directly to the Red River.

A third choice, utilizing a dragline, such as those commonly used in underwater gravel pits might also be considered. The dragline could operate from the north shore of the lake and pile the sediment along the access road, parking lot, and field north of the pond, taking care to preserve the two nice existing trees by the parking lot. The dragline is a lot slower than an excavator, but has a much longer reach so that disturbing the south shore or draining the lake would not be necessary. We offer these comments as a possible means to accomplish the remedial objectives while minimizing the length of lake closure, and the overall cost of implementation.

Response 21: *EPA thanks the U.S. Forest Service for its comments. They will be considered during remedial design.*

Comment 22: In addition to Eagle Rock Lake, we note the work that will occur in the "Red River, Riparian and South of Tailings Facility Area." Some of this area occurs on

National Forest System (NFS) land. For the same reasons as noted above, we request to be a party to the order or decree that implements work for the final remedy. Also, we understand from the Plan that most of the remedial activities will occur on public lands managed by the Bureau of Land Management. For that reason, EPA may wish to consult the U.S. Department of the Interior (DOI) on whether it should be included in ad administrative order or consent decree for the final remedy.

Response 22: *See response to Comment No. 16 above.*

Comment 23: Page 21 of the Proposed Plan identifies metals contamination in tailings spills. The tailings pipeline and access road traverses National Forest System (NFS) lands along the Red River. It is also stated that most of the 3,800 cubic yards of remaining tailing spills is located near the Lower Sump Dump. Since no other geographic reference is provided, we can only assume at least a portion of these tailing spills occur on NFS lands and removal actions will need to be coordinated with the U.S. Forest Service.

Response 23: *If any portion of the documented tailing spills is on federal lands, EPA will coordinate cleanup activities with the appropriate federal agency.*

Comment 24: Page 46 of the Plan states "… surface water will be addressed through reduction of inputs from sources to the river, such as upwelling of alluvial ground water and seepage into the river from seeps and springs near the Mine Site Area." The U.S. Forest Service would comment that efforts to reduce ecological risk from metals contamination to protect aquatic ecosystems (receptors) are a worthwhile endeavor.

Response 24: *No response is necessary from EPA.*

3.2 U.S. Department of Agriculture – Bureau of Land Management (Taos Field Office)

Comment 25: BLM is concerned with the lack of control mechanisms in the Preferred Alternative proposed for the area south of Dam No. 4 to remediate basal alluvial and bedrock contamination in ground water. It is understood that the risk to public health downstream of Dam No. 4 is reduced as the resident population is small and contamination levels are lower. However, contrary to the description on page 21 and 43 of the Proposed Cleanup Plan, the Red River Valley south of the tailings facility is a popular fishing and recreational area that is heavily used by the general public and Questa community. While this area is rugged and remote, there is a vehicle access point to the fish hatchery that allows easy hiking access in both directions on the river.

Response 25: *EPA's HHRA accounted for recreational visitors (including anglers) to the Red River and the results of this assessment indicated that there was no substantial risk to those receptors. The only risk to people from exposure to the contaminated ground water is through a lifetime of consumption (drinking) of the water. At this time, EPA is not aware of any human exposure from drinking the contaminated ground water south of Dam No. 4, with the exception of the Red River State Fish Hatchery. However, concentrations of molybdenum at the hatchery are currently below EPA's health-based cleanup level of 0.08 mg/L. Although the molybdenum levels are below EPA's cleanup level, CMI is providing the hatchery with bottled water at the request of hatchery personnel and the New Mexico Department of Game and Fish.*

Comment 26: It does not appear that the EPA is considering the lost potential for BLM to drill wells for recreational or cattle use as a result of underlying contamination from Dam No. 4.

Response 26: *EPA has selected government controls to limit exposure to contaminated ground water. Temporary well drilling restrictions will be sought from the New Mexico*

Office of the State Engineer for those lands where ground water contamination is present. EPA has also included the provision of an alternate water supply or point-of-use treatment system (e.g., filter at the tap) to persons that use the ground water as a drinking water supply. If BLM intends to use existing wells on BLM-managed lands to collect ground water for drinking purposes, and the ground water is shown to be contaminated, then provision of an alternate water supply or treatment system is appropriate. If BLM is prevented from drilling water wells to obtain needed water for drinking purposes, such provisions would also be appropriate. As stated in the previous response (Response No. 26), EPA's HHRA indicated that there was no substantial risk to recreational visitors. The contaminated ground water south of Dam No. 4 presents a risk to an individual that would drink the water over a lifetime. Additionally, EPA did not estimate risk to ecological receptors from exposure to contaminated ground water in the BERA.

Comment 27: The primary cause of contamination below Dam No. 4 of the tailings facility is associated with process water from mining activity and precipitation. Therefore, it seems that the final cleanup plan should include a reduction of water being delivered to the tailings – an action that can be implemented immediately – as well as an effort to treat contaminated basal alluvial or bedrock ground water below Dam No. 4. At the public meeting, EPA mentioned that the cost of treatment of ground water in this area was considered too expensive. This cost could be reduced if best management practices result in reduced delivery of water to the tailing facility, resulting in less water seeping through tailing, and if only basal alluvium was treated. In addition, this cost seems small relative to the overall costs of the plan. BLM prefers off-site ground water treatment as described in Alternative 4 and supports the selection of Alternative 4. BLM hopes that EPA will reexamine its preferred action regarding the tailing facility to provide better protection to the public and aquatic resources in the Wild and Scenic Red River and Rio Grande.

Response 27: *The current use of the bedrock volcanic aquifer as a source of water for drinking is limited (the exception being primarily the Red River State Fish Hatchery) and EPA anticipates that any future increase in such use is unlikely given the rugged landscape and remoteness of the area. Therefore, Alternative 4, with an increase in present value* *cost of approximately $85,000,000 over the Selected Remedy, was not cost effective. If such ground water use or the potential for such use changes in the future, further response actions would be required to ensure the protectiveness of the remedy.*

Comment 28: The BLM is concerned that the plan does not address the potential for acidification of tailings. It seems that the acidification of tailings may result in metals being released that are currently bound in the tailings because the high pH of tailings. There appears to be no long term plan to manage the tailings to prevent them from becoming acidic and thereby resulting in contamination of ground water and surface waters of the Red River and Rio Grande. In addition, it is unclear how a soil cap could reduce seepage of water through the tailings enough to protect ground water and a soil –vegetation cap would seem more likely to decrease the pH of water reaching the tailings, as biologic processes tend to reduce pH. EPA should clearly demonstrate how this cap will protect ground water in the future. BLM is skeptical that the soil and vegetation cap proposed to cover tailings will actually prevent seepage of contaminants to ground water.

Response 28: *The use of soil covers to reduce infiltration in arid and semiarid climates has been well documented both by industry and federal studies. It has been documented that a properly constructed and vegetated cover will remove a significant amount of the moisture from precipitation through evaporation and transpiration, rather than allow the moisture to percolate downward into the tailing material. Additionally, based on lysimeter testing performed at the tailing facility by CMI on various depths of soil cover, most of the moisture is stopped within a few feet below the soil/tailing contact. No soil cover system can or will eliminate 100% of the infiltration that seeps downward into the tailing material. However, if infiltration is significantly reduced, the remaining excess water will either be entrained within the tailing or diluted by the influx of fresh water from the existing aquifer to levels that do not cause an exceedance of ground water cleanup levels.*

With regard to the comment on acidification, the potential for tailing turning acidic is a very different concern. Currently, the tailing material has been heavily buffered, as lime is added to the tailing and water at the mine site before it is pumped to the tailing facility for *disposal. In addition, several studies have been conducted to determine the acid-potential of the tailing material. These studies suggest that the buffering capacity will last on the order to 50 to 100+ years. EPA recognizes that there is a possibility that the tailing may go acidic at sometime in the future and with the current technology available this cannot be avoided. Therefore, EPA has included monitoring of the tailing pile to provide early detection of acid generation and metals leaching at the facility. Monitoring and early detection is the key to protection of ground water beyond the facility in the long term. If acid generation and metals leaching occurs, additional response actions would likely be necessary to protect ground water.*

3.3 U.S. Department of the Interior – Fish and Wildlife Service

Comment 29: The U.S. Fish and Wildlife Service (USFWS), New Mexico Ecological Services Field Office, Albuquerque, New Mexico has reviewed the EPA's Proposed Cleanup Plan. The Proposed Cleanup Plan is adequate and appropriate, with respect to protecting trust resources. The selected "Preferred Alternatives" appear to be appropriate as per the RI/FS, the National Contingency Plan (NCP), and current technology.

Response 29: *No response is necessary from EPA.*

Comment 30: Many of the items affecting trust resources are temporally dependent upon mine closure (*i.e.* rock piles cover/re-grade, tailings facility cover, maintaining water levels in the mine below the Red River, etc.). These actions will have long term impacts on the exposure pathways and release of contaminants to be left in place. As such, the USFWS will monitor the progress of the implementation of this remedial activity and future mine closure actions. Please keep the USFWS informed of any changes made to remedial alternatives and the 5-year review process. Thank you for the opportunity to review and provide feedback concerning this process.

Response 30: *EPA will continue to communicate and coordinate CERCLA response actions at the Site with the USFWS as well as the other federal and New Mexico natural resources trustee agencies.*

4.0 PUBLIC COMMENTS AND EPA RESPONSES

4.1 CERCLA PROCESS

Comment 31: Why does EPA include a No-Action alternative as a possible remedy? The Proposed Cleanup Plan stated that "No Further Action alternative would provide a permanent solution." This suggests that EPA is not willing to alleviate the problems or research a solution that improves the health of the community of Questa and other communities downstream of the Red River. EPA must address the issues of protecting human health, reducing the toxicity, or reversing the contamination caused by the effects of mining on our once pristine environment.

Response 31: *EPA is required by CERCLA to include a no-action alternative when assessing possible remedial alternatives. The no-action alternative involves leaving the site essentially as it is. A no-action alternative is always developed as part of a FS, although analysis of this option frequently is more limited than other alternatives unless information suggests that indeed no action is necessary. The no-action alternative is useful since removals and/or enforcement actions may have taken place prior to the FS or maintenance activities may be ongoing at a site. In addition, analyzing the no-action alternative provides another useful baseline for evaluating costs of and protection provided by the other alternatives being considered.*

Comment 32: What is EPA's preference in selecting a remedy for the Site? It appears that the difference between the various remedial options is primarily the financial -- the cost differences of the alternatives. Is there a basis for preference other than cost?

Response 32: *The Superfund response effort is guided by the National Oil and Hazardous Substances Pollution Contingency Plan, commonly referred to as the National Contingency*

Plan (NCP). The NCP is the regulation that implements CERCLA. The NCP sets forth nine criteria for selecting Superfund remedial actions. The two most important are considered to be the following threshold criteria:

- *Overall protection of human health and the environment;*
- *Compliance with (or waiver of) requirements of other federal and state environmental laws.*

Each remedy that is selected at a Superfund site must meet the two threshold criteria. Potential remedial actions are also evaluated according to the five primary balancing criteria: long-term effectiveness and permanence; toxicity, mobility, or volume of waste; short-term effectiveness; implementability; and cost. The last two criteria are the modifying criteria of state acceptance and community acceptance.

EPA uses the nine criteria described above to determine the advantages and disadvantages of the various remedial action alternatives in meeting its mandate to protect human health and the environment from the current and potential threats posed by uncontrolled hazardous waste sites.

Comment 33: Describe how future land use is considered in EPA's decision making process.

Response 33: *The overarching mandate of the Superfund program is to protect human health and the environment from the current and potential threats posed by uncontrolled hazardous waste sites. In response to this mandate, EPA develops reasonable maximum estimates of exposure for both current land use conditions and potential future land use conditions. The analysis for potential exposures under future land use conditions is used to provide decision makers with an understanding of exposures that may potentially occur in the future. The reasonable maximum exposure estimates for future uses of the site will provide the basis for the development of protective exposure levels.*

Comment 34: What is the decision-making process up to and following the ROD**?**

Response 34: *The Superfund response process is guided by the NCP This plan outlines several steps that EPA and other agencies must follow in responding to hazardous substance releases.*

In brief, the process established by the NCP for handling hazardous substance releases is as follows:

- *Identify places where a hazardous substance problem may exist;*
- *Do a preliminary evaluation to assess the degree of contamination;*
- *If the preliminary evaluation reveals there is an emergency requiring immediate action, take the immediate "removal" action to remove or stabilize the threat;*
- *If the preliminary evaluation reveals longer-term action may be required to respond to the contamination, begin "remedial" action evaluation process;*
- *If the evaluation process indicates that longer-term action may be necessary to respond to the contamination, then conduct an analysis of the specifics of the contamination (e.g., affected populations) and select, design, and construct the remedy.*

The critical steps in the Superfund process are as follows:

- *Site Discovery*
- *Preliminary Assessment (PA)/Site Inspection (SI)*
- *Hazardous Ranking System (HRS)/National Priorities List (NPL)*
- *Remedial Investigation (RI)/Feasibility Study (FS)*
- *Remedial Selection/Record of Decision (ROD)*
- *Remedial Design (RD)/Remedial Action (RA)*

- *Site Completion*
- *Closeout/NPL Delisting*

Comment 35: What is the ROD and when is it expected to be finalized (*i.e.*, how are decisions made)?

Response 35: *The ROD is the final remedial action plan for the site or the phase of cleanup (operable unit) under consideration. The purpose of the ROD is to document the remedy selected, provide a rationale for the selected remedy, and establish performance standards or goals for the site or operable unit. The ROD provides a plan for site design and remediation, and documents the extent of human health or environmental risks posed by the site or operable unit. It also serves as legal certification that the remedy was selected in accordance with the requirements of CERCLA and the NCP. The ROD is one of the most important documents in the remedy selection process, because it documents all activities prior to selection of a remedy and provides a conceptual plan for remedial activities subsequent to the ROD.*

The ROD contains the following three parts:

- *Declaration — The declaration is the formal statement that makes the ROD legal and binding. It is signed by the proper delegated authority and identifies the selected remedy and indicates that the selection was carried out in accordance with the statutory and regulatory requirements of the Superfund program.*

- *Decision Summary — The decision summary provides an overview of the problems and risks posed by the conditions at the site, the remedial action alternatives, and the analysis of those alternatives. The decision summary also explains the rationale for the selection and how the selected remedy satisfies statutory requirements and performance goals.*

- *Responsiveness Summary — The responsiveness summary addresses comments received from the public. It provides the lead agency with information about community preferences regarding both the remedial alternatives and general comments about the site. It also demonstrates to members of the public how their comments were taken into account as an integral part of EPA's decision-making process.*

Comment 36: There are several clarifications that could be added to the ROD to improve readability and overall understanding of the document.

- **Part A – Soil:** The term "soil" is loosely used by EPA. It is an important term that should be defined and explained more precisely. Clarity and understanding of the basis for many of EPA's recommendations would be far more understandable if the ROD has more precise usage of these terms.

  There are many definitions for the term "soil" and there are many perceptions of the definition of this term, including a humus-rich aggregate of mineral and rock fragments that supports life, or any loose aggregate of rock overlying solid bedrock. It is important to clearly define this term because when you say "soil cover", what does that really mean? Will it be the humus-rich soil stripped from somewhere else or will it be crushed rock that presumably will generate a true soil layer with weathering over an unknown period of time? Please clarify.

Response 36(A): *For the purposes of this ROD, the term "soil" generally means the unconsolidated mineral and organic material on the ground surface that has been subject to and shows the effects of genetic and environmental factors such as climate (including water and temperature effects) and macro- and microorganisms over a period of time, and which serves as a natural medium for the growth of vegetation. This definition is taken from the Soil Science Glossary (Soil Science Society of America). This would also apply when the term "soil" is used when describing the type of cover or cap (i.e., "soil cover" or "soil cap") as a component of the remedial alternatives evaluated in the FS and ROD. The* *soil to be selected for use in the cover or cap would have to contain properties or characteristics that would be necessary for the cover or cap to perform as intended (e.g., quantity of organic material and nutrients, particle grain size, moisture holding capacity, etc.).*

A soil cover is a component of the Selected Remedy for the Tailing Facility Area. It is intended to perform as a store and release/evapotranspiration cover for limiting infiltration and net percolation of precipitation in tailing. Therefore, it must serve as an adequate growth medium that allows for successful vegetative growth. The ROD states that the soil to be used as cover at the tailing facility will be the local (nearby) alluvial/fluvial soil that is comprised of clay, silt, and sand-sized material. It is located on CMI's property. It will be stripped from the ground and transported to the tailing facility for placement as cover. At this time EPA anticipates that the alluvial/fluvial soil has adequate properties for its intended purpose. However, if it is determined that the soil is inadequate for such purpose, organic amendments may need to be applied or another soil selected for the cover.

A cover is also a component of the Selected Remedy for the Mill Area and Mine Site Area. However, the cover material preferred in the ROD is the non-acid generating waste rock located at the Spring Gulch Waste Rock Pile. EPA does not consider the Spring Gulch waste rock to be soil, nor does it have soil properties that are optimal for promoting sustained vegetative growth at a level considered necessary for achieving an effective store and release/evapotranspiration cover. The waste rock is the preferred cover material because it is located on the mine site and available in sufficient quantities, which makes it the most practical and least costly option for cover material. It will be excavated and transported to those areas to be covered (i.e., waste rock piles and mill). Before placement, it will be screened to limit grain size to eight inches or less. It will also receive multiple applications of organic amendments (e.g., compost) to promote sustained vegetative growth and improve the water holding capacity of the material. The Spring Gulch waste rock to be used for cover will also need to meet the EPA molybdenum *screening criterion of 600 mg/kg to ensure that potential uptake of molybdenum by plants does not occur at a level that may adversely affect plant growth or threaten wildlife.*

- **Part B – Contamination and Contaminants:** The terms contamination and contaminants and the quantitative criteria used to define them should be clarified in the ROD, as they are the basis for so many decisions and recommendations. It is difficult to evaluate the validity of such decisions and recommendations without a sound knowledge and understanding of what constitutes a contaminant and, therefore, contamination.

Response 36(B): *EPA agrees. The terms "contamination" and "contaminants", as well as "hazardous substances", "pollutants" and "release" under CERCLA have been defined in Sections 1.0 and 2.8, Part 2, of the ROD.*

A CERCLA response action is triggered by a "release" or a "substantial threat of a release" of hazardous substances into the environment. A "release" is defined in CERCLA as any spilling, leaking, pumping, pouring, emitting, emptying discharging, injecting, escaping, leaching, dumping, or disposing of hazardous substances into the environment. "Hazardous substance" includes substances defined as "hazardous waste" under RCRA, as well as substances regulated under the Clean Air Act (CAA), Clean Water Act (CWA), and Toxic Substances Control Act (TSCA). In addition, any element, compound, mixture, solution, or substance may also be specifically designated as a "hazardous substance" under CERCLA. "Pollutant or contaminant" is defined in CERCLA as any element, substance, compound, or mixture that, after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, will or may reasonably be anticipated to cause illness, death, or deformation in any organism. The term "contamination" is defined in the ROD to include media where any hazardous substance, pollutant, or contaminant has come to be located.

To simplify the use of the terms "hazardous substance", "pollutant" and "contaminant" in the ROD, they are collectively referred to as "contaminant". The term "contaminant of *concern" or "COC" is defined in Section 5.10 of the ROD to include those contaminants identified in the FS as needing to be addressed by the remedial action selected in the ROD. EPA uses a process to determine the COCs, beginning with an initial screening of chemicals of potential concern (COPCs) to established EPA screening level criteria as part of the baseline risk assessment. At the end of the risk assessment process chemicals of concern are identified that may be harmful to people or wildlife.*

The concentrations of the COPCs are also screened to naturally-occurring background concentrations in reference areas during performance of the RI. Since many of the Site-related contaminants are naturally-occurring metals and other inorganic chemicals, a statistical comparison of the concentrations of such contaminants found at the Site was made to natural background concentrations measured in the same media at corresponding reference areas considered to be unaffected by mining or mining-related activities. These background concentrations are referred to as "reference background concentrations" in the ROD.

The list of chemicals of concern from risk assessment is carried forward to the FS for further screening and evaluation. Other contaminants that do not pose a risk but exceed federal or New Mexico standards or criteria, as preliminary ARARs, are also carried forward as they would have to be addressed by the remedial action. Not all contaminants identified as COCs are chemicals (e.g., pH). Finally, the statistical comparison of COPC and reference background concentrations is also part of the further screening and evaluation in the FS to determine the final list of COCs that will warrant response actions. Only those contaminants with concentrations significantly above reference background concentrations warrant response actions and therefore are considered COCs.

For more information concerning contaminants and contamination please refer to CERCLA/SUPERFUND Orientation Manual, US EPA, Office of Solid Waste and Emergency Response, EPA/542/R-92/005, October 1992.

- **Part C – Fluorite, Fluoride and Flourine:** The terms fluorite, fluoride and fluorine, tend to be used interchangeably. More specific use of these terms should be adhered to in order to improve clarity of the report. Also, note that in the List of Acronyms and Abbreviations, the term "F" is associated with "Fahrenheit," but it also could be fluorine. Should there be a list of the chemical constituents that are cited in the report and their symbols?

Response 36C: *The terms fluorite, fluoride, and fluorine have been used correctly in the ROD. In addition, the ROD has been developed to ensure clarity concerning the use of acronyms, abbreviations, and terms.*

- **Part D – Requested Appendix on Risk and Contamination:** EPA included an Appendix titled "What is Risk and How is it Calculated," which is helpful. This appendix could be enhanced with some examples of calculating risk (and contamination). Another descriptive appendix that would be helpful in the ROD is "What Is Contamination and How is It Determined?"

Response 36D: *Sections 5 and 7 of the ROD have been developed with the commenter's issue in mind. Section 5 describes the COCs and Section 7 is a summary of how Site risks were calculated. Further discussion on contamination and COCs are provided in EPA Response No. 36B above.*

- **Part E – Debris Flow, Colluvium:** The following terms should be added to the Glossary in the ROD: (1) Debris Flow – as not all of the sediment deposited in the way described forms fan shaped bodies. Some accumulates within the confines of the channel in which the sediment flowed. Debris flows and fans are typically associated with rapid erosion of the hydrothermal alteration scars at the Site. (2) Colluvium – also forms by sub-aerial deposition of sediment on slopes. "Colluvium" is a term that is difficult to define, as it has been widely applied to lots of different kinds of unconsolidated sediment on the surface of the land that clearly have not been deposited by "sediment," as this will eliminate some misunderstanding surrounding the use of term "soil."

Response 36E: *EPA has checked the definitions of these terms to ensure that they are used appropriately in the ROD.*

- **Part F – Actual and Potential Releases:** Page 5-6 of the Proposed Cleanup Plan discusses releases that have occurred at the Site. EPA should distinguish between "actual" and "potential" releases cited in the Plan.

Response 36F: *The ROD has been written to indicate whether releases were actual, potential, or both.*

Comment 37: Was the preferred remedy modified in any way by comments submitted by the Public?

Response 37: *Yes. The ROD incorporates modifications as a result of the comments received from the public. Significant changes to the Selected Remedy from the Preferred Alternative are documented in Section 14.0, Part 2, of the ROD. These changes are also discussed in the individual responses to specific comments contained herein.*

Comment 38: What is the schedule for these remedial clean up operations?

Response 38: *After issuance of the ROD, EPA will first attempt to negotiate a consent decree with the PRP(s) to conduct the remedial design and remedial action activities at the Site. If the negotiations are not successful, then a unilateral administrative order (UAO) may be issued by EPA to the PRP(s) to perform the work. Detailed remedial design and remedial action project schedules will be developed at the start of the cleanup. EPA has decided to perform the work in a phased approach for the waste rock piles and other areas of the Site, partly because of the complex nature of the work and that the Site is currently an operating facility. With this approach, it is anticipated that design and construction* *work will take up to several decades to complete, depending on the nature of the work or area of the Site. Some remedial design activities are anticipated to take only a year or so to complete (e.g., Eagle Rock Lake and area south of the tailing facility) and construction work can commence following the completion of these designs. Remedial design work for the waste rock piles will be performed on a rock pile-by-rock pile basis with remediation of the first one or two piles to be conducted as pilot studies for developing optimal design criteria for the remaining rock piles. Design and construction of subsequent waste rock piles will be conducted in an adaptive and iterative phased approach. Therefore, it will likely take several years to complete all design work on the waste rock piles. The following construction and operation and maintenance (O&M) schedules are anticipated for the various remedial clean up operations:*

- *Mill Area – 1.5 years construction time with 30 years of operation and maintenance;*
- *Mine Area – 25 to 28 years of construction with 30 years of operation and maintenance;*
- *Tailing Area – 6 years of construction (after closure of area) with 30 years of operation and maintenance;*
- *Red River – 2 years of construction with 30 years of operation and maintenance;*
- *Eagle Rock Lake – 2 years of construction with 30 years of operation and maintenance;*
- *Water treatment – 30 years of operation and maintenance.*

Please see Section 9.0, Part 2, of the ROD for additional schedule details of the various alternatives.

Comment 39: The progress of the RI/FS efforts seemed slow. Does EPA expect the progress of the remedial action to be quicker? And, what will happen in the next 12 to 24 months?

Response 39: *As previously discussed, over the 12 to 24 months after ROD issuance EPA will attempt to negotiate an agreement with the PRP(s) to perform the cleanup and plan to initiate remedial design activities. If a settlement is reached, it will be memorialized in a document referred to as a "Consent Decree". If negotiations are successful, the U.S. Department of Justice (DOJ) would lodge the Consent Decree in Federal District Court on behalf of EPA. Once it is lodged with the Court, the Consent Decree is subject to a 30-day public comment period before it can be entered and approved by the Court. The start of remedial design activities could begin shortly after the Consent Decree is lodged. See response to Comment No. 38 above on the schedule for cleanup.*

Comment 40: Once EPA's remedial decision is made and the remedial action is implemented, who retains the liability for clean up, for health and safety of the Village pertaining to the remedy? Does responsibility fall on the Village, Taos County, the State of New Mexico, EPA, the mine owner, or someone else?

Response 40: *CMI, as a PRP, is liable for the mining-related contamination at the Site. During the formal negotiations, EPA will attempt to reach a settlement with the PRP(s) to conduct or pay for the cleanup. If such negotiations are unsuccessful, EPA may issue a unilateral administrative order (UAO) for the PRP(s) to conduct the work. If the PRP(s) conducts the cleanup, it is EPA's responsibility to oversee the PRP(s)' work to ensure that it is conducted in accordance with health and safety plans to be developed for protecting Site remedial workers as well as the community. The health and safety plans will include an air monitoring plan to monitor airborne particulate matter at the work zone and the perimeter of the work zone, and possibly beyond the perimeter of the work zone if necessary to protect the community. Such plans will also include measures for dust suppression during implementation of earthmoving activities. If EPA conducts the cleanup, the same measures would be taken to protect the workers and community.*

Comment 41: Describe how property owners are potentially impacted by the remedial action. Do the property owners have any input on remedial activities that will occur on their property?

Response 41: *EPA will seek written consent from property owners for entry or access to private property where cleanup activities are planned. A property owner that does not want the property to be remediated has the right to refuse consent of access or entry. In such cases, EPA, by the authority granted to it under CERCLA, can issue an administrative order to secure entry and access. However, this authority would only be exercised when a response action concerning the property is necessary to protect others that may be at risk in addition to the resident. Protecting human health and the environment is EPA's first priority when it gains access to property. Protecting private commercial and industrial enterprises from interruption may also be considered in certain circumstances where there is not an effect on EPA's accomplishment of its primary purpose to protect human health and the environment. Specific private land owner issues will be addressed during the development of the remedial design if remediation is needed on private property.*

Comment 42: With the potential for impacts into the future from Site-related contaminants, how does the remedy and ROD provide for the ability to change, adjust, and/or modify remedial actions based on future impacts?

Response 42: *After the ROD is signed, new information may come to light that may alter the effectiveness, extent, or implementation of the remedial action. This information may be collected through required long-term monitoring programs that will be implemented to assess the effectiveness of the remedy or through the performance of five-year reviews to assess the protectiveness of the remedy. CERCLA requires that EPA conduct a five-year review when the site cleanup does not allow for unrestricted use or access to a site. The ROD includes these monitoring programs and five-year reviews as part of the remedy.*

If EPA determines that modification or change to the remedy is warranted to protect human health and the environment, it may implement any one of the following three types of remedy changes:

- *Non-significant or minor*

- *Significant*
- *Fundamental*

Non-significant changes are characterized as minor changes that do not overly affect the scope or the objective of the selected remedy. They should be noted in the post-decision document file, or may be documented in an optional Remedial Design Fact Sheet.

A significant change does not modify the overall remedy but could alter a component of the remedy. If a significant change to a component of the remedy is needed, then an Explanation of Significant Differences (ESD) must be developed, approved, and released to the public.

A fundamental change to the overall remedy requires a ROD amendment. When such fundamental changes are made to a remedy, a repetition of the ROD process, including issuance of a revised Proposed Cleanup Plan and a new public comment period, is necessary.

A ROD amendment looks very similar to an initial ROD and should include a Responsiveness Summary; however, the introductory sections (such as the site history, community relations, and site risks) do not need to be readdressed. Rather, the focus of the discussion should be on the rationale for the ROD amendment, evaluating the alternatives in terms of the nine criteria, and provided assurances that the new proposed remedy satisfies the statutory requirements.

Comment 43: How long does EPA expect negotiations for a consent decree to take, and will that delay remedial design and remedial action?

Response 43: *See response to Comment No. 39 above.*

4.2 PREFERRED ALTERNATIVE

Comment 44: EPA should include the timeline for ongoing mine activities and longevity of such operations, including a termination plan to involve: socioeconomic consequences, environmental remediation, watershed level impacts and restoration, and any removal, containment and/or reclamation of mine waste material.

Response 44: *EPA has not been provided a timeline for the remaining operating life of the mine and tailing facility by CMI, nor will EPA speculate as to when permanent cessation of mining activities will occur. The fact that the Site is an operating mine does not prevent remedial activities from being conducted for the Selected Remedy, with the exception of the cover to be placed atop the tailing impoundments and the Mill Area. EPA will not require placement of the cover until tailing disposal and milling operations have permanently ceased. The ROD provides estimated timeframes for remedy construction and achievement of remediation goals (e.g., the timeframe to clean up ground water). Detailed project schedules will also be developed during the remedial design for each major component of the Selected Remedy. As stated in the ROD, the Selected Remedy will be implemented in a phased approach due to the large number of cleanup activities to be conducted and the complexities associated with designing waste rock pile regrades and conducting large earth moving operations at an active mining facility.*

The anticipated socioeconomic consequences are discussed in Section 12 of the ROD. EPA anticipates that the cleanup of the Site will have a significant positive effect on the socioeconomic climate of the area. Jobs will likely be created while cleanup activities are being implemented. The post-cleanup condition should also enhance quality of life and improve tourism.

The Selected Remedy, in combination with other activities to be conducted by the U.S. Forest Service under its CERCLA authority for remediating abandoned mines, the Total Maximum Daily Load (TMDL) program administered by New Mexico for the Red River as *an impaired water, and the Natural Resource Trustee agencies through the settlement with CMI to restore injured natural resources, will help restore the Red River Watershed. The restoration of the Red River Watershed should have positive socioeconomic and community revitalization impacts for the town of Red River and the Village of Questa such as for recreational purposes (e.g., camping and fishing).*

Comment 45: Does EPA's restoration plan cover social and economic impacts within unique cultural settings, such as the mine's centrality within centuries of local land use; tribal history, settlement, and current jurisdictional or cultural concerns; ongoing Spanish Land Grant considerations, the Rio Grande Wild and Scenic River Corridor, and the designated Northern New Mexico Heritage Area? Please advise.

Response 45: *No. EPA does not have the authority under CERCLA to directly address or compensate for socioeconomic impacts associated with a site regardless of the cultural setting.*

EPA also does not have the authority to address community or individual land grant claims by heirs or others advocating land grant reform. The recent interest in the validity of the Spanish land grant adjudications by the Office of the Surveyor General of New Mexico and the Court of Private Land Claims in the mid- to late-1800s has been assessed by the United States Government Accountability Office (GAO). In reports to Congressional Requesters in 2001 (GAO-01-951) and 2004 (GAO-04-59), GAO assessed community land grants and procedures under the 1848 Treaty of Guadalupe Hildalgo (Treaty). In the 2001 report, GAO identified three types of community land grants: (1) grants where community lands formed part of the original grant, (2) grants that heirs or others claimed that the grants contained community lands, but there are no existing documents that show community lands were part of the original grant, and (3) grants to indigenous Pueblo (village) cultures in New Mexico. Of the grants identified by GAO in Taos County, none are in the Questa area. Also, EPA is not aware of any community or individual land grant claims by heirs or others advocating land grant reform in the area of the Site. The GAO identified a *grant to the indigenous Pueblo of Taos. However, the Pueblo of Taos indicated no interest in EPA activities in the Questa area (as discussed below).*

EPA has not discussed Site activities or the Selected Remedy with the Northern Rio Grande National Heritage Area, Inc., (NRGNHA), the established management entity for the Northern Rio Grande National Heritage Area established by Congress (Public Law 109-338-October 12, 2006). However, the anticipated outcome of the Selected Remedy, in combination with other efforts by the U.S. Forest Service and other natural resource trustee agencies for restoration of the Red River Watershed and injured natural resources, is consistent with the Congressional mandate and objectives of the NRGNHA for conservation, management, and development of the resources of the Northern Rio Grande National Heritage Area, which includes Taos County. EPA welcomes the opportunity to discuss the planned cleanup with the NRGNHA as a potential stakeholder for Site activities.

Although EPA does not have the authority to provide compensation for socioeconomic losses, EPA does anticipate that socioeconomic and community revitalization impacts will likely occur through job creation and increased recreational use of the Red River and Eagle Rock Lake (see response to Comment No. 44 above).

Further, EPA recognizes the importance of unique cultural settings in the CERCLA process for cleaning up contaminated sites and they are taken into consideration when conducting CERCLA activities. During the initial stages of the remedial investigation and feasibility study (RI/FS), when scoping and work plan development is conducted, key stakeholders are identified and contacted for their input and involvement, including tribal entities that may have jurisdictional rights or be affected by site activities when tribal lands or Tribal Trust or Indian Allotment lands are at or near the site. EPA works with the DOI's Bureau of Indian Affairs (BIA) to identify the tribe(s) in the area of the site and their acceptance of the proposed remedy is one of the nine criteria evaluated during EPA's decision-making process for remedy selection.

Early in the scoping of the RI/FS, EPA contacted the BIA to identify the tribes located nearest to the Site. BIA notified EPA that the nearest tribe was the Pueblo of Taos. BIA also notified EPA that it contacted Pueblo de Taos and was informed that there was no interested in EPA's activities at the Questa mine. EPA sought no further involvement by the Pueblo of Taos.

The current land use and potential future land use at a site are also important considerations in EPA's decision-making process to ensure that the remedy will protect human health and the environment for current as well as reasonably anticipated future land uses. For historical land and cultural uses, there are federal and New Mexico laws that protect such resources. These include the National Historic Preservation Act and the New Mexico Cultural Properties Act. Compliance with these statutes will require an evaluation of whether historic or other cultural resources will be disturbed by the response actions or if there is a high probability of finding new cultural deposits at such lands. If historic or cultural resources are discovered, these laws require that remedial actions must avoid or minimize impacts on cultural resources.

The Selected Remedy does not address the Rio Grande Wild and Scenic River corridor, which includes the Red River just downstream of the Red River State Fish Hatchery. The findings of the RI, EPA's risk assessment, and other studies showed that Red River surface water quality and aquatic life improve significantly at and downstream of the hatchery. The Selected Remedy addresses environmental impacts to the Red River at locations along the mine site reach where acidic springs and seeps flow into the river at zones of ground water upwelling.

Comment 46: Institutional controls have been identified by EPA as a critical measure to assist communities in dealing with Superfund and related issues. However, the EPA's Proposed Cleanup Plan only provides cursory mention of institutional controls and limits their definition to that of legal processes, such as restrictive covenants or easements placed upon the property deed.

According to the EPA's Proposed Cleanup Plan, "The Institutional Controls or ICs (Conservation Easement and Restrictive Covenants) established by CMI in May 2009 restrict residential uses at the mine (including the Mill Area) as well as ground-water and surface-water uses." The Plan also identifies that "Many of these alternatives include common components. They are land use controls (LUCs), including controlling Site access (fencing, signage, etc.) and implementing institutional controls (restrictive covenants, conservation easement, ground-water use and well drilling restrictions)... ". The Plan defines institutional controls as follows: *Institutional Controls: Ways to reduce risks from contamination at a Superfund site using legal processes. Institutional controls can include zoning, deed notices, leases and other mechanisms.*

The ideal Superfund cleanup would result in complete elimination of the contamination such that the problem has been completely remedied and no longer exists. Unfortunately, due to the size and complexity of large Superfund sites such as the CMI site, and what EPA terms "technical or cost impracticalities," waste is often left in place to be contained or otherwise managed for centuries to come and theoretically in perpetuity. Institutional controls are the mechanisms that would ensure that appropriate measures are taken to control future exposures from waste so as to maintain the effectiveness of the remedy.

Institutional controls can be grouped into four categories as follow:

- Public access to information and services
- Regulatory mechanisms
- Legal mechanisms
- Operation and Maintenance

The first category, public access to information and services, is typified by mailing of fact sheets and education programs to ensure the public is aware of potential contamination and maintains the remedy, as well as takes voluntary precautionary measures. The second category, regulatory mechanisms, uses government administrative procedures, such as a

Development Permit System (zoning) or the equivalent to ensure that activities are conducted in such a manner as to maintain the remedy. The third category, legal mechanisms, includes covenants and easements placed on landowners that restrict or require certain activities, such as weed control.

Operation and maintenance of the remedy is the fourth category of institutional controls that is often not recognized. Operation and maintenance of such features as storm water conveyances and groundwater controls, soil and other protective covers, vegetation and weed control are essential to controlling exposure when waste is left in place at Superfund sites. Although it is often envisaged that the potentially responsible party (in this case, CMI) will conduct these activities in perpetuity, the reality is that no corporation is likely to exist in perpetuity to conduct such activities. Thus, the concept of financial assurance was established for most such obligations in the U.S., with one of the sole remaining exceptions being Superfund.

In order for institutional controls to be effective, in the case of the first three categories described, it is widely accepted that local governments have a clear self-interest in administering such activities. Similarly, it should be the responsibility of the federal and state governments to ensure that local governments have the wherewithal and financial ability to conduct operations and maintenance activities as a part of an institutional controls program. Where the ability of such local government is in question, the state and federal government agencies should partner with them to ensure they are a participant in any activities.

These findings are clearly supported by EPA regulations and guidance. It is important to note that one of the stronger messages in the Superfund regulations and guidance has to do with the intent of institutional control programs and how they are to be used. Institutional controls shall not substitute for active response measures and can be only used to control exposure, not to actually conduct cleanup of contamination. Cleanup must be conducted to the extent necessary to ensure that a institutional controls program can be effectively administered both technically and socio-politically (*e.g.,* so as not to impact redevelopment opportunities due to unresolved cleanup obligations).

It should be further noted that institutional controls, for the most part, have not proven to be effective at ensuring long-term protectiveness. For the most part, records of decision have only provided the objectives of institutional controls without detailing how to implement or enforce them. In addition, the GAO found that institutional controls were often misused, resulting in an inadequate remedy. The GAO (2005)[90] made three key recommendations concerning institutional controls:

- Clarification as to appropriate use of institutional controls - not to substitute as remedy;
- EPA needs to require a federal tracking system together with reporting and monitoring;
- Institutional controls should incorporate strategies and tools within EPA's Institutional Controls Site Manager's Guide.

EPA (2005)[91], partly in response to the GAO recommendations, evaluated institutional controls and realized that "the fundamental challenge presented by institutional controls is that, although the Agency frequently relies on institutional controls to ensure protectiveness, the responsibility of implementation, monitoring, and enforcement is often under the jurisdiction of other levels of government and private parties." The EPA came up with its own recommendations as to the successful implementation and enforcement of institutional controls that identified funding and coordination with local government as being the most important factor. As with any successful strategy, carefully planning and implementing the remedy with institutional controls in mind and laying out a clear strategy for implementation, management and funding are key steps that must be taken.

[90] GAO. (2005, January). *Report to Congressional Requesters, Hazardous Waste Sites: Improved Effectiveness of Controls at Sites Could Better Protect.* Washington, D.C.: GAO-05-163.
[91] U.S. EPA. (2005, October). *National Strategy to Manage Post Construction Completion Activities at Superfund Sites.* Washington, D.C.: OSWER 9355.0-105.

Ultimately, institutional controls can be used to address a multitude of relatively small, but highly significant problems and perceptions that the Superfund remediation process itself cannot address. In the case of the Site, and in particular, community health and related concerns, institutional controls should be developed to address local concerns including personal health issues, redevelopment issues, liability concerns and other matters. Local residents have long expressed concerns regarding domestic (drinking) water, water lines bedded in tailings, fugitive dust, impacts to *acequias*, redevelopment liability, impacts to property rights and values, and other issues raised by the Superfund process.

It is recommended that EPA in the ROD provide more details on the existing and future institutional controls envisioned for the Site. This should include recognition of the need for governmental institutional control programs including a Development Permit System (DPS) (or applicable local zoning system), Institutional Controls Program (ICP) and Community Protective Measures Plan (CPMP) developed by the Village of Questa and Taos County with EPA and CMI. Those programs would provide provisions that would restrict land or resource use at the site, control development activities, and provide community health information, as well as respond to concerns raised by local residents or business owners. It is also recommended that further decisions related to institutional controls, and as contained in the ROD be made pending additional discussions with the Village of Questa and Taos County in this regard.

Finally, it is recommended that the Village, County and EPA, as well as CMI, adhere to the following key tenets as they develop a comprehensive ICP/CPMP:

- Institutional Controls must minimize inconvenience, cost and loss of land use options to local residents.
- Institutional Controls must utilize, to maximum extent practicable, existing control mechanisms and local agencies.
- Institutional Controls must be self-sustaining and impose no additional cost on local government, residents, or property owners.

Response 46: *EPA will use institutional controls as part of the Selected Remedy in a manner which is consistent with the NCP and EPA guidance, including EPA's Institutional Controls Site Managers Guide (USEPA 2000). In re-evaluating institutional controls as presented in the FS Report and the Proposed Cleanup Plan, EPA decided not to include the proprietary controls (Deed of Conservation Easement and Declarations of Restrictive Covenants) recorded by CMI in the Selected Remedy. Rather, EPA has opted to use governmental controls and enforcement tools to protect the integrity of the engineered remedy and human health from potential exposure to contaminated ground water. Governmental controls will be sought from the New Mexico Office of the State Engineer to temporarily restrict well drilling at the Site until cleanup levels established for ground water are achieved. In the ROD, EPA also contemplates the use of local ordinances or zoning restrictions by the local or county governments at the completion of remedial construction to ensure that future land uses do not impact the integrity of the remedy. EPA will coordinate with the local or county governments should such ordinances or zoning restrictions be sought. Enforcement tools with institutional control components such as a consent decree or UAO for remedial design and remedial action may also be used to require the Site to be managed and controlled by CMI during the implementation of the remedy to ensure protectiveness and remedy integrity.*

EPA has had discussions with the Village of Questa and Taos County regarding the governmental institutional control programs proposed by the commenter. The Village of Questa was opposed to such programs as it had already agreed to be the "Grantee" to the Conservation Easement recorded by CMI in 2009 for the mine site. The Village of Questa has also agreed to be a third party beneficiary of the Declarations of Restrictive Covenants recorded by CMI for both the mine site and tailing facility.

In July 2010, EPA received a letter from Taos County stating that it formed a Mining Cleanup Task Force (MCTF) to identify potential shortfalls and opportunities in EPA's Proposed Plan and to ensure Taos County's participation in the Site cleanup. In a follow-up telephone call between Taos County and EPA on September 1, 2010, Taos County *indicated that it wanted to be a local resource to the community and it sought funding from EPA through a Cooperative Agreement. Specifically, Taos County wanted to conduct the following activities:*

- *Public outreach*
- *Medical monitoring, including testing on demand and performance of health studies*
- *Air quality monitoring (tailing dust blowing from the tailing impoundments)*
- *Water quality monitoring*

EPA considers all of these activities to be important for the community of Questa both in terms of community involvement and risk communication during a CERCLA (Superfund) cleanup. However, after thoroughly considering this proposal, EPA felt that Taos County was not the appropriate entity to conduct such activities. First, EPA typically funds local community groups through technical assistance grants (TAGs) to perform public outreach at CERCLA sites. The largest grant in the history of the EPA TAG program was awarded to the Red River Restoration Group (R3G) in 2009 for performing public outreach at this Site. In receiving these funds, the R3G has agreed to perform public outreach and be a local resource to the community of Questa.

Second, although EPA has no information to suggest that medical monitoring is needed at this time, it may be appropriate to perform some form of medical surveillance or monitoring during implementation of the remedy, especially given the length of time estimated for the completion of construction activities (25-28 years) as well as long-term post-construction remedial activities. Therefore, a Community Protective Measures Plan will be developed and implemented as part of the Selected Remedy (as suggested by the commenter) and such medical surveillance or monitoring will be considered as part of the plan. EPA believes medical monitoring is the jurisdiction of the State of New Mexico and therefore such a program will be discussed with the New Mexico Department of Health's Regional Public Health Office in Taos and the Environmental Health Epidemiology

Bureau in Santa Fe during the remedial design about conducting or overseeing medical monitoring for the Questa community. EPA will also seek the Agency for Toxic Substances and Disease Registry (ATSDR) involvement and support in any State-led monitoring program for Questa.

The Community Protective Measures Plan may also include providing the community health information or responding to concerns raised by local residents or business owners, as well as sampling private water wells at the request of a resident.

Third, EPA has included an air monitoring program as part of the Selected Remedy. It will include monitoring particulate matter at 10 micron (PM_{10}) and 2.5 micron ($PM_{2.5}$) size at monitoring stations to be located at and beyond the perimeter of the tailing facility. It will be conducted under the direction and oversight of EPA and NMED for the remaining operational life of the facility and during construction of the remedy. EPA recognizes that this is a significant issue with local residents because of the historic problems with tailing dust blowing off the facility and into the community. EPA documented an occasional dust event from the tailing facility during the RI (see response to Comment No. 126 below). Therefore, EPA will ensure that effective and thorough air monitoring is performed. This will be done by closely monitoring all aspects of the CMI's air monitoring program if CMI performs the Selected Remedy. At this time EPA has no reason to suspect the integrity of CMI's air monitoring activities and does not see a need for an independent air monitoring program. However, in the event that the monitoring effort is found or suspected to be unreliable, inaccurate, or in any way misleading in documenting windblown particulate levels at or downwind of the tailing facility, EPA will reconsider such an option.

Lastly, EPA has considered Taos County's proposal to conduct additional water quality monitoring and has concluded that the suggested monitoring program is unnecessary as the RI represents a comprehensive and thorough investigation of Site conditions, as documented in this ROD and the RI Report. Furthermore, the collected RI data are of a very high quality as they met all quality assurance and quality control requirements and standards set forth by EPA.

Comment 47: The community is concerned that the remedy will be delayed until the mine officially closes. Are the remedies tied to closure of the mine and tailing facility?

Response 47: *In light of the operational status of the CMI facilities, portions of EPA's Selected Remedy will not be implemented until cessation of CMI operations. They are the covers to be placed at the Mill Area and Tailing Facility Area. For the Mill Area, the cleanup of PCB-contaminated soil will be conducted at the start of the remedial action. For the Tailing Facility Area, ground water remediation, placement of the exclusion fence and wildlife drinkers, and all other components of the Selected Remedy will start before cessation of tailing disposal operations. For the other three areas to be remediated at the Site (Mine Site Area, Red River and Riparian and South of the Tailing Facility Area, and Eagle Rock Lake), implementation of those components of Selected Remedy are not dependent on closure of the facilities. It is noted that the remediation of the waste rock piles will be conducted in a phased approach, with only two rock piles at any one time being remediated. This is partly because the mine site is an operating facility and the number of trucks and other heavy equipment that can safely move about at an operating facility is limited. It is also partly because of the complexities of remediating the rock piles. Additionally, some sequencing of design, construction, and monitoring of all remedial activities will occur, as appropriate.*

Comment 48: EPA's preferred alternative needs to include Best Management Practices to control dust and ground water contamination during cleanup activities.

Response 48: *Several different operational methods are currently used to control dust at the tailing facility. Tailing is deposited into small cells of approximately 100 acres in size and a water cover is used to the extent practicable. In addition, soil binders (i.e., emulsion/tackifiers), soil cover, and straw mulch are used in areas where water cover cannot be maintained. Snow fencing is also used to disrupt the wind currents and reduce windblown dust. These dust control measures will continue to be used for the remaining operating life of the facility as well as during remedial activities.*

Concerning ground water contamination, all pumping and conveyance (piping) of contaminated ground water to the water treatment facility(ies) and, ultimately, authorized discharge point(s) will be conducted using standard practices to prevent or minimize spillage of water. Additionally, standard construction erosion/infiltration control measures will be utilized during the clean up. These measures will be specified during the development of the remedial design.

Comment 49: The feasibility and safety of continued and additional movement of contaminated tailings and waste rock for the purpose of burial, slope improvement, and other restoration plans mentioned in the preferred remedy needs to be thoroughly understood , as well as the cost ramifications, before long- term decisions are made in this regard.

Response 49: *EPA agrees, especially for the massive waste rock piles at the mine site. The design and construction activities for regrading the waste rock piles, removal of waste rock to an on-site repository(ies) and placement of cover on steep slopes is a very large and complex earthmoving project. However, EPA believes that movement of waste rock and tailing for the purposes of remediation is technically feasible and can be completed safely and cost-effectively for remediation purposes. These activities will be evaluated more thoroughly in the remedial design.*

Comment 50: The local residents would like to be sure that the following aspects are addressed in EPA's final remedy: point source, non-point source, and cumulative effects on surface water, ground water, soil and plant uptake, as well as aquatic life (as part of Federal Energy Regulatory Commission) license requirements, ongoing permitting, Superfund processes, federal/state/local zoning and planning, as well as continuing restoration needs).

Response 50: *This ROD, as required by CERCLA and the NCP, identifies all federal and State of New Mexico applicable or relevant and appropriate requirements (ARARs) that the Selected Remedy will attain (see Section 13,Part 2). The ARARs include the substantive* *provisions of any promulgated federal or more stringent New Mexico environmental standards, requirements, criteria, or limitations determined to be ARARs for this Site and the remedy selected. Key ARARs are identified in regulations promulgated pursuant to environmental statutes, including the Safe Drinking Water Act, Clean Water Act, Toxic Substances Control Act, New Mexico Water Quality Act and Mining Act, including the coal mining regulations, and the New Mexico Standards for Interstate and Intrastate Surface Waters. These ARARs include EPA-approved New Mexico water quality standards and criteria for point source discharges and nonpoint source ground water discharges into the Red River. They also include New Mexico coal mining regulations that require prevention of acid or other toxic drainage from entering ground or surface water and selection of appropriate soil amendments for revegetation. Federal Executive Orders are also identified as ARARs for the protection of wetlands and floodplains.*

CERCLA § 121(e) exempts any response action conducted entirely on Site from having to obtain a federal, state, or local permit, where the action is carried out in compliance with § 121. In this decision, however, EPA has opted to regulate any treated effluent discharges to the Red River as part of the Selected Remedy by EPA's National Pollutant Discharge Elimination System (NPDES) permitting under the Clean Water Act.

The Federal Energy Regulatory Commission licensing requirements are for hydroelectric projects by private, municipal and state entities and have no relevance to this CERCLA response action. The solar energy facility being constructed by CMI at the tailing facility in 2010 is not part of the Selected Remedy. However, it will be CMI's responsibility to obtain all federal, state, and local authorizations required to operate the solar facility.

EPA has selected temporary drilling restrictions to be imposed by the New Mexico Office of the State Enginee, as government controls to reduce potential exposure to contaminated ground water. EPA has considered using enforcement tools with institutional control components and local (village or county) ordinances, permits, and/or zoning plans as government controls to protect engineered source control measures and water collection and treatment measures after remedial construction activities are completed. Such *components of the remedy will need to be maintained for the long-term and possibly in perpetuity.*

The Selected Remedy will be carried out in accordance with CERLCA, the NCP, and EPA policy and guidance for conducting/overseeing the remedial design and remedial action.

Comment 51: EPA describes the logistics of how the clean-up plan will continue during mine operations, including containment of ongoing tailings materials and the lining/sedimentation/evaporation of any substances from tailings ponds or other on-site treatment areas. Please address methods of transportation and plans for hazardous waste removal.

Response 51: *During the remedial design, plans will be developed which will outline how hazardous wastes will be transported from the site. These plans will be developed in accordance with U. S. Department of Transportation guidelines which include hazardous materials regulations which specify requirements for the safe transportation of hazardous materials in commerce by railcar, aircraft, vessel, and motor vehicle. See the specific hazardous materials transportation regulations at http://www.access.gpo.gov/nara/cfr/waisidx_99/49cfrv2_99.html.*

Comment 52: What types of monitoring occur currently within the restoration planning area? How are atmospheric, weather-related, soil/water relationships and biological consequences being tracked? Do plans require a biodiversity assessment involving habitat features, corridors/connectivity issues, direct and indirect effects to species in the area? EPA must integrate these elements to ensure that aspects of sustainability are incorporated into the remedy.

Response 52: *Various monitoring is currently conducted at or near the Site. Some examples of the monitoring information that is collected are as follows:*

- *Meteorological data collected by the Western Regional Climate Center (WRCC) which has data from January 1, 1915, to present. WRCC's climate station nearest to the mine is located in the town of Red River and is located at the same relative elevation of the mine. Data such as monthly average total precipitation, monthly maximum total precipitation, monthly minimum total precipitation, monthly average total snowfall, monthly average snow depth, monthly average temperature, monthly average minimum temperature, and monthly average maximum temperature is collected.*
- *WRCC collects meteorological data (same information as from the Red River town station) from the Red River Pass #2 Snotel station which is approximately 10 miles southeast of the town of Red River and has recorded climatic data since October 1979.*
- *WRCC collects similar meteorological data (same as from the Red River town station) from the station located in Cerro, 3 miles north of Questa.*
- *Wind direction data from Alamosa, Colorado is utilized for general wind directions.*
- *Wind speed, wind direction, and dust particulate matter samples are collected from an air monitoring network at the site.*
- *Flow and water quality information is collected under a NPDES permit that regulates tailing facility ground water and seepage that is discharged to the Red River.*
- *USGS has various gauging stations on the Red River, Cabresto Creek, and Llano Ditch collect surface water elevation, velocity, and flow data. This information is available via the World Wide Web at http://nwis.waterdata.usgs.gov.*
- *CMI operates several weather stations at the mine site that measure cumulative precipitation and from which cumulative evaporation is calculated. The weathering stations are located at the waste rock piles. They were installed in 2000 as part of a water balance study of the rock piles performed in accordance with the New Mexico closure/closeout plan.*

- *CMI operates several storm water collection, conveyance, and disposal systems to achieve discharge control at the site.*
- *Ground water levels which are used to determine ground water flow directions are collected from ground water wells at the site. Samples from various ground water wells are obtained periodically to determine water quality impacts.*

Meteorological data, as well as surface water and other media monitoring data will continue to be collected and evaluated in conjunction with information that will be collected as part of an an Operations and Maintenance (O&M) Plan (to be developed during the remedial design). These data will be utilized to assess the effectiveness of the remedial actions.

Biological monitoring will also be performed as part of the Selected Remedy. Vegetation monitoring (including tissue sample analysis) will be performed on the vegetative growth to be established on the soil cover planned at the Tailing Facility Area and the amended Spring Gulch waste rock covers planned at the Mine Site Area waste rock piles and Mill Area. Such monitoring will be established to assess metals uptake (primarily molybdenum) into plants and potential adverse affects to achieving successful plant growth. Monitoring of aquatic biota in the Red River will also be performed to assess the effectiveness of the response actions in reducing or eliminating the migration of mining-related contamination in ground water to the Red River and, hence, protecting Red River aquatic species.

In addition, because the Selected Remedy will result in 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 remedial action to ensure that the remedy is or will be protective of human health and the environment. Such a review will be conducted every five years after the date of the initiation of the remedial action. For additional information concerning this five year review process, please see http://www.epa.gov/superfund/accomp/5year/index.htm

Comment 53: CMI agrees with EPA's proposed remedial actions for the Mill, Eagle Rock Lake, and Red River and Riparian and South of Tailing Facility areas with the caveat that certain of the proposed actions are dependent on actions to be taken at other areas of the Site, which will necessarily impact the schedule of implementation. Not all of the remedial actions for these areas can be accomplished or even begun in "Year 0".

Response 53: *As with any large construction project, a detailed remedial design/remedial action project schedule will be developed with the appropriate sequencing of all remedial activities at the start of the cleanup. EPA recognizes that some remedial activities associated with the Mill Area (e.g., cover placement) are dependent on the status of the mill as an operating facility and that the activities for disposal of contaminated soil and sediment as part of the Selected Remedy for the Red River and Riparian and South of Tailing Facility Area and Eagle Rock Lake are dependent to some extent on actions to be taken at the mine site and tailing facility. However, under its CERCLA authority, EPA is responsible to the Questa community to see that response actions are conducted in as expeditious a manner as possible to protect human health and the environment. Therefore, EPA will require a rigorous, but realistic schedule for all remedial design and remedial action activities.*

Comment 54: The limited RI data collection time frame is not adequate to characterize the ever-changing conditions at this active mine. Therefore, EPA's remedy must define a long-term, enforceable process of environmental monitoring that is tied to additional actions as needed, for the duration of active mining. The monitoring program should be targeted toward assessing the effectiveness of implemented remedies. The Plan should also define a process for implementing additional or enhanced remedial measures as needed to achieve remedial action objectives, if the remedial actions fail to keep up with changing conditions.

The Questa Mine is an active facility. Large quantities of tailing and impacted water will continue to be delivered to the tailing impoundment for many years or decades to come. EPA's remedy tends to evaluate effectiveness and ability of remedial measures to achieve the remedial action objectives from the perspective of post-closure conditions – i.e., after mining is ceased and reclamation covers are in place. While this scenario may be appropriate for the Mine Site waste rock piles and ground water remediation systems, it is not appropriate for the tailing facility.

Response 54: *EPA recognizes the potential for changing conditions associated with the ongoing tailing disposal operations, especially to ground water quality. EPA plans to continue monitoring ground water quality at the Tailing Facility Area, including the deeper portions of the alluvial aquifer and the basal bedrock (volcanic) aquifer where concentrations of some contaminants have been increasing over time or in direct response to increasing levels of tailing disposal operations. Other monitoring programs are also included with the Selected Remedy to evaluate its effectiveness in protecting human health and the environment. These include air monitoring, water quality monitoring for the Red River, as well as the Red River State Fish Hatchery, biota monitoring within the Red River and for metals uptake by plants growing on the soil or waste rock covers, performance monitoring of the ground water remediation systems, general ground water quality monitoring at all seeps and springs, early detection monitoring of acid generation within the tailing piles, and tailing dam performance monitoring.*

In addition to these monitoring programs, during the implementation of the remedy additional ground water characterization will be performed in the volcanic aquifer beneath and west of the tailing impoundments, and in the bedrock and/or alluvial aquifer downgradient of Dam No. 1. If additional contamination is found that will not be addressed by the Selected Remedy, the remedy will be expanded to address such contamination if warranted to protect human health and the environment.

The data to be collected by these monitoring programs and additional characterization will be used by EPA during performance of the CERCLA five-year reviews (as discussed above) to assess the protectiveness of the remedy. In the event that conditions change due to the ongoing mining and tailing disposal operations that result in the Selected Remedy not being protective, the five-year review process will allow EPA to identify the changing *conditions and determine what additional response actions may be warranted under CERCLA.*

Comment 55: Why are "recreational" concerns being put before "residential" concerns?

Response 55: *EPA disagrees with the commenter's opinion that "recreational" concerns have been put before "residential" concerns. In determining potential human health and ecological risks related to the Site, EPA considered current and future exposure to mining-related contamination present at the Site. Potential receptors and routes of exposure (oral, dermal, inhalation) were evaluated based on current and reasonably anticipated future use of the land, water and air. As an example, most of the land surrounding the mine is presently used for recreational purposes, including hiking, hunting, whitewater kayaking, fishing and camping. Currently, there are no residents living along the mine reach of the river. In the area south of the tailing facility, current and reasonably anticipated future land uses are residential, commercial, recreational, agriculture (irrigated pastures), livestock grazing, gardening and wildlife habitat. Within this valley, residential properties are located fairly close to the dam face and ground water is a current and potential drinking water source.*

EPA also notes that the most significant aspect of the Selected Remedy for protecting human health is the remediation of contaminated ground water, not only in the valley south of the tailing facility, but also for the mine site. Major components of the remedy at these areas include ground water remediation systems and engineered source control measures for the waste rock and tailing (i.e., regrade and cover of waste rock piles and the tailing impoundments). Such measures will cut off the source of ground water contamination and restore ground water quality at the Site, including existing or potential future residential areas.

4.2.1 Mill Area

Comment 56: According to the EPA's preferred remedy, with the institutional controls recorded by CMI in 2009 and the approved post-mining land use under Mining Permit TA001RE of forestry/light industrial, it is reasonable to anticipate a low occupancy (commercial/ industrial) future land use at this time. There is concern that the remedy for the Mill Area (described in Alternative 3) in terms of cover depth is inconsistent with the post-mining land use, and the post-mining land use is not necessarily consistent with future use, including that of public recreation as described in the *Declaration of Restrictive Covenants* submitted as the *Institutional Controls* for the site by CMI and relied upon by EPA in their determination. The proposed remedial action, Alternative 3, would leave significant waste in place that is contaminated with a highly toxic substance, PCBs. While our experience suggests it may be appropriate to leave less toxic waste under a protective soil cover with a minimum of 18-inches depth and a well implemented and enforced Institutional Controls Program (ICP), based on the presence of PCBs and our experience with the potential future use of this Site, we do not believe Alternative 3 is adequate from either a protectiveness or economic redevelopment standpoint.

It is, therefore, recommended that in light of future land use considerations and economic redevelopment purposes, EPA reconsider the adequacy of the proposed remedy and at a minimum require the implementation of Alternative 4. This action will require removing all PCBs to a level of less than 10 mg/kg, and that EPA together with other involved parties, such as the Village of Questa, further consider removal of all contaminated materials to allow delisting of the property and future unfettered use for the benefit of the local citizens and economy of the area.

Response 56: *There is a significant change in the Selected Remedy from the Preferred Alternative presented in EPA's Proposed Cleanup Plan. The 6-inch cover depth has been eliminated and, instead, a minimum 36-inch thick cover will be placed in the Mill Area in all areas designated for forestry as the post-mining land use. See Section 14.0, Part 2, of this ROD. EPA believes that such cover depth is necessary to limit uptake of metals* *(primarily molybdenum) in plants at levels which are protective of plants and herbivorous native wildlife. A discussion of EPA's rationale for cover depth in included in Section 12.0, Part 2, of this ROD. As the commenter noted, the 36-inch cover depth is also consistent with the New Mexico Closure/Closeout Plan for cover at the Mill Area developed under Mining Permit TA001RE-96-2 and Ground Water Discharge Permit DP-1055.*

For the Selected Remedy, no cover is required for the area to be designated for future commercial/industrial land use. The PCB cleanup level of 25 mg/kg will be protective of the commercial and industrial worker and only backfilling of the excavation is required. EPA believes that the commercial/industrial land use is a reasonably anticipated future land use for portions of the Mill Area. It is the preliminary location for water treatment facilities.

Proprietary controls have not been included with the Selected Remedy. Rather, EPA has selected temporary government controls for restricting the drilling of new water wells in areas of ground water contamination. EPA may also use a consent decree or UAO with institutional control components to restrict land use at the Mill Area as well as the mine site to protect the integrity of the engineered remedy. Further, EPA has contemplated using local ordinances, permits, and zoning restrictions after completion of remedial construction.

In the event that the anticipated land use of forestry and/or commercial/industrial land use changes to residential, then the Selected Remedy would not be protective of human health and additional response actions would be warranted under CERCLA.

Comment 57: The post-mining land use per state permit for the Mill Area is forestry and water management. However, in the *Notice to Deed* and the *Declaration of Restrictive Covenants* for the Mill Area recorded in Taos County, CMI has included potential permitted uses of "light industry and park, recreational or athletic field uses". At other Superfund sites, the issues of post-mining land use together with remedy choice have required significant foresight into both present and potential future use of the site. Failure to anticipate future use has led to significant shortcomings in remedy performance that jeopardizes remedy protectiveness and community economic stability. For example, future use of the Site for public recreation purposes may require significant redevelopment. With a six-inch cover and less than complete removal of contaminated materials, it is reasonably anticipated that any redevelopment is highly likely to encounter buried waste materials and disturb the cap. This would result in significant expense to the developer unless otherwise anticipated or addressed by an ICP and redevelopment funding mechanism, as well as the long-term protectiveness of the remedy and of human health. It is recommended that the ROD identify and include the post-mining land use of public recreation and the preferred remedy be modified to require a minimum 18-inch cover, and preferably a 3-ft cover, in anticipation of future public recreational use.

Response 57: *See response to Comment No. 56 above.*

Comment 58: The community is aware that PCBs were identified the Mill Area. What was sampled? Did CMI test for PCBs on primary and secondary crushers, and in the old pit shop? It is my understanding that there used to be transformers around the Mill Area.

Response 58: *During the Remedial Investigation, PCBs were sampled at the mine site and in riparian areas. Specifically, soil samples were collected and analyzed for PCBs at the mill area, the administration area, the explosives area, the historic fueling area, the truck shop area, the reference area for the mine site, the area potentially affected by windblown particulate deposition, the riparian area in the mine site vicinity, and the riparian area along the tailing facility. Sediment samples were collected and analyzed for PCBs from the Red River, upper Fawn Lake, and Eagle Rock Lake. Areas such as the primary crusher area, where suspected or known use of PCBs took place, were specifically targeted for sampling during the RI. For example, the majority of the 113 samples collected in the mill area were specifically targeted samples.*

For more information concerning the above samples, please see Sections 2.1 and 2.3 of the RI Report.

4.2.2 Mine Site Area

Comment 59: The Village of Questa endorses the proposed flexible “tool box” approach for evaluating and developing long-term reclamation designs on a case-by-case basis for the various waste rock piles. This approach is appropriate because the risks and consequences of failure, either in terms of long-term mass instability or failure of the reclamation cover systems, are different for different waste rock piles. A rational, risk-based, pile-by-pile approach will allow for consideration of various site-specific conditions such as: the location of a rock pile which influences the consequences of failure on human health and the environment (*e.g.,* back country piles versus roadside/riverside piles); underlying slopes and other topographic constraints on regrading; potential exposure of natural scars that could exacerbate acid-rock drainage; varying rock pile geotechnical and geochemical characteristics; and other factors affecting design decisions for each individual rock pile.

Response 59: *EPA appreciates that the commenter is supportive of the concepts for clean-up of the Site in the Preferred Alternative. However, in using a “tool box” approach in designing the waste rock pile remediation, EPA not only must balance the factors raised by the commenter, but comply with applicable or relevant and appropriate requirements for slope stability and factor of safety, as well as consider the requirements and conditions set forth in the New Mexico mining permit (TA001RE) and ground water discharge permit (DP-1055) for achieving the shallower 3 horizontal to 1 vertical (3H:1V) slopes, where practicable, as to-be-considered (TBC) material identified in the ROD. Although EPA has selected both the 3H:1V regrade and 2H:1V regrade options for the remedy, the preference is for achieving the 3H:1V regrade where determined by EPA to be practicable.*

Comment 60: EPA's Preferred Alternative for the mine site is Subalternative 3A – Source Containment (3H:1V: Balanced-Cut-Fill, Partial/Complete Removal, Regrade, and Cover for 3H:1V Slopes); Storm-Water, Surface-Water, and Ground-Water Management, Ground-Water Extraction and Treatment, and Subalternative 3B – Source Containment (2H:1V: Balanced-Cut-Fill, Regrade, and Cover for 2H:1V Slopes); Storm-Water, Surface-Water; and Ground-Water Management; Ground-Water Extraction and Treatment, and Mine Site Water Treatment – Year 0 Construction. This preference for source containment is consistent with previous requirements established by the NMED and EMNRD, and their respective regulatory requirements under the New Mexico Mining Act and Water Quality Act. However, R3G believes that the description in the Plan does not address the reality of the Site, wherein the actual regrading designs must deal with underlying steep slopes and other physical site constraints that limit regrading designs. The issue of geochemical stability/degradation of the rock piles has yet to be conclusively resolved. EPA states that the range of minimum slopes specified in the Preferred Alternative (3H:1V to 2H:1V interbench slopes) will be achieved for the rock piles. However, it is also recognized that regrade to an interbench slope that is steeper than 2H:1V may be appropriate and acceptable from a practical standpoint, if it can be demonstrated to the satisfaction of EPA that such design will be protective of human health and the environment and achieve ARARs.

In addition, R3G believes that the cover material for the rock piles will result in a problematic impasse between the views of the regulatory agencies and that of the responsible party (*i.e.,* CMI) that will ultimately result in delaying implementation.

It is, therefore, recommended that the ROD require a detailed design schedule and enforcement mechanisms to assure that the schedule is expedited to achieve on-the-ground remediation within the shortest reasonable time frame. In addition, the Agencies should anticipate significant disagreement during the design phase, and require associated funding for to form a Joint Technical Working Group (JTWG) with involvement of regulatory, community/local government and technical consultants. Consideration should be given to forming a high-level Independent Review Panel to serve as a formal advisory panel to EPA and NMED, and assist them in addressing issues raised by the responsible party, as well as other participants of the process.

Response 60: *EPA will conduct negotiations with CMI for performance of the remedial design and remedial action. If the negotiations are successful, a consent decree documenting the settlement will contain requirements concerning time frames to complete various design and remediation tasks. Additionally, at the start of the remedial design phase of the project, a detailed remedial design/remedial action project schedule will be prepared for all remedial activities. As stated in a previous response, the schedule will be robust, but realistic, to ensure that the cleanup is conducted in the most expeditious manner possible to protect human health and the environment. The enforcement mechanism for CMI to implement the project schedule is CERCLA, as CMI would be subject to stipulated penalties for not meeting the requirements set forth in the consent decree.*

With regard to the commenter's suggestion for a "Joint Technical Working Group" and "Independent Review Panel", EPA decided not to establish such groups at this time, but recognizes there may be value in this approach and will continue to evaluate its merits as EPA conducts formal negotiations with CMI for performance of the remedial design and remedial action. EPA was able to observe the working group formed in the late 1990s of state and local governments, the community, environmental groups, Molycorp and technical consultants during the negotiation and development of the Closure/Closeout Plan between NMED, MMD and Molycorp under the New Mexico Mining Permit TA001RE and discharge permits DP-933 and DP-1055. That group was mostly unsuccessful and ineffective in having its technical issues satisfactorily addressed by Molycorp, even after a facilitator was brought in to resolve conflicts between the parties. The group was eventually discontinued. Whatever the approach EPA decides to use for implementing the Selected Remedy, EPA will use its authority under CERCLA to not allow CMI to delay remedy implementation because of any impasse of technical opinions or views by the various experts that will likely be involved with this project. EPA has every intension of fully considering differing technical viewpoints of how best to proceed with work on the waste rock piles. However, it is ultimately EPA's decision how to proceed. Furthermore, EPA will not allow the type of endless debate of key issues that occurred with the previous *work group that were never resolved under the New Mexico permitting process to the satisfaction of many stakeholders.*

Comment 61: There is little to no discussion of any remedial action for the block-caving induced underground subsidence and subsequent surface impacted area (*i.e.,* subsidence zone). Similarly, there is no mention of actions to address the Open Pit. These unstable zones have created a rubbleized and highly irregular and unstable land surface that allows for increased infiltration of water into the underground workings. Because the subsidence area will not be capped, and open pit not backfilled, as well as safety and implementibility issues, water draining into the underground workings from these zones will be pumped and treated in perpetuity. It is recommended that the ROD address the mine subsidence areas and open pit because these features present a significant risk to human health, safety, and the environment. If EPA had some rationale for not addressing these aspects of the mine site, it should have been provided in the Proposed Cleanup Plan within the scope of the Mine Site Area remediation.

Response 61: *EPA did not conduct sampling in the subsidence areas during the RI over safety concerns for the sampling crews. The open pit was sampled, but EPA determined that there was no (or negligible) risk to human or ecological receptors, which is why the open pit was not targeted for response actions in the Proposed Cleanup Plan.*

However, EPA agrees with the commenter. As required by MMD in approving a waiver for reclamation of the open pit, EPA has included in the Selected Remedy physical barriers (a five-foot higher perimeter berm and fencing) and signage to restrict access to the open pit for the long term and possibly in perpetuity. EPA has also specified that the stability of the pit walls will be monitored periodically and a proposal submitted for response measures to address instability concerns, if necessary. Additionally, the open pit may be used as an on-site repository for waste rock to be removed during the regrading and re-contouring of the waste rock piles, which would result in all or a portion of the open pit being filled in and covered. Although the subsidence area is too large to fence off, EPA has included signage as part of the Selected Remedy to restrict access. In addition to these *physical barriers, EPA may also use enforcement tools with institutional control components (such as a consent decree or UAO) to require CMI to limit land use during construction of the remedy. EPA has also contemplated using local (village or county) ordinances, permits, or zoning restrictions at the completion of remedy construction to ensure the integrity of the remedial measures is maintained. See Section 14.0, Part 2, of this ROD for further discussion of institutional controls at the mine site.*

Comment 62: Why does the preferred remedy exclude cleanup and remediation of the subsidence areas and the open pit. EPA should require actions to minimizing water contamination from those areas, and analyze the potential for using the open pit as a tailing disposal facility.

Response 62: *See response to Comment No. 61, above, regarding CERCLA response actions for the open pit and subsidence area. With regard to minimizing water contamination in those areas, CMI currently discharges contaminated storm water to the open pit, subsidence area and catchment basins/infiltration galleries at the lower end of the tributary drainages, including the base of the roadside waste rock piles under the Clean Water Act NPDES MSGP for storm water discharges associated with industrial activity. Because storm water discharges are regulated by NPDES permits, they are federally permitted releases. Thus, pursuant to CERCLA § 107(j), discharges of pollutants to waters of the United States (e.g., the Red River) caused by storm water discharges regulated by the permits are addressed under the Clean Water Act, rather than by a CERCLA remedy.*

Comment 63: The community is concerned about the adequacy of the catchment systems at Springs 13 and 39, as well as how all other the seeps and springs will be addressed. Just the same old “Pump and Treat” is not enough.

Response 63: *The current systems that address Springs 13 and 39 are Best Management Practices (BMPs) under EPA NPDES Permit NM0022306. Seepage or contaminated ground water at other areas of the site will be addressed by the installation of seepage collection systems and/or ground water extraction systems or existing systems will be* *upgraded. All these systems combined, as well as the source control measures for the waste rock piles and perpetual dewatering of the mine, will assist in reducing the source water for many of the springs along the Red River.*

Comment 64: The Village of Questa questions the need for extensive water treatment at the Site. What are the anticipated environmental benefits associated with water treatment at the mine site? From our analyses, we conclude that the primary benefits would be realized at the tailing impoundment because the water being delivered to the tailing facility would have somewhat better quality, notably during non-milling periods. An analysis should be performed to estimate the likely impacts on tailing seepage water quality assuming: (a) reduction of concentrations coming from the mill under the Proposed Cleanup Plan scenario, and (b) continuation of current practice of treatment through lime addition at the mill only, accounting for anticipated increased volumes of impacted water that will be generated from enhanced ground water collection systems. We anticipate the relative impact on seepage water quality will largely depend on the assumed future production and milling rates, because process water associated with tailing delivery will remain the principal source of poor quality seepage water. Do the marginal benefits of improving water quality delivered to the tailing impoundment, primarily during non-milling periods, justify the costs for constructing and operating a water treatment plant at the mine site?

Response 64*: EPA believes that the relationship between the effectiveness afforded by water treatment from the start of the remedial action and its costs are reasonable when considering the additional benefits in the reduction of toxicity, mobility, or volume of the contaminants through treatment. CMI's practice of disposing contaminated ground water collected at the mine site to the tailing facility contributes to the contamination of the alluvial and basal bedrock (volcanic) aquifers at the Tailing Facility Area as well as the Red River, which is a violation of the Clean Water Act for an unauthorized discharge to waters of the United States. Approximately 75 percent of the water sent to the tailing facility is unaccounted for in CMI water balance calculations. Based on the findings of the RI, EPA has determined that most of this water seeps downward through tailing (as tailing* *seepage) into the underlying aquifers and contaminates the ground water with metals, radionuclides (uranium) and sulfide at concentrations exceeding federal or New Mexico drinking water standards, New Mexico water quality standards or EPA health-based criteria. Based on EPA's HHRA, there is an unacceptable level of risk to human health from potential exposure to this contaminated ground water by ingestion (drinking) which must be addressed by CERCLA response actions. The "marginal benefits" that the commenter mentions for treating the contaminated mine water would be the protection of human health and attainment of the following remedial action objectives for the Tailing Facility Area:*

- *Restore contaminated ground water at and off-site of the tailing facility to meet state/federal ARARs or Site-specific risk-based cleanup levels for inorganic COCs;*
- *Eliminate or reduce, to the maximum extent practicable, the seeping and migration of inorganic COCs from tailing to ground water at concentrations and quantities that have the potential to cause exceedances of the numeric ground water ARARs or Site-specific risk-based cleanup levels for ground water.*

The treatment and disposal of contaminated mine water at the mine site should allow CMI to significantly reduce the volume of water transported to the tailing facility during non-milling periods, thereby enhancing the ability of the Selected Remedy to achieve these remedial action objectives in a shorter period of time. Since EPA has decided to implement the source containment measures (cover and revegetation) after permanent cessation of tailing disposal operations, the reduction in the volume of water conveyed to the unlined tailing impoundments during the remaining operational life of the facility as a result of water treatment at the mine site is an important (albeit indirect) aspect of EPA's remedy.

Additionally, there is a statutory preference for selecting a remedy that involves treatment as a principal element (see Section 13.5, Part 2, of the ROD). Treatment of contaminated water to be collected by the remedial systems at the mine site, as a major component of the Selected Remedy, partly satisfies this preference.

Under the New Mexico Water Quality Act and related Water Quality Control Commission (WQCC) regulations, CMI is required to prevent and abate ground water and surface water pollution pursuant to §§ 20.2.6.3107 and 3109 NMAC. These regulations are identified by EPA in this ROD as ARARs to the CERCLA response action and must be attained. Under Ground Water Discharge Permit DP-933, CMI is allowed to operate the facility subject to several conditions. One of these conditions (Condition 7) requires submission of a proposal for reducing the volume of mine water discharged to the impoundments, to the extent practicable. CMI allegedly failed to meet this requirement, resulting in NMED's issuing a notice of violation of the Water Quality Act, the WQCC regulations, and DP-933 in 2010.

As for the cost of water treatment, EPA recognizes the need to perform an evaluation during remedial design to determine efficiencies in treatment system processes, location(s), and sizing that could result in significant cost savings for the construction, operation and maintenance of the water treatment systems and the reduction in ongoing operation, maintenance, and the disposal of treatment residuals with respect to these systems.

Comment 65: CMI does not agree with EPA's preference for a new water treatment plant at the mine site. CMI's Phased Plan for the Mine Site Area includes current mill neutralization/treatment of collected waters and possible enhancements of the current system rather than construction of a new water treatment plant at "Year 0". It also includes a phased approach to evaluate technologies that could be added to the existing mill neutralization treatment system that could be implemented in lieu of a new water treatment plant. CMI's phased approach would assess the need for additional treatment technologies instead of construction of two water treatment plants. CMI would continue the ongoing practice of allowing seepage from Capulin and Goathill North waste rock piles and storm water discharge to percolate through the subsidence zone into the underground mine.

The current capacity of the mill to treat water collected and extracted at the mine is sufficient to assimilate the additional extracted water in EPA's Preferred Alternative and

CMI's Phased Plan for the Mine Site Area. Construction and operation of a new water treatment plant prior to closure is not necessary to achieve treatment capacity. Although CMI is proposing enhancements to the existing mine water management and treatment system, the data demonstrate the system is effective.

The additional water treatment required by EPA's Proposed Cleanup Plan would produce no additional benefit but is estimated to cost a minimum of $132 million net present value more than the CMI Phased Plan. Based on the ground water models conducted for the FS, the proposed "Year 0" water treatment plants will not result in the achievement of ground water standards any sooner. The proposed "Year 0" water treatment plants would not significantly reduce risk since current risk to human health and the environmental is negligible.

Response 65: *See response to Comment No. 64 above.*

Comment 66: There is concern that the current methods used to collect contaminated seeps and springs that discharge to the Red River are inadequate. Further, EPA's remedy does not discuss upgraded collection systems or the collection of any other contaminated springs along the river.

Response 66: *The collection systems referred to by the commenter are French drains that were constructed at Springs 13 and 39 as part of Best Management Practices (BMPs) under EPA's individual NPDES Permit NM0022306. The Best Management Practices also include the Ground Water Withdrawal Well System located along Highway 38 near the roadside waste rock piles. This system consists of three extraction wells (GWW-1, GWW-2, and GWW-3) that pump contaminated ground water from the Red River alluvial aquifer. During the RI, EPA determined that these drain and well collection systems were effective at collecting some contaminated ground water that would discharge to the Red River. Therefore, they have been incorporated into the Selected Remedy. However, EPA has also expanded the ground water component of the remedy to include additional extraction well systems to be placed at the mouth of each tributary drainage at the mine site, including the* *drainages at the roadside waste rock piles. The new wells at the roadside waste rock piles will be upgradient to the GWW wells at the toe of the piles to effectively capture waste rock leachate in colluvial ground water before it enters the Red River alluvial aquifer. Collection systems (drains) will also be placed at the toe of the Capulin and Goathill North waste rock piles to capture waste rock leachate seeping from the base of the piles. The Selected Remedy does not include any additional collection systems for seeps and springs entering the Red River along its mine site reach. There are other impacted springs and seeps along the mine site reach of the river, but they are smaller than Springs 13 and 39 and do not impact or threaten aquatic life in the river to the extent that Springs 13 and 39 have done so. Based on the findings of the Baseline Ecological Risk Assessment (BERA), EPA has determined that response actions are not warranted for the other springs at this time. However, all seeps and springs along the mine site reach will continue to be monitored as part of the Selected Remedy.*

Comment 67: EPA's remedy fails to address violations of the two NDPES discharge permits issued by EPA that require CMI to intercept contaminants emanating from the tailing site and the rock piles site from entering into the Red River.

Response 67: *EPA disagrees. Most of the components of the Selected Remedy for the Mine Site Area and Tailing Facility Area will help EPA achieve the remedial action objectives set forth in this ROD for reducing or eliminating the migration of mining-related contamination to the Red River.*

CMI currently implements Best Management Practices under the NPDES individual permit NM0022396 to capture seepage entering the Red River at Springs 13 and 39 and collect contaminated ground water at the base of the roadside waste rock piles that would migrate downgradient and enter into the Red River at zones of uwelling (seeps and springs). The BMPS are the Seepage Interception Systems (French drains) at Springs 13 and 39 and the Ground Water Withdrawal Well System (extraction wells GWW-1, GWW-2, and GWW03). These systems have been somewhat successful at reducing contaminant concentrations in *the alluvial aquifer and in the Red River. Therefore, they have been included with the Selected Remedy.*

The Selected Remedy also includes source containment for the waste rock piles (regrade, cover, and vegetation) to reduce or eliminate acid-rock drainage as well as an expanded ground water remedy that includes additional drains and extraction wells in all of the tributary drainages at the mine site to capture COCs in colluvial and bedrock ground water that would flow to the Red River alluvial aquifer and, subsequently, to the Red River. The combination of the NPDES BMPs, source containment, and additional ground water remedial systems at the mine site is anticipated to intercept COCs that would otherwise enter into the Red River. The source contaminant, upgraded seepage collection systems and ground water extraction and treatment planned for the Tailing Facility will do the same.

Comment 68: Has EPA considered maintaining the water level in the underground mine site equal to the elevation of the Red River surface water? This should help minimize both flow and volume to be treated.

Response 68: *EPA believes that the water level in the underground mine must be maintained below the elevation of the Red River to prevent the flow of contaminated ground water from the mine to the river through a hydrologic connection. However, during remedial design the approach to mine dewatering will be to minimize the volume of water to be collected, to the extent practicable.*

Comment 69: The community assumed optimized capture and treatment of the mine site seeps and springs was a part of EPA's preferred remedy for the mine site waste rock piles and would result in protection of the Red River from associated discharges. It is recommended that the preferred remedy be modified to require enhanced capture and treatment of all ground water associated with waste rock piles in order to protect the water quality of the Red River.

Response 69: *As stated in response to Comment No. 67, the Selected Remedy for the mine site includes several new or upgraded ground water collection systems in the tributary drainages at the mine site. These will be located at the toes of several waster rock piles, and/or at the mouths of each drainage. The new extraction systems are targeted to remove approximately 300 gpm of additional ground water (see Table 12-1, Part 2, of this ROD). The conceptualized total estimated volume of water that will be collected by all the remedial systems and mine dewatering operations at the mine site is 1,070 gpm. Of this total volume, approximately 550 gpm will be treated. The remaining 520 gpm of water are to be collected as part of CMI's NPDES BMPs and, therefore, are exempt from this response action under CERCLA § 107(j) if CMI is in compliance with the NPDES permit.*

Comment 70: The use of a "tool box" approach, or risk-based design, is supported by CMI. Rock pile reclamation is complex and allowing for a flexible "tool box" of approaches that recognizes the variable site conditions, rather than imposing a rigid set of requirements for all rock piles, will result in a better overall remedy. A risk-based approach should be considered during design for comparing reclamation options and assessing their risks relative to one another considering associated social, environmental, and economic consequences. Previous projects on site, such as the Goathill North rock pile regrading, have achieved success using the failure modes assessment (FMA) process to engage stakeholders in determining the optimum design. A key factor in the success of this proposal (the "tool box" approach) would be the full involvement of stakeholders and experts who are familiar with the systems being evaluated or have site-specific knowledge and information. A Joint Technical Working Group with involvement of regulatory, community/local government and technical consultants should be formed.

Response 70: *EPA acknowledges CMI's support for the "tool box" approach for remediation of the waste rock piles. EPA also agrees with CMI that it is the best approach to provide the necessary flexibility in completing designs on a rock pile-by-rock pile basis, recognizing the variable conditions of each individual waste rock pile. However, such approach will be used by EPA to protect human health and the environment, attain ARARs, and achieve the remedial action objective set forth in this ROD to eliminate or reduce, to the maximum extent practicable, leaching and migration of COCs and acidity from waste* *rock (acid rock drainage) to ground water at concentrations and quantities that have the potential to cause exceedances of ARARs or Site-specific risk-based cleanup levels. EPA's approach will also include an evaluation of the long-term static/seismic stability of the rock piles and revegetation and erosion control for the cover system. The "tool-box" approach will not be used to assess social or economic consequences of rock pile regrading, as these types of analyses are not pertinent to this CERCLA response action.*

With regards to the proposal for a Joint Technical Work Group, see response to Comment No. 60 above.

Comment 71: The issue of geochemical stability/degradation/weathering of the rock piles has yet to be conclusively resolved. Several agencies, selected residents, and the Village of Questa support EPA's commitment to conduct future treatability studies as the remedial design is developed. Early-stage reclamation of some rock slopes should be conducted to serve as learning tools for later efforts and treatability studies should incorporate variable amendment types, rates and application methods, as well as re-grading strategies that promise more stable slope configurations, such as geomorphic re-grading designs. Pilot tests are needed to validate infiltration models, vegetation success, and reclamation cover performance. The Goathill North Waste Rock Pile is the ideal site for undertaking pilot programs. Factors which influence its selection include: safe access, previous regrading, variable slopes, relatively small size, a separate mini-watershed, and a location away from public areas.

Response 71: *Many of the issues discussed by the commenter will be considered during the remedial design. While EPA agrees that Goathill North Waste Rock Pile would be a good candidate in which to undertake a pilot study (and the Selected Remedy indicates such preference), the final determination as to which waste rock pile(s) will be selected for the pilot study will be made during remedial design as other factors may need to be considered. Such factors may include the potential expansion of the subsidence area toward the Goathill North Waste Rock Pile and the effect on the stability of the rock pile.*

Comment 72: The ROD should require a detailed design schedule and enforcement mechanisms to assure that the schedule is expedited to achieve on-the-ground remediation within the shortest reasonable time frame. The agencies should anticipate significant disagreement during the design phase. R3G's past participation in the Site technical processes suggests that the cover material for the rock piles constitutes what has been an impasse between the views of the regulatory agencies and that of the responsible party (*e.g.,* CMI). We are very concerned that more revegetation test plots will be utilized in the anticipation of useful results, delaying actual remediation implementation. We are particularly concerned that CMI will continue to conduct test plot exercises which do not incorporate required amendments and approaches that are most likely to result in revegetation success. The ROD should anticipate the divergence of opinions on vegetative success and remediation/reclamation approaches in general, and anticipate and encourage means to cause large-scale demonstration area and corrective adaptive management in response to results obtained from those areas. The ROD should not encourage further test plots as contained in the EPA's preferred remedy except as a means or tool for determining longer-term approaches to reclamation at the Site.

Response 72: *EPA is committed to completing the waste rock pile remedial design and remedial action activities at the site in a timely manner, and does not anticipate that installation of test plots will impede the schedule. EPA has specified in the ROD that treatability test plots will be conducted concurrent with remediation of the rock piles and that testing will not delay the remediation. Rock pile regrading will likely take a significant period of time to achieve the slopes required for cover construction, due to the size of the rock piles. Regrading of rock piles will also be implemented in a phased or staggered approach due to logistical and worker/public safety concerns. The phased implementation of rock pile remediation will provide sufficient time to implement test plots and analyze data if implemented at the beginning of the remedial design/remedial action process.*

Comment 73: The selection of reclamation measures at the Sugar Shack South, Sulphur Gulch South, and Goathill North waste rock piles should give significant weight to the impacts of hydrothermal scars bother under existing conditions and if the scars are exposed. EPA's preferred remedy for the Mine Site Area would result in increased exposure of hydrothermal scar material under Sulphur Gulch South and Sugar Shack South waste rock piles. In terms of long-term effectiveness, a larger area of scar will be exposure by Subalternative 3A resulting in an increased potential for erosion and potential debris flows. The existing rock pile covering a portion of the Goathill scar by the Goathill North waste rock pile prevents potential damaging debris flows and erosion.

Response 73: *See response to Comment No. 81 below.*

Comment 74: Spring Gulch waste rock is considered to be of marginal quality as a cover material. It is doubtful that an ET cover consisting of Spring Gulch waste rock pile material and vegetation will consistently increase ET and that percolation rates are likely to exceed 25 percent. Test plot data indicate that the materials will require grading (*e.g.,* sizing) to achieve the desired physical properties and significant amendment with organic materials to achieve revegetation, erosion control, and a sustainable ecosystem. Elevated levels of molybdenum in this material may be bioavailable to the extent that molybdenum accumulation in plant tissues may produce long-term negative impacts in the creation of a self-sustaining ecosystem.

Response 74: *EPA agrees with the commenter. To address this issue, EPA has included in the Selected Remedy a performance-based remediation goal for establishing successful plant growth. This remediation goal is to ensure that molybdenum uptake from the Spring Gulch borrow material to plants shall not be at levels that inhibit attainment of re-vegetation success standards or exceed risk-based concentrations considered protective of herbivorous native wildlife. For further details of the performance-based remediation goal, see response to Comment No. 84 below.*

Comment 75: Though safety does not fall under EPA's direct jurisdiction, it is important in the design, implementation, and maintenance of remedial actions at the mine site. Subalternative 3A would create more collateral adverse environmental impact because of moving 122 million cubic yards of waste rock versus 35 million cubic yards waste rock removal for Subalternative 3B. With respect to short-term effectiveness, Subalternative 3A could result in potentially three times as many accidents as Subalternative 3B and Subalternative 3B would provide greater short-term effectiveness. Subalternative 3B would lessen the collateral environmental and safety impacts from truck haulage, potential road closures (school/hospital access impacts), and long-term operation and maintenance of a separate/new rock repository.

Response 75: *Protection of workers and the community will be one of many issues that will be considered during the remedial design and construction phases of the project.*

Comment 76: Why would EPA select one-foot of soil cover depth, which sounds like a possibility instead of three feet? And, with the steep slopes both pre- and post-remediation, how can one foot of slope cover be efficient or sufficient?

Response 76: *The thickness of the cover specified in the ROD is 36 inches (3 feet) for the waste rock piles in the Mine Site Area as well as areas at the mill to be designated for forestry, the post-mining land use approved by MMD. In the Proposed Cleanup Plan, EPA did indicate that 6 inches of cover would be suitable for areas at the mill that would be used for commercial or industrial purposes. However, there has been a change to the Selected Remedy from the Preferred Alternative presented in the Proposed Plan regarding the 6-inch cover. Based on the degree of cleanup planned for PCB-contaminated soil at the Mill Area, a cover is not needed for those areas designated for commercial or industrial use to ensure protectiveness. Only backfilling of the excavation will be performed.*

Comment 77: EPA's Proposed Plan would allow CMI to re-grade some waste rock piles to slopes greater [*i.e.,* steeper] than 2H:1V. The community is concerned about the safety of highway traffic traveling alongside these unstable roadside dumps along the Red River corridor.

Response 77: *Health and safety plans will be prepared to protect the workers and the community during all construction activities. Because of the close proximity of State Highway 38 to the roadside rock piles, all necessary and appropriate precautions will be taken to ensure the safety of motorists traveling this roadway. EPA will also coordinate the work with the New Mexico Departments of Transporation and Public Safety, as well as all other appropriate state and local officials responsible for highway safety. Temporary road closings and advisories will likely be necessary for some aspects of the work.*

Comment 78: EPA should comment on the effect of weathering on the long-term (100 and 1,000 years) gravitational stability and the acid-rock drainage-generating potential of the rock piles? Is it important to address this topic in the context of EPA's proposed cleanup plan?

Response 78: *EPA considers both short and long-term stability to be very important in the development of the final remedy for each waste rock pile. Once covered, the waste rock piles will be much less susceptible to infiltration of precipitation and thus the production of acid-rock drainage. These issues will be a critical consideration in the remedial design process.*

Comment 79: For the mine site, Preferred Alternative 3B comprises source containment by re-grading the rock piles to achieve a 2H:1V slope, covering them with soil and native vegetation and constructing a new treatment system to collect and treat contaminated mine waters. This alternative is preferable to 3A because of the reduced area of surface disturbance, both in terms of the rock pile footprint and the potential need for an on-site repository, as well as improved feasibility. Existing test plots have shown that the covered rock pile surfaces can hold a 2:1 slope with even minimal vegetation. We urge the EPA, when conducting the engineering studies necessary to support this action, to remain flexible toward the use of "geomorphic" options using variable slope/cover thickness combinations, as has been proposed in the past by CMI.

Response 79: *EPA acknowledges the commenter's concern regarding surface disturbance when regrading the rock piles. This concern as well as other issues will be considered in the evaluations that will be performed during the remedial design.*

Comment 80: It is stated in EPA's Proposed Cleanup Plan (USEPA 2009a) that the preferred alternative is grounded in a "tool box" approach for remediating each rock pile with each rock pile evaluated independently using a multi-factorial analysis during remedial design. While CMI does not agree that Subalternative 3A is supported using the NCP criteria for evaluating remedial alternatives, it does support the use of a "tool box" approach, or risk based design as it is commonly referred to.

Response 80: *EPA acknowledges that CMI endorses the flexible "tool box" approach of addressing the waste rock piles outlined in the ROD.*

Comment 81: In evaluating its preferred alternative for remediation of the rock piles, EPA designates both Subalternatives 3A and 3B as "Preferred Alternatives" in the Proposed Cleanup Plan. But it adds the following: "However, the 3H:1V interbench slope (Subalternative 3A) is preferred over the 2H:1V interbench slope (Subalternative 3B). Each waste rock pile would be evaluated during the remedial design phase with the objective of achieving the 3H:1V slope." (USEPA 2009, p. 63). This presumption in favor of Subalternative 3A is not consistent with EPA's assertion that "a 3H:1V interbench slope cannot be achieved for most of the waste rock piles due to steep underlying bedrock slopes." (USEPA 2009). It is also inconsistent with the EPA's comparison of the subalternatives using the nine-factor NCP criteria (40 CFR § 300.430(e)(9)(iii)) and the three-step process for evaluating those criteria described on pages 82 and 83 of the Proposed Cleanup Plan (USEPA 2009).

Step No. 1 – Consideration of the Two Threshold Criteria

The two threshold criteria include: Overall Protection of Human Health and the Environment (NCP Threshold Criteria #1) and Compliance with ARARs (NCP Threshold Criteria #2). Both subalternatives "are protective," but Subalternative 3A "would expose areas of natural scars underlying the piles," resulting in Subalternative 3B as providing greater protection. Both subalternatives employ systems that would achieve ARARs, i.e., groundwater standards, in the alluvial aquifer but neither demonstrated that the standards would be achieved in the colluvium or bedrock in all cases.

Step No. 2 – Consideration of the Primary Balancing Criteria

According to EPA: Five primary balancing criteria are used to identify major trade-offs between remedial alternatives. These trade-offs are ultimately balanced to identify the preferred alternative and to select the final remedy (USEPA 1990, p.3). The balancing criteria include long-term effectiveness; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementibility; and cost. With respect to long-term effectiveness and permanence:

- Overall, Subalternative 3A would provide the highest level of effectiveness and permanence in the long term, closely followed by Subalternative 3B.
- Subalternative 3A provides shallower slopes which will promote successful revegetation and a "more effective store and release cover."
- Subalternative 3A would create more collateral adverse environmental impact because of moving 122 million cubic yards of waste rock versus 35 million cubic yards waste rock removal for Subalternative 3B.
- Subalternative 3A would expose hydrothermal scars with a potentially devastating environmental consequence.
- No difference in weight is given to each of the different adverse impacts from the two subalternatives. However, for the reasons stated in Section 5.3, much greater weight should be given to the adverse environmental consequences of the greater exposure of hydrothermal scars by Subalternative 3A.

With respect to reduction of toxicity, mobility, or volume through treatment, Subalternatives 3A and 3B both "provide greater reduction in toxicity, mobility, and volume" and both are equal in reduction of toxicity, mobility, or volume through treatment.

With respect to short-term effectiveness, Subalternative 3A "could result in potentially three times as many accidents" as Subalternative 3B and Subalternative 3B would provide greater short-term effectiveness.

With respect to implementability, Subalternative 3B "would be next easiest to implement" after Alternatives 1 and 2. Subalternative 3A "would involve the largest scale construction activities, including almost complete removal of the Roadside Waste Rock Piles."

With respect to cost, Subalternative 3B is most cost-effective. According to EPA: "Cost may play a significant role in selecting between options that appear comparable with respect to the other criteria, particularly long term effectiveness and permanence, or when choosing among treatment options that provide similar performance" .

Present value cost for Subalternative 3A = $310 million versus Subalternative 3B = $114 million. The difference in cost is $196 million (costs based on those provided in the EPA Proposed Cleanup Plan).

Subalternative 3B satisfies more of EPA's own regulatory criteria and EPA has shown that it is protective and achieves applicable ARARs to the extent Subalternative 3A does. And it does so without the requirement to spend an additional $196 million. Cost effectiveness can only be justified if the costs are proportional to overall effectiveness (40 CFR § 300.430(f)(1)(ii)(D)). Subalternative 3A's increased costs do not meet this requirement.

Response 81: *As stated by the commenter, a comparative analysis of the remedial alternatives using the nine NCP evaluation criteria was performed by CMI on behalf of EPA. This analysis is documented in the FS Report (URS 2009b) approved by EPA. However, in developing the Preferred Alternative presented in the Proposed Cleanup Plan, EPA re-evaluated CMI's comparative analysis and determined that such analysis for Subalternatives 3A and 3B for the Mine Site Area was inadequate and flawed. The FS Report did not adequately assess the advantages of the shallower (3H:1V) slope regrade* *for cover placement as compared to the steeper (2H:1V) slope regrade throughout the analysis, even after such advantages were thoroughly discussed between EPA, NMED, MMD, and CMI during the FS and documented in EPA/NMED letters to CMI dated August 12, 2008 and May 28, 2009. Additionally, CMI overemphasized the potential environmental impacts of exposing natural hydrothermally-altered scars (scars) with Subalternative 3A. EPA considers statements made by CMI in the FS Report that exposing scars could result in a potentially "devastating environmental consequence" to be scientifically unsubstantiated as well as an attempt to bias EPA remedy selection.*

EPA will address this comment in four parts: (1) EPA's preference for shallower slopes, (2) environmental impacts of exposing scar material at the mine site, (3) refinement of CMI's comparative analysis for Subalternative 3A and 3B, and (4) Cost-Effectiveness Determination.

EPA's Preference for the Shallow 3H:1V Interbench Slope: *EPA disagrees with the commenter that there is an inconsistency in the preference for the shallower 3H:1V slope. EPA has selected both subalternatives for the Selected Remedy, but recognizes that the shallower 3H:1V interbench slope would be superior to the steeper 2H:1V interbench slope for supporting an erosion-resistant cover that would provide a long-term stable medium to promote vegetative growth capable of reducing acid-rock drainage and metals leaching. Therefore, as stated in the ROD, each waste rock pile remediation will be designed with the intent to achieve a 3H;1V slope. If it is determined by EPA that attainment of the 3H:1V slope is technically impracticable, based on factors such as steep underlying bedrock slopes, then a steeper slope will be targeted but no steeper than 2H:1V. Further, the targeted slope shall be the shallowest slope attainable, given the various factors that must be considered during design.*

Environmental Impacts of Exposing Scar Material at the Mine Site*: At the mine site, regrading of several of the waste rock piles to a 3H:1V slope will result in the exposure of near vertical outcrops of scar material. As a result of such exposure, the area for incident rainfall will be minimized and runoff will be maximized resulting in little to no infiltration* *of water in these areas. The soil erosion which feeds the natural mud/debris flows within scar-impacted tributary drainages observed north of the mine site originates from the colluvial fans at the base of the scars and not from the near vertical faces. The absence of infiltration and scar-related debris has been observed on the upper north side of the regraded Goathill North Waste Rock Pile. A veneer of coarse waste rock over steep scared areas will encourage infiltration of rainfall as observed in the roadside waste rock piles and likely result in further impacts to ground water. Consistent with observations at the Goathill North Waste Rock Pile and in natural drainages north of the mine site, EPA expects that debris flows will not occur from areas where regrading exposes near vertical scar faces and that the vertical exposed scars are a lesser environmental consequence than scars covered with a veneer of overly steepened coarse waste rock.*

***Refined Comparative Analysis for Subalternatives 3A and 3B**: The comparative analysis performed by CMI and contained in the FS Report was refined for Subalternatives 3A and 3B and, along with the cost-effectiveness determination (discussed below), forms the basis for EPA decision-making for the Mine Site Area. The refined comparative analysis is summarized below.*

- *<u>Protection of Human Health and the Environment</u>: EPA determined that all of the alternatives, except the No Further Action alternative and Limited Action alternative are protective of human health and the environment by eliminating, reducing, or controlling risks posed by contaminated ground water and surface water through, land use controls, engineering controls and active ground water and surface water remediation. However, differences between Subalternative 3A and 3B are noted relevant to protectiveness. Subalternative 3A would be superior to Subalternative 3B for supporting an erosion-resistant cover that would provide a long-term stable medium to promote vegetative growth capable of reducing net percolation and, hence, acid production and metals leaching. Subalternative 3A would also be superior to Subalternative 3B as it would result in shallower slopes than Subalternative 3B and there are inherent dangers of personnel fatalities and injuries associated with constructing, repairing, and maintaining the steeper 2H:1V* *slope surfaces. However, the use of a repository for waste rock placement in Subalternative 3A would result in increased emissions and safety concerns associated with haul truck traffic.*

- *<u>Compliance with ARARs</u>: As stated by the commenter, both subalternatives employ systems that would achieve ARARs, but CMI could not demonstrate that standards or background levels would be achieved in colluvial and bedrock ground water in all cases. Such demonstration is based on modeling performed by CMI and its consultants assuming a 60 percent reduction in net infiltration through the store and release/evapotranspiration cover system to be constructed on the waste rock piles. Although there is significant uncertainty with the modeling results, EPA accepted this assumption for FS purposes but not as a potential performance criterion in design of the cover system. A higher performance cover design (i.e., higher percent infiltration reduction) would be necessary to satisfy the remedial action objective established by EPA for reducing acid rock drainage and metals leaching in waste rock piles to levels that would not cause exceedances of ground water standards or natural background levels. As stated previously, the shallower slopes of Subalternative 3A would be superior to the steeper slopes of Subalternative 3B for reducing net infiltration and, hence, attaining ARARs.*

- *<u>Long-Term Effectiveness and Permanence:</u> Subalternative 3A would achieve shallower slopes as compared to Subalternative 3B, thus significantly increasing the long-term structural and erosional stability of the rock pile and associated cover. Secondary weathering minerals found in the mine site waste rock piles such as illite and smectite clays, gypsum, and iron oxides have properties that can adversely affect stability such as the brittle nature of the oxides, the fine grain size of the clay particles, and the swelling nature of the clays. The shallower slopes of Subalternative 3A would also reduce surface water flow velocities, thus reducing erosion. Erosion on the steeper 2H:1V slopes would be greater and require a significant increase in the level of effort to maintain and repair the cover system for the long term. Furthermore, the shallower slopes of Subalternative 3A would be more favorable for optimizing vegetative growth as a necessary component of evapotranspiration cover performance. Cover performance is the most critical* *aspect of the remedy for reducing acid-rock drainage and metals leaching and achieving ground water cleanup levels. The degree of success (i.e., reduction in net percolation) which can be achieved by a cover system constructed on steeper (2H:1V) slopes has a higher level of uncertainty and would need to be demonstrated through the performance of additional treatability test-plot studies. Based on these factors, EPA considers Subalternative 3A to be more effective and permanent in the long term as compared to Subalternative 3B.*

- *<u>Short-Term Effectiveness:</u> Subalternative 3B presents greater inherent dangers of personnel fatalities and injuries associated with constructing, repairing, and maintaining the steeper slope surfaces and cover as compared to Subalternative 3A. The risk of equipment roll-over due to operating either on a slope in a direction not perpendicular to the slope's contour, or too close to the edge of a bench, increases markedly on the steeper slopes. The higher risk incidence becomes exacerbated because of the increase need for maintenance and repair on steeper slopes. Subalternative 3A would result in the exposure of near-vertical scar faces, though the risk to the cover systems from erosion of scar material is expected to be minimal and can be mitigated through permanent engineering controls. The scars may also compromise the long-term effectiveness of the cover's vegetation downslope of scar areas. For Subalternative 3A, approximately 122 million yd^3 of the waste rock piles would be removed and transported to an on-Site repository for long-term management. This increases the collateral impact of the remediation through increased truck haulage and other direct and indirect environmental impacts. For Subalternative 3B, a regrade would be achieved within and between waste rock piles and approximately 35 million yd^3 of waste rock would be removed, lessening the collateral impacts from truck haulage. The volume of waste rock requiring removal to an on-Site repository in Subalternative 3A could result in potentially three times as many accidents as Subalternative 3B. For Subalternative 3B it is expected to take an additional 3 years to complete the earthwork on the waste rock pile due to the slower progress on steeper slopes. This adds to the collateral damage of Subalternative 3B (28 years) versus Subalternative 3A (25 years). In* *light of all these advantages and disadvantages, Subalternative 3B is considered to be overall more effective in the short term than Subalternative 3A.*

***Cost-Effectiveness Determination**: EPA disagrees with the commenter that Subalternative 3B is cost effective and that the additional cost of Subalternative 3A is not justified. In performing the cost effectiveness determination based on the refined comparative analysis, EPA has determined that both subalternatives are cost effective.*

When considering each subalternative individually (i.e., all of the waste rock piles are regraded to either 3H:1V slopes or 2H:1V slopes), the relationship between overall effectiveness and cost are proportional for each component. The cost of the 3H:1V slope regrade is significantly higher than the cost of the 2H:1V regrade (approximately $196 million present value), but the overall effectiveness of the 3H:1V slope regrade is anticipated to be significantly higher than the overall effectiveness of the 2H:1V regrade. In fact, as stated above, the success which can be achieved by a cover system constructed on steeper (2H:1V) slopes has a higher level of uncertainty and would need to be demonstrated through the performance of additional treatability test-plot studies and pilot studies. Because of these uncertainties, such studies are required as part of the Selected Remedy.

When considering each subalternative together, the cost of the Selected Remedy will actually be somewhere between the range of costs defined by these two subalternatives as some waste rock piles will likely not be regraded to the 3H:1V interbench slope. Additionally, by using the "tool box" approach to design the remedy on a rock pile-by-rock pile basis, each waste rock pile will be regraded in the most effective and practicable manner possible given the characteristics of the rock pile and other key factors previously discussed herein. Therefore, the relationship between the effectiveness afforded by the "tool box" approach and its associated costs are reasonable in comparison to the higher costs estimated to achieve the 3H:1V slope regrade for every rock pile.

Comment 82: CMI agrees that the actual location of the on-site repositories for waste rock placement should be determined in the remedial design phase based on the risk based design for reclamation of each rock pile. Locations previously discussed for potential placement of rock include the open pit, Capulin Canyon, Goathill Gulch, Spring Gulch, and/or Sulphur Gulch North/Blind Gulch. However, there are limitations with use of a number of these areas as a repository that must be considered in the language of the ROD as to how much waste rock must be transferred to a repository.

Limitations to Capulin Canyon - using Capulin Canyon as a repository site has the following limitations:

- The capacity of a repository constructed with 3H:1V slopes results in a disturbance of over approximately 300 acres of previously undisturbed land.
- Construction of new haul roads across one or two drainages (Slickline Gulch and Goathill Gulch) would be required. Construction of a haul road across an active subsidence zone is restricted due to safety issues.
- Capulin is the most remote and highest location on the mine site. Depending on the location of the rock being removed, longer haul distances than Spring Gulch or Blind/Sulphur Gulch North would be necessary resulting in increased fuel usage and increased air emissions.
- Restricted work/construction in area of instability (Northwest lobe of Capulin Rock Pile). Efforts during design would need to address significant stability concerns to mitigate potential for unsafe working conditions and changes to long-term stability of Capulin rock pile.
- Construction of major surface water management facilities (ponds, collection system) to accommodate storm water from a watershed of over 800 acres.
- Complex modifications to existing Capulin Rock Pile seepage collection and conveyance system, and construction of new seepage collection and conveyance systems.

Limitations to Goathill Gulch - using Goathill Gulch as a repository site has the following limitations:

- Construction of new haul roads across one drainage (Slickline Gulch). Construction of a haul road across the subsidence zone is restricted due to safety issues.
- Depending on the location of the rock pile being removed, longer haul distances than Spring Gulch or Blind/Sulphur Gulch North resulting in increased fuel usage and increased air emissions.
- Construction of major surface water management facilities (ponds, collection system) to accommodate storm water from a watershed, including multiple drainages, of over 500 acres.
- Significant safety concerns with placement of material in an area actively subsiding, and limited area for construction and placement of material due to ongoing subsidence. Eastern portion of Goathill Gulch lies within the designated subsidence zone (Zone of Relaxation and Zone of Deformation, Feasibility Study [DocIDs #873842, #9116332] Figure 4-1).
- Limited area due to the Narrows restricts capacity for placement and accessibility.
- Restricted worker and equipment access due to active subsidence.
- Construction in a drainage that has a significant amount of hydrothermal scar exposed, which is an unstable surface for construction.
- Goathill North was constructed on an historic landslide (Docid #9116683). Restricted work/construction in an area (below Goathill North Rock Pile) that has had a slide that was mitigated in 2005 (Table 6-2, Norwest 2003, Norwest 2004, and Norwest 2007). Efforts during design would need to address stability to mitigate potential for unsafe working conditions and changes to long-term stability of Goathill North.
- Restricts future underground mining in areas covered with mine rock due to safety concerns (collapse).

Limitations to the Open Pit - using the Open Pit as a repository site has the following limitations and consequences:

- Future mining in the open pit would be precluded by the presence of mine rock removed to the pit from other rock piles. If rock is placed in the open pit during CERCLA remedial action, removal of the rock and placement at another rock pile would be required to allow future mining of the open pit wall or portal access to underground ore bodies. In addition to the safety issues that would entail, the cost of removing rock placed in the pit from the remedial actions would likely make future recovery of valuable ore deposits in the pit wall or accessible through the pit wall infeasible.
- While a New Mexico Mining Act new unit permit may not be required because of CERCLA, the substantive requirements of the permit(s) must be met in order to use the open pit (or another on-site repository that is not a current rock pile). Meeting these requirements would take several years, and would result in further delays in implementation, and should be considered in evaluating on-site rock disposal locations and could constitute a partial regulatory taking.

CMI concludes from a mining feasibility study conducted in 2009 at the mine that economically viable and profitable area will be precluded from development if the open pit is used as a repository. This action would result in CMI losing significant revenue (*e.g.* future mining opportunities) and may be a compensable regulatory taking. Although computation of man-years of employment that would also be lost was not performed, the economic magnitude of the loss suggests that lost employment opportunities would be significant. Several mine plans and the character of the ore body beneath the NW corner of the pit were identified and demonstrated the mine's need to utilize the pit as part of its near future mining plans. These plans and ore body include the following:

The Southwest (SW) Slice - the Southwest (SW) Slice includes the Southern and Southwestern portions of the pit that will mine 126,761,000 tons of overburden rock and 15,734,000 tons of ore at an average grade of 0.157% MoS_2. Approximately 6,278,000 tons of non-acid rock drainage generating flow breccia rock will be stockpiled for use at a later date. The remaining overburden rock will be deposited sequentially in three areas designated as The Truck Shop Dump (non-acid rock drainage material), Southeast Dump (non-acid rock drainage material only), and the north In-pit Dump (acid rock drainage material in the northern portion of the pit) as SW Slice pit mining proceeds. As the overburden is removed, the ore body will be mined and ore transferred to the mill site. Mining Life for this mining activity will be 2.6 years. The SW Slice ore occurs beneath the lowermost portions of the pit walls on the south and southwest parts of the open pit. There is 23,998,000 lbs of extractable molybdenum contained in the ore in the SW Slice.

South Wall Only - the South Wall Only mining option will mine and move 37,477,000 tons of Overburden Rock; 2,345,000 tons of this total Overburden Rock tonnage will be re-handled. Some 4,178,000 tons of ore will be mined over 2.2 years of Mining Life. There is 7,282,000 lbs of extractable molybdenum in this ore body having an Average Head Grade of 0.175 % MoS2. The overburden rock will be hauled and placed in the North In-pit Dump area, Truck Shop Dump area non-acid rock drainage material, and Southeast Dump area (non-acid rock drainage material). The South Wall Only mining option ore occurs beneath the south wall of the pit and at the south eastern entrance of pit. The South Wall Only mining option is the lowest overall cost option of the numerous plans examined.

Sublevel Cave Mining - in the event that the molybdenite ore at the entrance to the pit in the Southeast corner of the pit is not mined by surface mining, a Sublevel Cave underground mining method will be employed. The ore to be mined by this methodology is what remains of an old stope-mining area of molybdenite lodes mined from 1920 to 1956. Ore will be removed with haul trucks from the mine workings and the haul trucks will return through the twin portals. The current crusher location is eastward of the portals. The portal entry will be in the ravine at the entrance to the pit, and this area cannot be in-filled before mining activity is completed. Overburden rock will not be removed from the mine workings. Approximately 1,793,000 tons of ore having an average grade of 0.300 % MoS2 (3,621,000 lbs of molybdenum) will be mined over 1.5 years of Mining Life.

F-2 Ore Body - the F-2 Ore Body is a significant reserve of molybdenite mineralization that occurs beneath the northwest corner of the open pit. If 0.20 % MoS2 is used to define the boundaries of the ore body, 23,295,000 tons of ore with an average in situ grade of 0.299 % MoS2 (83,488,000 lbs, molybdenum) defines the resource. If 0.25 % MoS2 is used to define the cutoff grade, then 19,070,000 tons of ore with an average grade of 0.335 % MoS2 (76,575,000) defines a reserve.

The ore body is exposed in the bottom of the pit at this location, and it plunges some 25 degrees to the West-Southwest. This ore body will be mined underground, and ore will be hauled by haul trucks. These trucks will move along twin ramps, hauling ore along one and returning along the other. Exit and entry will be through twin portals across from the twin portals of the Sublevel Cave underground mine or through portals located low in the pit on the east wall of the pit. In order to operate efficiently, the ramps should have a grade of no more than 10.5 %, and locating the portal as low as possible is critical to reducing the grade of the ramps. Finally, these twin portals must be located within the porphyry rocks on the eastern wall of and bottom of the pit. The rock quality of rocks immediately beneath the west wall of the pit is very poor, and the location here of the large ramp openings is extremely problematic. Covering the portal locations means that the portals will have to be located at a higher elevation which will dramatically increase the length of ramp in order to maintain the maximum percent grade (*i.e.* slope) of the ramp thereby significantly increasing the costs to mine this ore body.

Relocation of any or part of any existing waste rock pile into the Questa mine's open pit will either prevent mining of the pit wall ore or prevent practicable access to high grade, underground ore bodies. Mining of the open pit wall ore requires that the mined overburden rock be placed in the pit, away from the mining activity. Neither of these two activities can be accomplished if waste rock pile material is placed against the pit wall ore. Placement of any significant amount of mine waste rock material in the pit also will cover any close portal access to underground ore bodies.

Response 82: *EPA appreciates the extensive detail about potential sites that EPA has considered for on-Site repositories. And, please note that it is not EPA's objective to limit access to or restrict potential economic mining reserves. However, as CMI elicits early in the comment, these are remedial design considerations and EPA will not discredit or put constraints in the ROD on any of these potential on-Site repositories. They are all viable repositories, regardless of the issues raised by CMI. EPA recognizes that there are no simple solutions to dealing with the massive volume of waste rock from an environmental standpoint. Therefore, all options for relocating waste rock must be fully evaluated to achieve the remedial action objectives, remediation goals, and for protecting human health and the environment.*

Comment 83: EPA's remedy and the State permit call for the waste rock piles to be covered with 3 feet of Spring Gulch waste rock pile material and vegetation. The cover material and vegetation would function as a store and release/ET cover that has the capacity to limit net percolation by storing precipitation within the cover for a period long enough for water to be removed by evaporation and transpiration.

First, it is doubtful that any cover system can consistently increase ET, and percolation rates are likely to exceed 25% and be as high, or higher, than 50%, as has occurred at numerous other mine sites where rates have been reliably measured. Second, it is likely that even the best efforts using Spring Gulch waste rock will result in limited short-term revegetation and will require significant on-going supplementary effort and patience to achieve sustainable and highly effective (from an ET standpoint) vegetation.

It is recommended that EPA write the ROD to recognize the limitation of net percolation into the rock piles as a goal, but may not be realistically achieved to the extent anticipated by the agencies. Therefore, this cover material is not adequate in and of itself as a means of source control and capture of resulting ground water is still required. As such, it is further recommended that additional consideration be given to the enhanced capture and removal/management/ treatment of ground water resulting from percolation through the rock piles with particular attention being given to those areas that are not highly likely to be mitigated by the underground mine hydraulic sink, and that might impact the Red River or associated alluvial aquifer.

Response 83: *EPA understands the technical uncertainties associated with the Spring Gulch waste rock that is proposed for use as cover material on the waste rock piles at the mine site. However, Spring Gulch waste rock material, if determined to be suitable for cover, will be amended with multiple applications of organic material to promote successful and sustained vegetative growth. Additionally, the Selected Remedy includes an enhanced or expanded ground water component consisting of seepage interception systems and ground water extraction well systems at the toe of Capulin and Goathill North waste rock piles as well as at the mouth of each tributary drainage at the mine site to capture, convey and treat contaminated ground water from the colluvium and Red River alluvium. Such expanded ground water systems will reduce the concentrations of contaminants entering the Red River at zones of ground water upwelling and, hence, help protect aquatic life in the river.*

Comment 84: EPA's toxicity studies have shown that molybdenum in soil is toxic to plants at 300 mg/kg. Additional Site-specific testing was performed for molybdenum toxicity, bioaccessibility, and bioavailability. Based on the results of this testing, EPA developed a molybdenum suitability criterion of 600 mg/kg for screening the borrow material. The 600 mg/kg suitability criterion is higher than the 300 mg/kg molybdenum preliminary remediation goal because a significant portion of the molybdenum in Spring Gulch waste rock is of a form (molybdenite [MoS_2]) that is not readily bioavailable for ecological receptors.

It is recommended that the ROD require that a 300 mg/kg suitability criterion be used for Spring Gulch waste rock that will be used as cover material. Handling and regarding of the Spring Gulch waste rock as cover material will expose it to oxidation over time and will make the previously unavailable molybdenum readily available for plant uptake. The testing of *in situ* characteristics of the material in a large pile where it is not exposed to the same conditions as when it will be used as cover soil does not provide for comparative results. Conservatively, it is likely that the molybdenum will become more available when used as cover material due to oxidation and other natural processes which will degrade molybdenite.

Response 84: *EPA agrees with the commenter that the handling and regrading of the Spring Gulch waste rock will expose it to oxidation over time, and likely increase the amount of molybdenum readily available for plant uptake. However, if at all possible EPA does not want to be overly conservative with the molybdenum screening criterion should a significant volume of the Spring Gulch waste rock not meet such criterion and be unacceptable for use as borrow. The economics of importing cover material would significantly increase the cost of the remedy. Because molybdenum concentrations in Spring Gulch waste rock are highly variable, it is not a certainty that sufficient Spring Gulch borrow material will be suitable for cover. Additional characterization of molybdenum in Spring Gulch waste rock will be performed as part of the Selected Remedy to assess its suitability. Additionally, to address the concern for molybdenum uptake in plants growing on Spring Gulch waste rock, the Selected Remedy also includes a monitoring program for assessing plant growth performance. Such monitoring will be performed to assess if molybdenum uptake from borrow material to plants inhibits vegetative success or poses risk to herbivorous native wildlife. Monitoring will include measuring concentrations of molybdenum in plant tissue co-located with media samples (e.g., soil, waste rock) to quantify oxide and sulfide species of molybdenum and degree of uptake by plants. Additionally, the Selected Remedy includes the application of organic amendments to Spring Gulch waste rock material to improve the physical properties and promote successful and sustained vegetative growth.*

Comment 85: Amigos Bravos is very concerned about relying on Spring Gulch Rock Pile waste rock as the sole source of cover material EPA will prescribe to prevent percolation into the underlying acid-generating waste rock. The coarse nature of, and lack of substantive organic matter in, the Spring Gulch waste rock renders this material inadequate for storing water and growing enough vegetation to function as a store-and-release cover.

The failed vegetation test plots at the mine are a testament to the inadequacy of the material. If there is no alternative to using the Spring Gulch material, then EPA will have to require constant upkeep of the cover, including erosion controls and periodic application of organic enhancers.

Response 85: *EPA agrees with Amigos Bravos about the inadequacies of the Spring Gulch waste rock material (see response to Comment No. 87 below). Issues such as the consistency and the organic matter content of the cover material and how they will affect long term stability will be evaluated and addressed in the remedial design. EPA specifies in the Selected Remedy that multiple applications of organic matter will likely be necessary for successful and sustained vegetative growth. Additionally, EPA specifies a preference for the shallower 3H:1V interbench slope because it is superior to the steeper 2H:1V slope for supporting a erosion-resistant cover that is optimal for establishing effective vegetative growth in a store and release/ET cover system.*

Comment 86: EPA's documents indicate that key cover performance questions remain to be answered and should be resolved by closely targeted test plots. Therefore, EPA's preferred remedy will include test plots for the store and release/ET cover system to demonstrate the anticipated improvement in vegetative productivity with organic amendment application, erosion resistance of amended cover materials, and that moisture holding properties will be sufficient to provide an effective cover system that protects ground water.

The community is very concerned that more test plots will be required in the anticipation of useful results, thus delaying actual remediation implementation. We are particularly concerned that CMI will continue to conduct test pilot exercises which do not incorporate the required amendments and approaches that are most likely to result in revegetation success. Clearly, CMI's tests thus far, demonstrate that the materials will require grading (e.g., sizing) to achieve the desired physical properties and significant amendment with organic materials to achieve anything resembling erosion control and a sustainable ecosystem.

It is time to quit "testing" and go forward with remediation of a significant area, such as the Goathill North geotechnical mitigation area. The agencies should clearly define their short-term and long-term performance requirements, and CMI should be allowed to go forward with a reasonable, but not risk-free, approach towards implementing regrading and revegetation to achieve those requirements. If short-term performance is achieved within 2 to 3 years, then further remediation/reclamation on other areas should proceed with similar designs. CMI should be required to implement an iterative test-redesign process that may require time periods of 2 to 5 years for EPA acceptance. This iterative process, which is difficult to drive forward much less predict, is nonetheless the only way significant progress is likely to be made in the short-term at this highly complex Site.

EPA should anticipate the divergence of opinions on vegetative success and remediation/reclamation approaches in general, and anticipate and encourage means to cause large-scale demonstration area and corrective/adaptive management in response to results obtained from those areas. The ROD should not encourage further test plots as except as a means or tool for determining longer-term approaches to reclamation at the site.

Response 86: *EPA agrees that treatability testing should not delay remediation of the waste rock piles and has specified in the ROD for treatability testing to be conducted as part of the initial large-scale pilot study on one or two waste rock piles. The treatability testing will include an evaluation of amendment types, methods, rates of application and other approaches that will provide design criteria for achieving optimal vegetative success at the remainder of the waste rock piles. EPA is concerned that prior vegetation test plots conducted by CMI were limited in scope and design (especially with regards to physical properties such as grain size and amendments); a key reason that NMED never approved the prior test plots that were conducted under the direction and oversight of MMD. The treatability testing and large-scale pilot study(ies) will be performed concurrent with the design and remediation of subsequent waste rock piles in an adaptive and iterative phased approach. The results of the testing will provide critical design criteria and lessons learned for the next set of rock piles to be remediated.*

EPA is also well aware of the divergent opinions on vegetative success and remediation approaches for the waste rock piles over the last 10-15 years at the Site. And although EPA has every intention of considering different technical approaches for the waste rock piles during remedial design, it will ultimately be EPA's decision on the remedial approach to be taken. EPA plans to put together a team of mining experts to evaluate design options and provide recommendations on how best to proceed with remediation of the waste rock piles.

Comment 87: Why is it not possible to vegetate the rock piles without disrupting (re-grading to lower slope angle) them? Many coniferous trees appear to be growing in rocks throughout the Red River Valley. What is their secret to growth in such a substratum and how might that knowledge be applied to promoting growth of trees on the rock piles? And if the rock piles are re-graded, why will it be necessary to cover them with amended Spring Gulch waste rock? Would not native plants do just as well in the sediment of the rock pile itself?

Response 87: *The conifer trees referred to by the commenter grow in shallow but essential soil that has taken hundreds if not thousands of years to develop directly on bedrock. The shallow soil gives the tree roots the ability to anchor the tree. The waste rock is an unconsolidated crushed rock that has only recently been excavated and dumped into piles during open pit mining conducted from the mid-1960s to the early 1980s. Therefore, the surface of the rock piles has not had the necessary time to form natural soils that are essential to the successful development of vegetation and, hence, lacks the necessary nutrients and other soil properties for promoting vegetative growth. EPA does not consider the current surface of the waste rock piles to be natural soil.*

Additionally, the waste rock is comprised of very acidic material. This acidity also inhibits the growth of plants, including trees. A root zone investigation was conducted by CMI in 2008 to determine root-growth patterns and growth characteristics of various aged conifer trees growing in acidic waste rock material at the mine site. The observation of rooting *patterns generally verified that acidity controlled root development. When soil pH was below 3.8, root growth appeared to be impeded. As one can visually observe, there is very little vegetation growing on the waste rock piles after nearly 30 years.*

The weathering of the waste rock piles produces acidity (acid-rock drainage) that leaches metals and other inorganics to ground water, resulting in contamination of the ground water above New Mexico standards and EPA health-based criteria. For EPA to successfully clean up the contaminated ground water and protect current and future ground water resources, acid-rock drainage and metals leaching occurring within the waste rock piles must be significantly reduced. To do this, the waste rock piles must be covered in a way that significantly reduces the infiltration and percolation of rain water (precipitation) through the waste rock.

EPA has selected a cover system that, in concept, will hold the precipitation in the cover medium until plants can remove it through evaporation and transpiration (i.e., a store and release/evapotranspiration cover system). Transpiration is the process by which moisture is carried through plants from roots to the leaves where it can be returned into the atmosphere by evaporation. In order for this cover system to be successful, the cover medium must have properties for adequate water holding capacity and serve as a growth medium to promote successful and sustained vegetative growth.

The non-acid generating Spring Gulch waste rock material is currently the preferred cover material. However, it is a poor growth medium for vegetation because it lacks the nutrients, organic matter, and other properties of a natural soil which are necessary to promote robust vegetative growth. It is preferred only because it is abundant and located on the mine site and, therefore, represents the least costly of the options for cover material. For the waste rock to be suitable cover material, it will require significant and multiple applications of organic amendments, as well as meet grain size and other requirements.

The regrade of the waste rock piles to shallower slopes is necessary for achieving and maintaining a successful store and release/ET cover system. Covers placed on shallower *slopes are more resistant to erosion and improve probability of vegetative success. The regrade to shallower slopes also improves the structural stability of the rock piles.*

Comment 88: The Village of Questa questions the need to treat storm water. What data indicate that storm water quality would require treatment beyond sediment removal in conventional temporary unlined detention/infiltration basins prior to allowing storm water to infiltrate to ground water or be discharged to surface water?

Given the steep topography at the mine site, fairly high dams may need to be constructed to create lined impoundment areas of adequate size to store all the runoff. The sizing of these storage facilities would also be dependent on the capacity of the water treatment plant and the potential need to store back-to-back storm events if the plant capacity cannot treat water fast enough to empty the reservoirs quickly in between storms. These storage facilities are likely to be considered as high hazard water storage dams, which present new risks to the public and the environment in the event of failure, compared to the more modest sized infiltration basins currently in place. In addition, storage and treatment of storm water will impose costly operational costs on the mine with dubious potential improvement to environmental protectiveness beyond the status quo. It seems likely that the fraction of storm water infiltrating directly downward through the waste rock and the rubblized overburden above the block-caving subsidence area is of poorer quality than the storm water runoff infiltrating from unlined detention basins below disturbed areas. What are the relative volumes and qualities of waters which directly infiltrate disturbed areas that cannot be contained versus runoff that would be stored for treatment?

Further data and modeling need to be completed to address questions related to storm water. It seems premature and unreasonable to impose a storm water treatment requirement in the EPA's preferred alternatives in the Proposed Plan.

Response 88: *Storm water discharges from the Site are regulated under an individual EPA permit and EPA's MSGP under the Clean Water Act. After consultation with the NPDES program personnel, EPA has decided to defer management of storm water to the EPA*

Region 6 NPDES program, rather than include it as part of the CERCLA response action. See Section 14.0, Part 2, of this ROD for a discussion on storm water and documentation of significant changes in the Selected Remedy from the Preferred Alternative presented in the Proposed Cleanup Plan.

Comment 89: CMI does not agree with the EPA proposal of construction of a storm water treatment plant. This proposal would require construction and operation of an additional water treatment plant that could cost at least $38 million (net present value), and up to $387 million (net present value) in infrastructure to contain between 112 and 245 acre-feet of storm water. This proposal has the significant potential to make ongoing mining operations infeasible; its costs would be roughly equivalent to construction of a ground water treatment plant at the mine; and there are significant impracticability issues raised by the modification. Nevertheless, no notice of the modification was provided until late in the public comment process. To the contrary, EPA's previous position on storm water treatment, as stated in the Proposed Cleanup Plan in several places, was that CMI's storm water management system, which operates under a Clean Water Act permit and State discharge permits, is effective and will continue as a component of the remedy.

Response 89: *See response to Comment No. 88 above.*

Comment 90: CMI does not agree that new ground water extraction wells in lower Capulin Canyon and in lower Goathill Gulch near the head of the debris fan are necessary. These areas are not impacted by mining activities so extraction serves no purpose. CMI has commented to EPA that these wells are not warranted because the ground water at the two areas is unaffected by mine operations (see CMI response to EPA Comment No. 108 on the Draft Final FS Report, Table 6-2 [CMI 2009]). Initial remedial alternatives for ground water developed by CMI did not include these new extraction wells for this reason.

In lower Capulin Canyon, the USGS Baseline Study concluded that drainage from the scar in the middle portion of the canyon dominates the water quality (Table 6-2, Nordstrom 2008). CMI concurs with this finding, which has been substantiated by the recent improvement in colluvial water quality in MMW-23A, located downgradient of the Capulin pumpback pond compared to the water quality in the lower canyon. Pre-mining concentrations estimated for the lower portion of the canyon are based on median values from MMW-2, which is near the mouth of the canyon. The estimated pre-mining concentrations from MMW-2 were adopted by EPA and NMED as preliminary cleanup levels (Administrative Record – Document Identification No. 873832). However, the proposed location of a new extraction well in lower Capulin Canyon is near MMW-2 and would, therefore, extract water that has been found to be unimpacted by mining. The September 2009 analytical results for MMW-2 show concentrations to be below all preliminary cleanup levels, which is not surprising because water quality from the well was used to define pre-mining or baseline concentrations. The significance of this is that a new extraction well installed in lower Capulin Canyon could be immediately shut down because it would meet the preliminary cleanup levels adopted by EPA.

The same is true for adding a well in lower Goathill Gulch. As stated earlier, mine-affected water has been demonstrated to be captured in the subsidence zone and underground mine (RI Report [Administrative Record – Document Identification Nos. 872954 and 9103809], USGS Baseline Study [Table 6-2, Nordstrom 2008]). As a result, mine-affected water does not migrate downgradient of the subsidence zone into lower Goathill Gulch. Based on this finding, wells in lower Goathill Gulch (MMW-42A and MMW-44A) were used to estimate pre-mining concentrations that were subsequently adopted by EPA as preliminary cleanup levels. Comparison of August 2009 sample results from MMW-42A to the preliminary cleanup levels found all constituents to be below such levels and all but sulfate to be below such levels in MMW-44A (sulfate was 3,300 mg/L and the preliminary cleanup level is 3,100 mg/L). Similar to lower Capulin Canyon, a new extraction well in lower Goathill Gulch could immediately, or after a short period of time, be shut down because it meets the preliminary cleanup levels.

Response 90: *EPA disagrees with CMI's conclusion that the extraction well systems planned for the mouth of Capulin Canyon are unnecessary. Although estimated pre-mining concentrations from MMW-2 were adopted by EPA as preliminary cleanup levels for*

Capulin Canyon, there is considerable uncertainty about whether this well is influenced only by scar material. The USGS Baseline Study Report 25 (Nordstorm 2008) explicitly expresses this uncertainty by stating that the influence from waste-rock leachates cannot be ruled out completely. In addition, the interpretation of the geochemical data presented in Figures 52 to 55 of the USGS Baseline Study (Report 25) which the commenter refers to is somewhat tenuous. The fact that concentrations of metals in the catchment impoundment below the Capulin Rock Pile are noticeably higher and more concentrated than in downgradient well MMW-2 may be attributed to evaporation from or higher dissolution rates in the impoundment. This possibility has been acknowledged by the USGS in the report inferring that seepage from the waste rock pile (impoundment water) may be more similar to the water quality in MMW-2 than what is apparent on these figures.

A more reliable indicator may be a comparison of ground water from MMW-23A to MMW-2. As shown on Figures 52 to 55, concentration ratios plot fairly close together indicating similar water quality and likelihood of upgradient influence on MMW-2. Further analysis of these plots, also shows the dissimilarity in chemical ratios between ground water in MMW-2 seep samples from a scar in Capulin Canyon.

In addition, given that the permeability of materials in this drainage is known to be fairly low, it is entirely possible that residual contamination (post catchment pond era) is moving down the canyon in the ground water. To validate this possibility, a ground water flow velocity was calculated for the upper reach of Capulin Canyon from near MMW-23A to MMW-2 located in the lower portion of the canyon by EPA in 2010[92]*. The calculation was performed to determine the transit time for a water particle to travel from the lower catchment pond (pumpback), located upgradient and near MMW-23A to MMW-2. The catchment pond was installed in 1992 and later upgraded in 2006 to prevent overflowing of the ponds during storm events. Assuming by 2006, no further downgradient migration of leachate from the Capulin rock pile, the transit time calculation was made to determine if residual contaminants are still traveling down Capulin Canyon in the flowpath to the lower*

[92] CDM Technical Memorandum: Determination of Ground Water Flow Velocity in the Capulin Canyon Drainage, Molycorp Inc. Site, 2010

portions of the canyon. The transit time for a water molecule to travel this distance ranges from approximately 0.5 years to 247 years. Assuming that capture of seepage from the Capulin rock pile did not occur until 1992 or later, it is entirely possible that contaminant migration could be occurring in the lower portions of the canyon for years to come.

EPA plans to reassess background water quality in Capulin Canyon during the remedial design and remedial action and modify the cleanup levels for the colluvial and bedrock ground water if appropriate.

EPA also does not agree with CMI's conclusion for lower Goathill Gulch. Concentrations of aluminum and sulfate are significantly higher in MMW-44A than the USGS values from the Straight Creek analogue presented in Table 10 of Report 25. While differences between certain metals detected in MMW-44A and Straight Creek are adequately explained in this report, there is no explanation for aluminum and sulfate.

In a similar approach to Capulin Canyon, EPA calculated a ground water flow velocity for the lower reach of Goathill Gulch from the rim of the south edge of the subsidence zone to MMW-44A located in the lower debris fan of Goathill Gulch.[93] *The calculation was performed to determine the transit time for a water particle to travel from the subsidence zone to MMW-44A. The subsidence zone formed as a result of block-caving mining techniques sometime after the current phase of underground mining began in 1983. Assuming no further downgradient migration of leachate from the Goathill rock pile by 1983, the transit time calculation was made to determine if residual contaminants could still be traveling down canyon in the flowpath to the lower portions of Goathill Gulch.*

The transit time for a water molecule to travel this distance ranges from approximately 2 to 130 years. Assuming that capture of seepage from the Goathill rock pile did not occur until 1983 or later, there is the possibility that contaminant migration could be occurring in the lower portions of the canyon for years to come. Therefore, an extraction well system

[93] CDM Technical Memorandum: Determination of Ground Water Flow Velocity in the Goathill Gulch Drainage, Molycorp Inc. Site, 2010

at the mouth of Goathill Gulch is a necessary and requisite part of the Selected Remedy for the mine site.

Comment 91: CMI does not agree with the EPA statement that the ongoing practice of allowing seepage from Capulin and Goathill North waste rock piles and storm-water discharge to percolate through the subsidence area into the underground mine is not an approvable disposal method under the state discharge permits and results in further ground-water contamination (USEPA 2009a).

Discharges of seepage from the rock piles and storm water at the Mine Site are regulated by two discharge permits issued by NMED under the Water Quality Act and the Water Quality Control Commission's ("WQCC") regulations. 20.6.2.3104 NMAC prohibits any person from "caus[ing] or allow[ing] effluent or leachate to discharge so that it may move directly or indirectly into ground water" without a permit issued by NMED. DP-1055 (Admin. Record – DocID Nos. 874123 and 873857) regulates discharges of leachate from the rock piles and storm water runoff from the Mine Site Area.

The permit requires CMI to "continue to maintain its mine dewatering system so that it maximizes capture of leachate from the mine workings and open pit and ensures underground mine water, pit water, and contaminated ground water in fractured bedrock are collected in a manner that prevents, to the maximum extent practicable, any additional contamination of ground water and its subsequent impacts on surface water. Collected water must be disposed of in accordance with [DP-933] (Admin. Record – DocID No.s 874123, 873857, Condition 20, p. 10).

Nothing in the Administrative Record indicates that NMED found that these discharges cause ground water standards to be exceeded at a place of withdrawal for present or reasonably foreseeable future use (See 20.6.2.3109.C NMAC [requiring NMED to find that the "person proposing the discharge demonstrates that approval of the proposed discharge plan . . . will not result in either concentrations in excess of the standards of 20.6.2.3103

NMAC or the presence of any toxic pollutant at any place of withdrawal of water for present or reasonably foreseeable future use”]).

While upgrades to the leachate collection and storm water treatment systems have been made under the discharge permits, NMED has not proposed nor required any alternative method or technology for the disposal of the leachate or storm water. Under the WQCC’s regulations, the currently permitted practice could be removed from the permit only if NMED were to find that the discharge results “in either concentrations in excess of the standards of 20.6.2.3103 NMAC or the presence of any toxic pollutant at any place of withdrawal of water for present or reasonably foreseeable future use” (20.6.2.3109.C(2) NMAC). No such finding has been made.

In 2007, NMED approved DP-1539 (Admin. Record – DocID No. 874016) for “the discharge of water contaminants at the [CMI] North Storm Water Detention Pond system.” The permit describes the discharge as follows: Storm water, which contains leachate from the waste rock piles located at the [CMI] Questa Mine, may be discharged to the North Detention Pond.

DP-1539 authorizes the North Storm Water Detention Pond System, which consists of “the North Detention Pond, and all piping that direct impacted water to the open pit” (Admin. Record – DocID No. 874016, p. 1). In granting the permit, NMED specifically found that “the requirements of 20.6.2.3109.C NMAC have been met.” Consequently, the statement in the Proposed Cleanup Plan is inconsistent with the statements in DP-1539 (Admin. Record – DocID No. 874016) that the discharge of impacted storm water and leachate to the open pit and ultimately to the underground mine met the requirements of the WQCC regulations.

The only other previously articulated position that could form the basis for the statement in the Proposed Cleanup Plan is EPA comments that the vertical borehole between the old underground mine workings and the current underground mine and the subsidence zone are “by definition” unpermitted Class V UIC wells (Admin. Record – DocID No. 874068).

While there is some question whether the vertical borehole and the connection between the subsidence area and the underground mine are UIC wells, they would nevertheless clearly be permitted under the WQCC regulations. Class V UIC wells are regulated in New Mexico by the WQCC (20.6.2.5006 NMAC [specifying that "Class V injection wells must meet the requirements of Sections 20.6.2.3000 through 20.6.2.3999 NMAC and Sections 20.6.2.5000 through 20.6.2.5006 NMAC"]). 20.6.2.3000 through 20.6.2.3999 NMAC are the WQCC's ground water discharge permit regulations; the same regulations governing the issuance of DP-1055 (Admin. Record – DocIDs Nos. 874123 and 873857) and DP-1539 (Admin. Record – DocID No. 874016). CMI has the requisite permits under those regulations for the specified discharges. 20.6.2.5000 through 20.6.2.5006 NMAC define the classes of UIC wells and specify notice and other requirements for such wells, including Class V wells. It has not been suggested that CMI does not comply with these requirements.

Finally, to the extent that the discharges to the subsidence zone and the underground mine are subject to Class V UIC permit requirements under the federal Safe Drinking Water Act, those permit requirements are satisfied by CMI's existing discharge permits (DP-1055 [Admin. Record – DocIDs Nos. 874123, 873857] and DP-1539 [Admin. Record – DocID No. 874016]); and CMI is in compliance with those permits. The discharges are federally permitted releases exempt both from further regulation under CERCLA and CERCLA liability (CERCLA § 107(2)(j)).

Response 91: *Pursuant to CERCLA § 107(j), discharges of pollutants to waters of the United States in compliance with a federal permit may not be regulated by a CERCLA remedy. Storm water discharges at the Site are regulated under the Clean Water Act by an individual NPDES permit and the NPDES MSGP. Therefore, as stated in Section 14, Part 2, of this ROD, EPA has elected to defer management of storm water to EPA's Region 6 NPDES program.*

CMI asserts that discharges authorized by the New Mexico discharge permits are exempt from regulation under CERCLA and CERLA liability. This statement is incorrect. The *section 107(j) exemption applies only to discharges authorized by permits issued by the federal government. It does not apply to discharges authorized by permits issued by a state.*

New Mexico permits DP-1055 and DP-1539 authorize storm water discharges to the subsidence area and open pit where it is allowed to infiltrate and percolate to ground water. As CMI is aware, NMED intends to disallow such practice in the ongoing permit renewal process for DP-1055 (see August 2009 NMED letter to EPA's National Remedy Review Board). Condition 22 of DP-1055 requires that a new method for disposal of collected storm water must be developed and shall be other than the current practice of discharging impacted storm water. NMED has notified CMI that it will have to collect, convey and treat all storm water that comes into contact with mining water and is contaminated at levels exceeding New Mexico water quality standards.

The collection, conveyance and discharge of waste rock leachate from the upper Capulin Canyon and Goathill Gulch drainages to the subsidence area is not regulated under the NPDES MSGP. Therefore, it is not a federally permitted release and the CERCLA § 107(j) exemption does not apply. EPA has determined that waste rock leachate poses a risk to human health and the environment and warrants response actions under CERCLA.

Comment 92: CMI disagrees with EPA's Preferred Alternative for the Tailing Facility Area that includes the immediate installation of an extraction system southeast of Dam No. 1. The CMI Phased Plan for the Tailing Facility Area involves a phased approach that includes monitoring of the area southeast of Dam No. 1 to assess the effectiveness of piping of the irrigation water on reducing constituents in ground water in this area. If monitoring after 5 years shows decreases in constituent concentrations, no further remedial action will be taken. If after 5 years concentrations remain the same or above current concentrations, extraction wells will then be installed southeast of Dam No. 1. Both alternatives provide for the protection of human health and the environment. However, the phased monitoring approach allows the piping remedial component to be evaluated prior to installation of a costly and potentially unnecessary extraction and treatment system.

Response 92: *In proposing to wait five years for active ground water remediation southeast of Dam No. 1, CMI is relying on monitored natural attenuation (MNA) by advection and dispersion as its preferred remedial approach. Currently, tailing seepage-impacted ground water is spreading in this area and concentrations are generally increasing. With such spreading, the extent of the contamination may soon migrate off of CMI property toward a residential area, if it has not done so already. Additional monitoring down gradient of the seepage-impacted front and beyond the CMI property boundary must be conducted as part of the Selected Remedy to further delineate the extent of contamination off CMI Property in this area.*

When relying on natural attenuation processes for remediation, EPA prefers those processes that degrade or destroy contaminants. Typically, inorganic contaminants are not degraded or destroyed by other natural attenuation processes, but continue to migrate. However, dissolved concentrations of inorganic contaminants (both metals and non-metals) may, under certain conditions, be attenuated by sorption reactions such as precipitation and adsorption or oxidation – reduction (redox) reactions. For non-radioactive inorganic contaminants and radionuclides possessing long decay half lives, immobilization within the aquifer via sorption to aquifer solids provides the primary means of attenuation of the ground water plume. In such cases, it is necessary to know (1) if removal of inorganic contaminants from the dissolved phase would lead to a stable or shrinking ground water plume, and (2) the degree of stabilization of the inorganic contaminant immobilized onto aquifer solids such that future re-mobilization would not occur to a level that threatens human health or the environment.[94,95] *Evaluating the feasibility of using natural attenuation for inorganic contaminant remediation would require demonstrating that the rate and capacity of the attenuation meets remedial action objectives and that inorganic contaminant immobilization is sustainable to ensure long-term effectiveness and permanence. This evaluation was not done during the FS.*

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[94] Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, EPA OSWER Directive 9200.4-17P

[95] Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume 1: Technical Basis for Assessment, EPA 600-R-07-139, 2007

Also, EPA generally expects that MNA will only be appropriate for sites that have a low potential for contaminant migration. Sites where the contaminated plume is no longer increasing in extent, or are shrinking, would be the most appropriate candidates for MNA. This has also not been demonstrated for the area southeast of Dam No. 1 and, therefore, MNA should not be used since such an approach may result in the continued migration of the seepage-impacted ground water.

Lastly, there has not been an adequate demonstration by CMI that cutting off irrigation flow in the east diversion channel will have any success in preventing the further migration of seepage-impacted ground water or reduction of contaminant levels to below EPA cleanup levels.

EPA has decided to perform active ground water remediation for contamination southeast of Dam No. 1, especially in light of the nearby residential area located downgradient of the contamination. Waiting a period of five years to determine whether or not natural attenuation decreases contaminant levels is not the approach preferred by EPA for protecting human health and the environment.

4.2.3 Tailing Facility Area

Comment 93: The preferred remedy does not indicate how long CMI will operate the tailing facility. The community strongly supports immediate closure and dismantling the current tailing facility and retaining all tailing waste at the mill site. If it remains operational, it is unclear why portions of the tailings facility, which EPA acknowledges are no longer in use, cannot be capped immediately. Other sections reportedly use water for dust control, which makes no sense. It has been reported that approximately 75% of the water piped into the tailings facility is unnecessary, so why waste more when polymers have been used successfully at other mine sites for this purpose.

Response 93: *EPA does not know how long CMI intends to operate the tailing facility, nor will EPA speculate on when the facility will be permanently closed. Since this is an operating facility, as for immediate closure, EPA cannot mandate termination of use given the current status. The tailing facility is operating under an active state ground water discharge permit, DP-933, under the jurisdiction of the State of New Mexico and can remain open until permanent cessation of milling operations. Therefore, its use is authorized by the State. In addition, there is no imminent or substantial threat to human health or the environment, which could potentially support closure. Although the tailing facility contaminates ground water underneath and down gradient of the facility, the potential risk from exposure to such contamination is fairly low and will be addressed by the provision of a temporary alternate water supply and active ground water remediation.*

Requiring partial closure is similar to complete closure. EPA cannot mandate closure of a permitted, compliant operating unit without an imminent threat. Additionally, historic operations indicate that expansion and additional placement of tailing may occur on many areas of the facility.

CMI has experimented with a number of dust suppression options, including polymers, with varying degrees of success. However, with ongoing tailing slurry placement, water continues to be a significant component of the dust suppression strategy. Through the implementation of the Selected Remedy, including treatment of tailing facility water as well as mine water collected by the remedial systems, EPA anticipates significant reductions in water placement at the tailing facility.

Comment 94: Why does EPA refuse to consider closing and reclaiming the tailing facility and its infrastructure? This will greatly reduce CMI's exposure to liability from ground water contamination and tailings spills. Furthermore, by removing the tailing pipeline and processing tailing at the mine site, the Red River and the community of Questa will be protected from the health impacts of additional tailing spills. A third major benefit of this approach to cleanup at the tailing facility is that by containing and discharging tailing water at the mine site instead of sending it downstream to the tailing facility, CMI will increase flows in the section of Red River adjacent to the mine site where water contamination is at its worst, and thus help dilute acid mine drainage from seeps adjacent to the mine site.

Response 94: *See response to Comment No. 93 above.*

Comment 95: Ground water clean up at the tailing facility, must be very efficient. Positive cutoffs are needed to ensure effective capture and containment of contaminants because contaminated ground water plumes containing uranium and other contaminants are migrating off CMI property to the south and southeast of the impoundment. Also, increasing concentrations have been found in the deeper alluvial aquifer below Dam No. 1. Finally, additional subsurface geotechnical data are needed along proposed barrier alignments to support design of improved interception measures.

Response 95: *EPA agrees with the commenter. EPA believes that the Selected Remedy will adequately mitigate ground water contamination, including uranium contamination, at the Tailing Facility Area. EPA has included with the Selected Remedy further characterization of the ground water and monitoring of ground water quality, including the deeper portion of the alluvial aquifer, to fully delineate the extent of contamination and assess the effectiveness of the remedial systems. The Selected Remedy also includes the collection of geotechnical data along the proposed seepage barrier alignments to support design of the upgraded barrier.*

Comment 96: The EPA discussed water treatment at the tailing facility in a couple alternatives. What is the difference between Option 3A, Option 3B, and Option 4 - are the differences in the cost, amount of water to be treated, or the method of treatment?

Response 96: *To summarize, Alternative 3A did not include water treatment, while Alternatives 3B and 4 did include treatment. Alternative 3A allowed for a portion of the collected and impacted seepage/ground water to be discharged (untreated) to the Red River under the NPDES program, while the non-compliant (exceeds surface water standards) seepage/ground water would have been pumped back to the tailing facility.*

This is the current disposal methods. The water that is pumped back to the tailing impoundment percolates downward through the tailing and seeps into the ground water, thus it is a cyclic process. With the expanded ground water remedy, EPA estimated about 800 gallons per minute (gpm) of water would be collected at the tailing facility. For Alternative 3A, 400 gpm of water would be discharged to the river untreated and 400 gpm would be pumped backed to the impoundment.

Alternative 3B included water treatment. Under this option, all 800 gpm of water to be collected at the tailing facility was to be treated in a new or modified existing water treatment plant potentially located south of the tailing dams. Alternative 3B was more expensive than Alternative 3A because it included water treatment. The other alternative that included water treatment was Alternative 4. Alternative 4 had a higher cost because the volume of water to be treated was higher. Alternative 4 included collection and treatment of about 4,000 gpm of water (four times the volume to have been treated in Alternative 3B). The greater volume of water to have been treated obviously had a higher cost; $96 million for construction and 30 years of O&M for Alternative 3B versus $160 million for construction and 30 years of O&M for Alternative 4.

Comment 97: The mixing of river water and ground water for mine operations increases the total volume of water to be treated. Is this taken into account in the water treatment remedies?

Response 97: *No. The water treatment component of the Selected Remedy will address only those contaminated waters collected pursuant to the CERCLA action. They include the water collected from mine dewatering operations, the seepage interception systems at the base of Capulin and Goathill North waste rock piles, and the ground water extraction well systems in the lower portion of the tributary drainages. The water collected by the seepage interception systems and ground water withdrawal well system as part of NPDES Best Management Practices will not be treated as part of the CERCLA response action as long as CMI is in compliance with NPDES Permit NM0022306. Under the NPDES program, CMI is allowed to discharge those waters to the tailing facility, either as makeup* *water for transporting tailing as slurry during milling periods or commingled with other water and used to maintain a continuous flow of water in the tailing pipeline for maintenance purposes and dust suppression at the impoundments during non-milling periods. During non-milling periods, the pH of the NPDES water and other waters are adjusted with lime to between 6.0 and 9.0 standard units to meet NMED discharge permit DP-933 requirements at the tailing facility. Since the NPDES waters are federally-permitted discharges, they are exempt from CERCLA response actions under CERCLA § 107(j).*

The conceptualized estimated total flows of water to be collected by the remedial systems are depicted in Table 1, below

Table 1
Conceptualized Total Estimated Flows
For Water Treatment

Remedial Component	***Estimated Flow (gpm)***
Mine Dewatering	*250*
NPDES BMP Ground Water Withdrawal Well System	*420*[1]
NPDES BMP Seepage Interception Systems at Springs 13 and 39	*100*[1]
Seepage Interception Systems at Base of Capulin and Goathill North Waste Rock Piles	*80*
Ground Water Extraction Well Systems in Lower Drainages	*220*
Total	*1,070*

[1] *Method of water disposal to be determined by NPDES regulatory authority if CMI is in compliance with NPDES Permit NM0022306.*

Comment 98: What's going to be done with the collected water once it is treated at the tailing facility?

Response 98: *The current plant is to discharge a majority of the treated water to the Red River. EPA estimates that approximately 800 gpm of water will be collected by the seepage interception systems and ground water extraction systems at the tailing facility. Approximately 400 gpm will be discharged without treatment to the Red River at the current NPDES permitted outfall 002. This NPDES-permitted discharge is a federally-permitted release and, therefore, it is exempt from the CERCLA response action under*

CERCLA § 107(j). The remaining 400 gpm of seepage-impacted ground water will be treated as part of the Selected Remedy. Although a permit is not required under CERCLA for an on-Site action, EPA has decided to regulate the treated effluent discharge to the Red River through NPDES permitting. A pre-construction draft NPDES permit application will be developed in accordance with 40 C.F.R. Part 122. The discharge limits (levels of contaminants allowed in the discharge) will be determined though the NPDES permitting process. A smaller portion of the treated water may continue to go to the tailing facility for dust control, but these details will be formalized in remedial design.

Comment 99: EPA must require CMI to build a second state-of-the-art treatment plant at the mouth of the canyon below the tailings to treat the water currently being released into the Red River under the failed NPDES permitting process.

Response 99: *Construction of a water treatment plant or refurbishment of the existing ion exchange plant at the tailing facility will begin at the start of the remedial action. The water treatment plant will be tested and operated once construction is complete. As stated above, a pre-construction draft NPDES permit application will be developed and submitted for obtaining authorization to discharge treated effluent. The discharge limits (levels of contaminants allowed in the discharge) will be determined though the NPDES permitting process. If the existing ion exchange plant is used for water treatment, modifications may be necessary if contaminants in ground water, in addition to molybdenum, require removal (e.g., uranium). Reverse osmosis will be included for additional treatment if needed.*

Comment 100: Most of the tailing seepage (estimated 92%) is discharged to the bedrock aquifer where it is treated through natural dilution and dispersion processes. Are the costs for requiring treatment of the remaining 8 to 10 percent of seepage that is captured from the alluvial aquifer justified?

Response 100: *See response to Comment No. 64 above.*

Comment 101: The main difference between the two alternatives is that EPA's Preferred Alternative for the Tailing Facility Area includes treatment of all collected water in "Year 0", whereas the CMI Phased Plan for the Tailing Facility Area includes continued discharge of approximately 400 gpm of water currently permitted through Outfall 002 and pumpback of the balance of collected water to Dam No. 5A. Collected water that is currently pumped back to Dam No. 5A, and the anticipated additional amount of water to be collected and pumped back, will have minimal, if any, impact on the ground water quality within the volcanic aquifer beneath the Dam Nos. 4 and 5A impoundments. This is supported by the molybdenum concentrations in monitoring wells MW-22 and MW-23, which are approximately 2,000 feet downgradient of Dam No. 5A, where the pumpback system has discharged water since 2004. The molybdenum concentrations in the wells are 0.006 and 0.01 mg/L, respectively, which are very low concentrations near background. If the discharge from the pumpback system had an impact on the ground water quality over the last 6 years, it would have been observed in the two downgradient wells, but there have been no such observations.

The CMI Phased Plan for the tailing facility Area includes additional ground water performance monitoring southwest of Dam No. 5A and beneath the tailing facility to assess the effects of remedial actions on ground water quality and evaluate the potential need for further ground water remediation. Additionally, the water collected from existing and new extraction wells and seepage barriers that would have to be treated by the new treatment plant advocated by EPA has relatively low concentrations of a number of constituents, including molybdenum (1.3 mg/L), sulfate (1,000 mg/L), manganese (0.5 mg/L), and fluoride (1 mg/L).

The tailing facility will not need a new water treatment plant unless future information provided by the enhanced ground water monitoring system and analysis contemplated by the CMI Phased Plan establishes the need for such treatment. Further, according to the HHRA (Admin, Record – DocID No. 869500) and the BERA (Admin. Record – DocID No. 869493), there is an even greater absence of what EPA characterizes as principal threats at the tailing area than at the mine. Moreover, the program expectations that are the basis for the preference for treatment analysis declare that "containment will be considered for wastes that pose a relatively low long-term threat" (USEPA – A Guide to to Selecting Superfund Remedial Actions, OSWER Directive 9355.0-27FS, April 1990, p. 1). Based on EPA's risk assessments, the analysis in the FS Report (Admin. Record – DocID Nos. #873842, 9116332), and the analysis in Section 3.0, the tailing area represents exactly the "relatively low long-term threat" described by EPA in its guidance (USEPA 1990) as calling for containment. The hydraulic controls that are the primary remedial measure in both the CMI and EPA preferred remedial alternatives for the tailing area provide exactly the sort of containment contemplated by EPA's Program Expectations for low long-term threats.

CMI does not agree that a water treatment plant at the tailing facility is necessary. There is an apparent perception that treating the mine water with discharge to the Red River, resulting in the elimination of non-mining discharges to the tailing facility, would reduce constituent concentrations in seepage from the tailing impoundments. This overlooks the fact that the mine is an operating facility which must place tailing at the tailing facility during mill runs and requires water in the pipeline for maintenance purposes during non-milling times. Reducing non-milling discharges might result in a temporary improvement in ground water quality at the tailing facility, but the improvement would be short-lived once milling operations resume. It has also been suggested that water at the mine site could be treated and discharged through the tailing pipeline during non-milling times and that doing so would improve ground water quality beneath the tailing area. However, once discharged at the tailing facility the treated water would re-contact tailing and take on chemical characteristics similar to the tailing pore water and effects that may have resulted from treatment would be immediately lost. In summary, current water treatment at the mill achieves the CERCLA threshold criteria of reduction of toxicity, mobility, and volume of mine-affected water in a manner that would be similar to a new water treatment plant. Therefore, immediate water treatment is not warranted nor can it be deemed cost effective.

Response 101: *During typical mining operations, historical data show that milling occurs only two-three months out of the year. That means the rest of year approximately 3,200* *gpm of mine water is sent to the tailing facility where approximately 83% is uncollected and allowed to seep back into the basal aquifer system behind Dam 4 and 5A. EPA agrees that the issue here is that treating mine water prior to disposal behind Dam 5A will not reduce leachate impact to the ground water because regardless of the initial water quality in the decant ponds, vertical infiltration through the tailing material will result in poor water quality. However, if mine water that would be sent to the tailing facility during non-milling periods is, instead, treated and discharged to the Red River, then an overall reduction in potential seepage from the ponds can be achieved. The less water discharged to the tailing ponds, the less water is available for seepage and impact to the ground water system.*

See response to Comment No. 64 above, for additional discussion regarding impacts to ground water at the tailing facility and EPA's rationale for water treatment.

Comment 102: EPA's remedy fails to address the shallow well contamination in the Village of Questa and remediate that contamination.

Response 102: *It is not clear whether the commenter was referring to the Village of Questa municipal water supply wells or private water wells in the area of Questa. The municipal wells operated by the Village of Questa are not known to be impacted by mining-related contamination. Monthly sampling and analysis by the Village of Questa on its municipal water distribution system verify compliance with federal drinking water quality standards. All of the residences in the vicinity of the tailing facility to the south and southeast of Dam No. 1 that formerly were supplied with water from private wells are believed to be connected to the municipal water supply distribution system.*

As noted by the commenter, ground water to be drawn from private water wells located in certain areas south and southeast of Dam No. 1 is contaminated at levels not suitable for drinking. However, this water may still be used for non-consumption activities like irrigation or washing clothes. The Selected Remedy targets the shallow ground water *south of the tailing facility for clean-up; however, it is estimated that it could take up to 15 years after the tailing facility is closed and covered to achieve drinking water quality.*

Comment 103: Mine wastes have contaminated private water wells and over time resulted in illnesses. This condition has existed for 20 plus years, and both humans and cows living in the area have been impacted.

Response 103: *To date, no documentation (e.g., pathology report, etc.) has been obtained by EPA to verify the reports by local residents of livestock loss from molybdenosis. However, based on the findings of the RI, shallow soil in the meadow contains concentrations of molybdenum at levels which pose a risk to cattle and sheep, as well as other large herbivorous mammals, such as deer and elk, for molybdenosis. The molybdenum-contaminated soil in the meadow will be cleaned up as part of the Selected Remedy to levels that are protective of wildlife as well as livestock.*

Comment 104: The result of 15+ years of tailing disposal is ground water contamination exists below the facility and extends to the Red River. What will happen over the next 15 years as the operation continues and as they continue to pollute the area? How is EPA addressing that issue? How does EPA know how these contaminants will behave in the future?

Response 104: *The Selected Remedy for the tailing facility includes additional extraction wells and seepage barrier drains to be located south and southeast of Dam No. 1 to cut off and treat impacted ground water. As part of the remedy, seepage-impacted ground water from the drains and wells will be collected and pumped to a water treatment plant for treatment, rather than pumped back to the impoundments where it is allowed to re-infiltrate and percolate through the tailing to the underlying aquifers, which is a current practice of water disposal by CMI.*

EPA has also included additional ground water characterization and a number of monitoring programs with the Selected Remedy for the Tailing Facility Area. Additionally, *EPA will perform five-year reviews of the remedy to assess protectiveness. If, during the remaining life of the operating facility, EPA finds that conditions have changed which affect the protectiveness of the remedy, then additional CERCLA response actions would be conducted to protect human health and the environment.*

Comment 105: There is concern by the homeowners that live along upper Embargo Road (along the south boundary of the tailing facility) downgradient from the Change House. Tailing seepage is documented in monitoring wells in that area. Have the contaminant concentrations increased in those wells over time? And, what is the monitoring schedule?

Response 105: *Monitoring wells located downgradient of the Change House that are closest to residences along upper Embargo Road are MW-4 and MW-17. Contaminant concentrations measured in ground water samples collected from these wells have been sporadic over the years, but in 2006 there was a significant and sharp increase in molybdenum levels in both wells. EPA believes this increase to be associated with an increase in CMI's mining and tailing disposal operations between 2006 and 2008. Since then, contaminant levels have decreased in both wells but still exceed EPA's cleanup level for molybdenum of 0.08 mg/L at MW-17.*

Monitoring of MW-4 and MW-17, along with the other monitoring wells at the tailing facility will be performed as part of the Selected Remedy. They are currently monitored quarterly as required by New Mexico Ground Water Discharge Permit DP-933. Additionally, EPA believes new monitoring wells need to be constructed downgradient of MW-4 and MW-17 and off of CMI's property to determine whether molybdenum levels exceed EPA's cleanup level in the residential area along upper Embargo Road. EPA would also be interested in sampling any private wells that are located in that area.

It is EPA's understanding that all residences along upper Embargo Road are currently hooked up to the Village of Questa's municipal water supply distribution system and that no one uses ground water in this area as a drinking water supply.

Comment 106: EPA appears to be focused on the area south of the tailing facility and not east of the tailing facility where contaminated ground water could migrate to the Village of Questa's municipal water supply wells in the next 20, 30, 40 years. Is this happening now? Can these data be made public so the community is aware of any problems within those wells?

Response 106: *Currently, the municipal water supply wells are not contaminated by mining-related activities. In addition, the results of the RI show that the ground water flow paths from the tailing facility move to the south and southwest, rather than east toward the municipal wells. Therefore, seepage-impacted ground water beneath the tailing impoundments flows primarily south and southwest towards the Red River. Under the Safe Drinking Water Act, the Village of Questa is required to analyze water quality within its distribution system periodically to ensure that it provides the Questa community with a safe drinking water supply. The Village of Questa can provide a copy of these data to the public. As part of the Selected Remedy, all of the monitoring wells at the Tailing Facility Area will continue to be monitored. Some of these wells are located east of the tailing facility and can be used to identify any movement of seepage-impacted ground water to the east. Finally, all data collected by EPA during the RI are available to the public in the Administrative Record, which is maintained at the document repository at the Village of Questa municipal offices.*

Comment 107: The community is concerned about reports that suggest that the tailing materials can change from a neutralized condition from lime addition to an acid-generating geochemical condition. And further, it was reported that one might not see acid generation within 10 or 15 years, but possibly in 20 to 30 years, as is being seen in the rock piles. At a minimum, a 3-foot cover over the tailing facility is needed to protect against acid generation.

Response 107: *EPA agrees with the commentator's recommendation for the required thickness of the soil cover for the tailing facility. Consistent with conditions of the New Mexico Mining Permit TA001RE-96-1 and Ground Water Discharge Permit DP-933, a* *minimum 3-foot thick soil cover will be placed on the tailing facility, graded, and revegetated. In November 2009, EPA approved a joint proposal by Chevron Mining Inc. and Chevron Technology Ventures for a cover depth pilot demonstration at the northeastern corner of the tailing facility. The pilot demonstration will be for a period of five years and include an evaluation of 1-, 2-, and 3-foot cover depths. In a joint letter with NMED and MMD, dated November 13, 2009, EPA agreed that if a 1-foot or 2-foot thick cover is demonstrated to be successful in the five-year pilot, the CERCLA remedy would be modified accordingly.*

The cover type will be a store and release/ET cover designed to reduce infiltration and percolation of water through the tailing material to ground water that would cause an exceedance of ground water quality standards. In limiting infiltration and percolation, the cover will also minimize oxidation and acid generation of the tailing.

Additionally, the Selected Remedy for the tailing facility will include ground water monitoring and other monitoring along the perimeter or within the tailing piles to provide early detection of any potential acid generation and metal leaching. Pyrite and other sulfide-bearing minerals are known to be present in the tailing at levels sufficient to generate acid. At this time, the tailing appears to be sufficiently buffered with some carbonates and hydrated lime to preclude acid-generating conditions. However, over a longer time period, should these relatively soluble materials be leached by deep seepage processes or applied process waters then acid producing conditions may prevail. Although soil cover and vegetative canopy should minimize this risk, the EPA believes it prudent to include such monitoring.

Comment 108: EPA's remedy must include a detailed plan for the clean-up of uncontrolled releases of contaminants while mine is in operation, as well as plans for containment of contaminants from the tailing facility.

Response 108: *EPA agrees with the commenter. The Selected Remedy will protect human health and the environment through a combination of technologies such as treatment,* *removal, and engineering controls for containment, along with physical barriers for access restrictions and temporary well drilling restrictions to restrict the use of ground water. The remedy will (1) eliminate or reduce the leaching and migration of contamination caused by acid rock drainage and tailing seepage to ground water, and subsequently to surface water at zones of ground water upwelling, (2) restore ground water to meet drinking water or water quality standards, risk-based cleanup levels, or background levels, (3) protect Red River aquatic and aquatic-dependent life from chronic exposure to contaminants by eliminating or reducing mining-impacted discharges to the Red River, (4) reduce or eliminate exposure by human and ecological receptors to tailing in ponded areas, and (5) eliminate or reduce direct exposure and exposure via accumulation in plants by wildlife and livestock to mining-affected soil and tailing spills that contain molybdenum.*

Comment 109: EPA's Proposed Cleanup Plan for Site mitigation states that extraction of ground water in the basal volcanic aquifer south of Dam No. 4 (i.e., Alternative 4) would increase protection of human health. The alternative that would be the most effective and permanent in the long-term is Alternative 4. Yet EPA has chosen Subalternative 3B as the Preferred Alternative over Alternative 4 because of "limited beneficial use of ground water in the area south of Dam No.4 and the likelihood of no future increases in such use ". The community at-large wholeheartedly disagrees with this justification and, instead, supports Alternative 4 for closure of the tailing facility.

Response 109: *See response to Comment No.114 below.*

Comment 110: Data show clearly increasing trends in contaminant concentrations in both the basal alluvial aquifer south of Dam 1 (*i.e.,* MW-26, MW-27 and MW-28) and in the basal bedrock aquifer west of the impoundment near Dam 5A (*i.e.,* MW-22 and MW-23). These areas were specifically excluded from further consideration through the RI/FS screening process because contaminant levels were low at the time of the RI data collection period. Although contaminant concentrations remain lower than the preliminary remediation goals as of the 4th quarter 2009, the steadily increasing concentrations are of concern. The Proposed Cleanup Plan does not address potential long-term seepage effects on these deeper aquifers.

Additional monitoring wells are needed in the basal alluvial aquifer below Dam 1 and in the western portion of the basal bedrock aquifer to monitor the effects of long-term recharge by tailing seepage on these deeper aquifer systems.

Response 110: *EPA agrees with the commenter that additional monitoring wells are needed to monitor the effects of long-term recharge by tailing seepage on the deeper aquifer systems and has included these and other requirements in the Selected Remedy. EPA has also included additional ground water characterization at the tailing facility, especially for the basal bedrock aquifer and deeper portion of the alluvial aquifer.*

Comment 111: The contaminant plume south of the Change House area in the vicinity of MW-17 is mischaracterized in the RI and does not accurately represent the current extent of contamination. A side-by-side comparison of isoconcentration contour maps for molybdenum between 2nd quarter 2004 and 2nd quarter 2008 reveals increased concentrations of molybdenum within the mapped plumes south and southeast of the Dam 1 impoundment. While concentrations have clearly increased, the interpretive mapping (all done independently) indicates very little change in the either lateral extent or shape of the inferred contaminant plumes. Critical data are lacking in the more recent (2008) molybdenum map which is missing control points south of the MW-17/MW-4 plume. The more recent map no longer includes TPZ-6U or TPZ-7U (temporary well points), which provided the only control points in the low-lying area between the impoundment and the river.

However, without data between Embargo Road and the river south of MW-4, the statement in the RI (Section 5.5.1.3) that "…the extent of off-site migration is not believed to be beyond Embargo Road…" cannot be substantiated. Further, if the map were re-contoured with maximum 0.36 mg/L control point instead of 0.2 mg/L, the lateral extent of the mapped plume would have to be enlarged and would extend south of Embargo Road.

Lacking these data in conjunction with liberal interpretations, EPA's remedy should include additional monitoring wells in the low-lying area between the impoundment and the River to evaluate the current extent of the plume south of the Change House area, and to monitor the effectiveness of the proposed extraction well system in containing that plume.

Response 111: *EPA agrees with the commenter that additional monitoring wells are needed in the area south of the Change House. For additional discussion on ground water contamination in this area, see response to Comment No. 105 above.*

EPA's Selected Remedy for the tailing facility area includes, among other systems, a ground water extraction system that is expected to remediate ground water contamination that may have a source in the easternmost tailing impoundment rather than the historic buried tailing north of the Change House.

Comment 112: The community supports Subalternative 3B for the tailing facility, which does not include active measures to prevent further degradation of the basal bedrock aquifer, provided additional monitoring wells are installed in the bedrock aquifer starting in Year 0 to significantly expand the area of monitored coverage on the west side of the facility, directly under the western impoundment, and southwest of the facility.

Response 112: *EPA agrees with the commenter that additional monitoring wells are needed in the bedrock aquifer. EPA's remedy incorporates monitoring systems to allow evaluation of performance. The specific monitoring details will be developed in the remedial design process.*

Comment 113: The community requests that comprehensive aquifer characterization studies and water balance studies be performed (initiated at Year 0) to gain a better understanding of the water balance and potential fate and transport mechanisms of tailing seepage in the bedrock fracture flow system. Ground water models should be developed and validated with well data, to assess the long-term risk to the aquifer under varying future tailing discharge scenarios. Available data indicate that molybdenum and sulfate concentrations are increasing in wells completed south of Dam 4, and also in monitoring well MW-23 on the west side of the impoundment, and data such as these are of concern. One of the tasks of the aquifer impact assessment is to understand if those trends will be sustained or accelerated with increased production, or if the aquifer will be able to “absorb” the anticipated discharges through dilution and dispersion mechanisms to the extent that concentrations will not exceed the New Mexico ground water standards.

Response 113: *EPA agrees with the commenter that comprehensive aquifer characterization studies are needed. Although a substantial amount of work has been performed during the RI over the past 10 years at the tailing facility, EPA recognizes that additional characterization will be needed to ensure that the extent of ground water contamination has been adequately delineated for designing the remedy. The community makes several good recommendations and these will be considered in remedial design.*

Comment 114: According to a 2006 water balance calculation by CMI, approximately 76% of all water placed on the western portion of the tailing facility discharges to the basal bedrock (volcanic) aquifer. EPA will require additional studies to characterize this discharge, but the current Plan continues to allow this discharge to leave the tailing facility untreated, and enter the Red River. EPA argues that this discharge does not exceed NMED standards (except for the molybdenum health-based preliminary remediation goal). The following statements are from the Proposed Cleanup Plan:

> *"Elevated concentrations of molybdenum above the risk-based PRG of 0.05 mg/L are detected at monitoring wells near the Dam (approximately 0.7 mg/L at MW-11). Trends in the molybdenum and sulfate levels sharply increased from 2006 to 2008 in response to an increase of mining, milling, and tailing disposal operations (molybdenum levels increased from about 0.4 mg/L in 2006 to near 1.0 mg/L in 2007 at MW-13)* [emphasis added].

> *There are several seeps and springs located south and southwest of the tailing facility which flow to the Red River. Some are located as far as the Red River State Fish Hatchery about one mile downstream of the facility. Sample analytical results show concentrations of molybdenum and sulfate in the springs to be elevated and, hence, contaminated by tailing seepage. The pathway for contaminant migration is the leaching of tailing seepage downward from the tailing facility to ground water that migrates through fractures to surface water of the Red River via seeps and springs. Although the concentrations of molybdenum at some springs exceed the risk-based PRG for ground water (0.76 mg/L at Spring 12), they do not exceed ecological screening levels for surface water."*

The relationship between mining/milling operations resulting in tailing deposition containing large amounts of water and increases in contaminant levels in springs and seeps connected to the underlying basal bedrock aquifer has been clearly established.

Ground water associated with the basal bedrock aquifer in the area of the Red River is clearly connected to surface water and the Red River. Based on the information provided by EPA in the Plan and available to us, it is believed that cost (*i.e.,* EPA's preference of Subalternative 3B versus Alternative 4) is the only reason that CMI is not being required to capture and treat all discharges from the tailings facility. Given the value of the downstream waters to the State of New Mexico and its citizens who utilize and recreate in those waters, the impact of beneficial use by any water that discharges from the Site should be restricted as part of the Plan.

Further, EPA's preferred remedy requires that <u>all other</u> contaminated waters at the tailing facility and on the mine site be captured and pumped to a water treatment plant for treatment *in perpetuity*. Allowing the ongoing discharge of untreated water from the Dam No. 4 area of the tailing facility is simply irresponsible environmental policy. Because the tailing facility contains approximately three million tons of unoxidized pyrite, the long-term potential for acid generation and the continuing release of contaminants is very high.

It makes no sense to capture and treat all other contaminated water from the mine site and tailing facility, and then allow the untreated discharge of up to 2,510 gallons per minute from the tailing facility to enter the Red River. This untreated discharge amounts to ~1.35 billion gallons/year that will be allowed to contaminate both the Red River and Rio Grande. If the water were to be treated before discharge, or even better yet not removed from the river in the first place by mining operations, it would benefit the State of New Mexico and all downstream users of the Rio Grande aquifer as a whole.

The community group recommends that EPA select Alternative 4 for the tailing facility area and require that all waters discharging from under the tailing facility (migrating west to the Rio Grande and south to the Red River) be captured and treated, just like contaminated water on the mine site. This southern area should be given additional emphasis since it involves the greatest risk of domestic use and impact of related property rights including impacts to local *acequia* users.

Response 114: *EPA agrees that, overall, Alternative 4 is the best alternative to address ground water contamination at the tailing facility area as it includes ground water extraction for the basal bedrock (volcanic) aquifer south of Dam No. 4 and is expected to restore ground water to appropriate cleanup levels (i.e., MCLs and state ground water quality standards) in the shortest time (i.e., 8 years following placement of the cover). However, EPA's decision not to select Alternative 4 is based on the current and anticipated future use of the aquifer as a drinking water supply and the significant additional cost. The area of ground water contamination is primarily within the Red River Canyon on BLM-managed lands. It is a remote and rugged area with no residential development. There is very little use of the aquifer for drinking water purposes and EPA does not anticipate such level of use to change significantly in the future.*

EPA recognizes that the Red River Gorge is a popular fishing and recreational area that is heavily used by the general public and Questa community. Further, there is a vehicle access point to the Red River State Fish Hatchery that allows easy hiking access in both directions along the bank of the river. However such use of the area for fishing and *recreational purposes does not equate to additional use of the ground water for drinking, which is the exposure pathway (consumption) that presents a risk to human health.*

The Red River State Fish Hatchery uses the ground water from the volcanic aquifer. It is piped to the hatchery buildings and residential dwellings from several springs along the Red River Gorge. Several full time employees and their families reside at the facility and use the water as a drinking water supply. At this time, the concentration of molybdenum in the tap water at the hatchery is below EPA's health-based cleanup level. However, the trend in molybdenum concentrations has been increasing over time and, therefore, will be closely monitored as part of the Selected Remedy. Currently, at the request of hatchery personnel and the New Mexico Department of Game and Fish, CMI provides bottled water to the hatchery.

Alternative 4 was also significantly more costly, an increase of up to $85 million in present value, than the selected alternative because the estimated volume of approximately 4,500 gpm of water that would have to be extracted from the volcanic aquifer and treated was an order of magnitude higher than the estimated volume of approximately 400 gpm for the selected alternative.

The source containment component of the Selected Remedy (i.e., cover and revegetation of the tailing impoundments after closure) will reduce infiltration and seepage generation within the tailing piles and, subsequently, seepage impacts to the underlying alluvial and volcanic aquifers. EPA estimates that cleanup levels will be achieved in the alluvial aquifer in about 15 years after closure of the facility and placement of the cover. Cleanup levels would likely take less time to be reached in the volcanic aquifer.

In the event that the future ground water use significantly changes for the volcanic aquifer, then additional CERCLA response actions may be warranted to protect human health and the environment. As stated above, EPA will continue to monitor ground water quality in the volcanic aquifer on the western side of the impoundments, as well as the alluvial aquifer and conduct further ground water characterization as part of the Selected Remedy.

EPA will also use the five-year review process to assess ground water use in this area over time and whether the remedy remains protective.

Comment 115: The residents of Questa are directly impacted by both the positive economic benefits that the mine represents for the community, and the negative short-term and long-term adverse environmental effects associated with mining. It is important to the Village that the remedy be effective. Protecting our environment and water resources is paramount. In particular, the Village insists that the contaminant plumes in the upper alluvial aquifer south and southeast of the tailing facility be fully contained with a robust system of deep ground water barriers and extraction wells. Ground water monitoring must be enhanced in the low-lying area south of the Change House to ensure that contaminants are cleaned up in areas where village residents may be at risk to exposure.

Response 115: *EPA agrees with the commenter that the remedy must be effective. These considerations will be incorporated into the remedial design. The existing ground water extraction and seepage barrier systems will be upgraded and a new extraction system has been incorporated to the east-southeast of the existing extraction systems. Ground water monitoring will be performed as part of the Selected Remedy, including the area south of the Change House. See additional discussion regarding the area south of the Change House in response to Comment No. 105 above.*

Comment 116: The Village of Questa, residents, and community groups are all very much in support of alternative energy generating proposals and use of the tailing facility for generating solar energy. However, the community as a whole is very concerned that the CERCLA remedy for the tailing site -- which includes establishing a three-foot thick cover and revegetation – will be compromised if the installation of the solar array is approved.

The community has heard that the pilot project includes a cover depth pilot demonstration to analyze the effectiveness of 1-ft, 2-ft and 3-ft cover depths over a five-year period. And, EPA has suggested that if a 1-foot or 2-ft thick cover is demonstrated to be successful in the five-year pilot, the CERCLA remedy would be modified accordingly. A five-year test is too short a time period for collecting data that can scientifically predict the effectiveness of the cover to protect water quality and wildlife habitat for the long term.

In short, EPA must not succumb to pressure from the company to decrease cover thickness and sacrifice protectiveness for the community. Further, it is likely that the power from the solar panels will go to help the mine operations, rather than a collaborative initiative to help the village, the schools, and/or the government entities.

Response 116: *The Selected Remedy specifies a cover thickness of 3 feet for the tailing facility. As noted, there is a proposed pilot test to evaluate the performance of 1-ft, 2-ft and3-ft cover thicknesses relative to moisture infiltration and EPA has agreed to modify the remedy if CMI can demonstrate a thinner cover will be protective of human health and the environment (see Appendix C). However, EPA will not agree to a thinner cover if it will sacrifice protectiveness. Further, as stated in response to Comment No. 10 above, EPA has included with the Selected Remedy the monitoring of metals uptake (including molybdenum) in plant tissue growing on the cover to ensure the degree of uptake is not harmful to vegetation as well as herbivorous native wildlife that forages on the vegetation. Regarding an energy-share initiative, EPA cannot direct CMI or Chevron Technology Ventures to donate power to outside recipients, as it is fully funded by the company.*

Comment 117: Please describe the monitoring program that will be implemented in areas within and beyond the boundaries of the solar demonstration plot on the tailing facility.

Response 117: *Monitoring for the cover depth pilot demonstration will be comprehensive. CMI is installing equipment that will monitor all the moisture that percolates through the cover and into the underlying tailing. CMI must demonstrate to EPA that that 1- or 2-foot cover does not allow downward percolation of precipitation to ground water. Monitoring to be conducted at the tailing facility as part of the Selected Remedy includes ground water quality and early detection of acid generation using monitoring wells, metals uptake in plants growing on the cover by analysis of plant tissue, and ambient air monitoring during the remaining operating life of the tailing facility.*

Monitoring of the overall condition of the cover will also be performed to ensure its integrity for preventing infiltration and as a barrier for protecting wildlife and plants. Metals uptake in plants growing on tailing may occur at a level that presents a risk to plants and large herbivorous wildlife (deer and elk) grazing on the plants. Since burrowing organisms and erosion over time can degrade the cover, it will have to be maintained.

Comment 118: The community encourages EPA, the State of New Mexico, and CMI to really look at the three foot cover for the entire 1,000 acres of the tailing facility. Wind storms are common in northern NM and there is concern that the wind will erode a thin cover away quickly, as well as cause dust problems.

Response 118: *The soil cover to be placed atop the tailing impoundments will be vegetated. The vegetation will help minimize dust and wind erosion processes to some degree. However, wind erosion over time is a concern to EPA regardless of the thickness of the cover. If high winds erode the cover, maintenance of the cover must be performed to ensure its effectiveness as a store and release/ET cover system and barrier to protect plants and wildlife. See response to Comment No. 117 above. Also, five-year reviews of the remedy will be conducted by EPA to ensure that it is, or continues to be, protective of human health and the environment.*

Comment 119: The tailing facility must be covered with the proper materials during closure, rather than available and cheap materials. This covering must seal and stop the probably upward seeping of toxic materials and seal the bottoms to avoid further ground water contamination.

Response 119: *The tailing facility will be closed with sound engineering practices and oversight. The closure will include a vegetative cover to maximize runoff and minimize infiltration. However, the bottom will not be sealed, as there is no means to access the bottom of the facility without excavating the tailing. Instead, source control and ground* *water protection will be achieved by minimizing infiltration of water from the surface, which will eventually allow the tailing to dry out and curtail ground water impacts.*

Comment 120: EPA's proposed remedy fails to disclose where CMI is planning to obtain top soil for the reclamation of the tailing ponds. Will striping of topsoil from another location create another ecological disaster elsewhere to accomplish this goal?

Response 120: *As stated in the Proposed Cleanup Plan (pg. 98), the source of the cover material will be the alluvial soils located at the northern portion of the tailing facility. EPA does not anticipate significant environmental impacts from the stripping of topsoil, although it is recognized that a new soil layer will take some time to develop in the area of excavation.*

Comment 121: EPA needs to reassess the opinion that there are no wildlife grazing at the tailing facility, because there is a resident herd of elk in the Guadalupe mountains that does graze the tailing vegetation considerably.

Response 121: *Elk have been observed foraging at the impoundments in the late evening by local ranchers and tracks have been seen on the impoundments by regulatory officials. EPA's Selected Remedy will include controlled access to the tailing facility, consisting of an exclusion fence, to restrict access by deer and elk and wildlife drinkers.*

An exclusion fence (e.g., high fence) will be installed around the perimeter of the tailing facility to prevent deer and elk from gaining access to the tailing impoundments prior to closure of the facility and placement of final cover. The height of the fence will be determined during remedial design, but will be anywhere from 8 feet to 10 feet, as determined by the EPA. The fence will also have one-way gates at intervals around its perimeter to allow animals to get out should they become trapped within the fenced area.

In combination with the exclusion fence, wildlife drinkers will be constructed along the western perimeter of the tailing facility on the eastern flank of the Guadalupe Mountains to *replace the water supply (i.e., tailing ponds) that will be unavailable to the herds after placement of the final cover. The source of the wildlife drinking water will be supplied by precipitation capture, and the catchments will be sized to provide water continuously through drought conditions. The actual number of drinking facilities, as well as the design specifications, will be determined during remedial design based on field conditions and as approved by the EPA, in consultation with the New Mexico Department of Game and Fish. In addition to being a water supply to the deer and elk, these drinkers may help control animal movements in terms of keeping them from moving around the fence to undesired or unanticipated locations (e.g., crop fields and highways).*

Comment 122: In reference to the elk, I have witnessed or heard of elk drinking tailings water from the storage ponds on the facility, and I have seen harvest elk when they are drinking the tailing water. People are potentially consuming those animals. Has the New Mexico Department of Game and Fish done any sampling of those animals?

Response 122: *EPA is not aware of any sampling performed of deer and elk tissue for the purpose of determining effects to humans who may consume these animals.*

Comment 123: EPA should be aware of a problem with the dams at the tailing facility. Right now Dam No. 1 is leaking water. Has EPA checked it recently or not? If either dam ever bursts, the residential area and the fish hatchery will get wiped out. Has anyone monitored the stability of the dam recently?

Response 123: *The earthen dams are permitted through the New Mexico State Engineer's office. This office has the authority and obligation to inspect and evaluate the stability of these dams.*

It is important to note that earthen dams leak regardless of the materials used in their construction. They are designed to leak. Unfortunately, they have contributed to the ground water contamination in the area of the tailing facility. The ground water contamination will be addressed by the Selected Remedy.

The collection of quarterly piezometer data and performance of annual inspections of the tailing facility dams to meet requirements of the New Mexico Office of the State Engineer will be part of the Selected Remedy until it is demonstrated that the tailing dams have been dewatered.

Comment 124: I understand that there is approximately 15 years of tailing disposal remaining at the facility. The discharges from the 001 and 003 seeps at the tailings impoundment are right by my house. Because of seepage, there is concern in my area that a mud slide or tailing slide could come down the drainage and impact our properties; it has happened previously.

Response 124: *EPA understands your concern. There have been historical releases at the tailing facility. However, there have been efforts in recent years to upgrade and improve collection of seepage at the 001 and 003, and these collection systems have been effective for a number of years now. In addition, the State of New Mexico monitors these areas quarterly. Because of these improvements EPA and NMED do not anticipate, but will continue monitoring to minimize the potential for, another mud or tailing slide.*

Comment 125: Under the current preferred alternative, does EPA still plan to cover the 1,100 acres comprising the tailing facility with three feet fill material? And, what is the plan to reseed that area? Who is going to maintain the vegetated cover, and is that water going to be pumped back to take care of the dust? The local residents want this closure expedited, because when the wind blows here, it is very dusty. With a one-foot cover, it is anticipated that wind erosion will remove that thickness in two or three years?

Response 125: *As stated above, EPA will not allow the cover system to degrade to a level where it becomes ineffective for the purpose intended. CMI is evaluating cover thicknesses, and must demonstrate to EPA that a one-foot or two-foot cover will be protective. If they ultimately do demonstrate that a thinner cover is protective, and EPA accepts that cover, then EPA will have to make sure that the integrity of that thinner cover* *is maintained through monitoring and through five-year reviews. CMI will be required to repair the cover if there is erosion or animal burrows, or if vegetation dies off.*

In addition, EPA is committed to preventing excursions of dust above regulatory standards. CMI will continue air monitoring as part of the final remedy for the tailing facility. They have several stations along the perimeter of the facility.

Comment 126: Something has to be done about the dust blowing from the tailing facility. In the past, there were horrible dust storms from the tailing area that were experienced at the neighboring Questa Middle School. The winds would come up and all the students had to be kept inside and the school tightly shut. Unfortunately, meaningful reclamation has not occurred to address this problem since operations started. Furthermore, there are numerous references to low to negligible risk associated with fugitive dust at the tailing facility, including:

- *"Worst case estimates of past exposures to metals contamination from breathing in tailing dust were too low to result in short- or long-term health effects. However, intermittently high dust levels could have resulted in short-term eye and respiratory irritation and an increase risk of respiratory problems in sensitive groups (people with asthma or other respiratory disease, the elderly, and children). Recent studies indicate that adverse health effects are unlikely today."* (Page 9 of EPA's Proposed Cleanup Plan)
- *"Exposure by inhalation (breathing) of interior dust or particulates (PM10) in ambient air by residents, school children, workers, and recreational visitors was estimated to pose no health risk."* (Page 24 of EPA's Proposed Cleanup Plan)
- *"The tailing dust control measures would continue for the duration of tailing disposal operations. The ongoing voluntary air monitoring program (PM10 monitoring, PM2.5 monitoring during earthmoving remediation activities) would be incorporated into the CERCLA remedy and a contingency plan for dust suppression would be implemented in the event of mining-related exceedences of ambient air*

quality standards beyond the property boundary that threaten human health." (Page 64 of EPA's Proposed Cleanup Plan)

With all due respect to EPA and other parties' analysis, the community does not feel the problems have been correctly identified or addressed and that the dust from CMI's tailing facility continues to cause the following deleterious impacts:

- Physical injury to the public with chronic lung disease, asthma and other lung related illness;
- Significant detriment, nuisance or annoyance to the public;
- Injury or damage to business or property;
- Hazardous conditions on public right of ways; and
- Blight and impairment of property values.

The community appreciates the public health study conducted by ATSDR on EPA's behalf. However, the study fails to point out in its conclusion that the present state of medical/human health toxicology does not provide for a conclusive answer with respect to health concerns from metals associated with tailings dust. As the study points out, health impacts can occur from airborne dust alone to those who suffer from existing chronic lung disease, asthma and other lung related illness.

The community is not satisfied that the actions taken thus far by EPA, NMED and MMD have adequately addressed this matter. We demand on behalf of local citizens that the State and federal agencies do everything within their power to further address this matter. While the regulatory agencies may view this as a minor issue, in fact the viability of the entire remedy depends on addressing a successful solution to this most very public aspect of the remedy. Towards that end we ask that EPA consider the following on an immediate basis:

- Formation of a Task Force mandated with review of CMI's present voluntary Dust Control Plan and on-the-ground procedures and development of a comprehensive and enforceable plan with public input. We ask that principles of environmental justice with a high-level of local governmental and citizen involvement be incorporated into this review.
- Immediate implementation of proven Best Management Practices, including the use of chemical dust suppressant, such as polymers, currently in use and required at other Superfund sites including the 10,000 acre Opportunity Tailings Ponds at the Anaconda Smelter Superfund Site.

Response 126: *EPA recognizes that the dust is unsightly and may result in respiratory difficulties, particularly in elder people, but if a regulation is not violated; it is difficult to take an action. EPA has brought this issue up to CMI on several occasions and EPA is aware of improvements that have been made. CMI has employed a variety of dust control measures since the last quarter of 2005. Analysis of the air monitoring data show these measures are working, evidenced by lower overall dust levels and the number of exceedances decreased during 2006 and in early 2007. Since 2003, air sampling stations have operated at the edge of the tailing facility. These stations are located from the south end, nearest active operations, to the far north end of the facility. One station is located near the elementary school. The stations measure dust particles (PM_{10}), which are 10 microns in diameter and the EPA standard for PM_{10} is 150 µg/cubic meter of air. At the two stations nearest the elementary school, there were no exceedances in 2006. There have been exceedances at the southernmost station closest to active operations in 2006 and 2007 but no exceedances at the northernmost stations. Also during this time, active measures by CMI to suppress dust emissions at the tailing facility have been implemented and include: reducing the active area of tailing operations, spreading straw, and applying a dust suppressant emulsion spray. Further, CMI has reduced the response readiness by storing the dust suppressant and straw at the tailing facility.*

Regardless of these dust suppression measures, EPA has included the air monitoring program as part of the Selected Remedy (see Section 12.0, Part 2, of this ROD). It will *include PM_{10} and $PM_{2.5}$ monitoring at the perimeter of the facility and possibly beyond the CMI property boundary. As part of the air monitoring program, CMI will also be required to develop and implement a contingency plan for further mitigation of windblown tailing dust should ambient air quality standards be exceeded and EPA considers it warranted to protect the community.*

As stated in response to Comment No. 46 above, EPA has no reason to suspect the integrity of CMI's air monitoring activities and does not see a need for an independent air monitoring program. However, in the event that the monitoring effort is found or suspected to be unreliable, inaccurate, or in any way misleading in documenting windblown particulate levels at or downwind of the tailing facility, EPA will reconsider such an option.

Comment 127: EPA's revegetation plans must include species-specific analyses before implementation, including the uptake and potential release of substances through roots/soil interactions; organic material/live stems and leaf tissue, fruit/seed, and respiration/photosynthetic pathways. Containment of waste accumulated in living tissue and decomposing biomass may be an issue for several contaminants in both tailings and pond areas, as well as their interaction with the acid alteration weathering, hydrologic systems, and naturally occurring substances in the area. How are these issues addressed?

Response 127: *The final cover will be revegetated with grasses and forbs and possibly woody shrubs. The species of such plants will be determined in design and consist of those species best suited for performance as part of the store and release/ET cover system. As stated in Section 12.0, Part 2, of this ROD, the revegetation will also be designed to screen out individual species that may take up metals in tissue at levels harmful to the plants, as well as to large herbivorous wildlife (e.g., deer and elk). Such uptake into plant tissue, as the commenter indicates, may redistribute contaminants to the surface in decomposing biomass. To screen out individual species a species-specific evaluation will be performed during the design as recommended by the commenter.*

4.2.4 Red River and Riparian and South of Tailing Facility Area

Comment 128: EPA's remedy does not address the issue of buried tailing in the water lines that supply drinking water to the community or in the *acequias* that irrigate the fields in Questa. The remedy also does not address the ongoing issues of spills from the pipeline in the Red River or into *acequias* near the pipeline, or problems with the Upper Dump Sump, or the Lower Dump Sump (that is in disrepair).

Response 128: *The question as to whether tailing material used as bedding for municipal water supply piping could adversely impact the quality of the water supplied to individual residences resulting in adverse health effects has been evaluated. Sampling was conducted by NMED's Drinking Water Bureau and EPA of several residents' tap water to evaluate the potential for metals contamination. The concentrations of metals in these tap samples were well below drinking water standards. In addition, ATSDR, in its Public Health Assessment for the Site (February 28, 2005), concluded that "No adverse health effects from drinking this water [from municipal water lines] are expected". As part of ATSDR's evaluation, the following "worst case" scenario was evaluated:*

ATSDR assumed that residential water lines were, twice a week, contaminated with tailings used to bury the lines. ATSDR assumed that the water would contain a level of suspended solids, consisting purely of tailings, of 150 milligrams of tailings solids per liter of water. This level of suspended solids would appear "dirty" to the naked eye and it would be unlikely people would drink a large quantity of it. To be conservative, ATSDR further assumed that an adult would drink 2 liters, and a small child would drink 1 liter, per day of this water. ATSDR also assumed that each contaminant present in the tailings suspended in the water was at the maximum level detected in any tailings sampled during the RI. Using these assumptions, potential exposure doses were calculated for each contaminant. ATSDR determined that all the estimated "worst case" doses were lower than health *guideline values. ATSDR concluded that "in the unlikely event people regularly drank water containing some tailings, adverse health effects would not be expected."*

EPA also sampled water at select areas in the acequias. Based on the analytical results, EPA found no evidence of elevated metals contamination. Low levels of diesel range organic chemicals (DROs) were detected in acequia water samples, but they did not appear to be sourced from the mine. Low levels of DROs were also identified in Cabresto Creek, which drains an area undisturbed by mining activity. The presence of DROs in Cabresto Creek suggests a source likely associated with farming activity (see Section 3.7.5, Part 2, of this ROD).

As for tailing spills, the Selected Remedy includes the removal of hot spot tailing spills within the Red River riparian corridor, as well as in and around the Upper and Lower Dump Sumps.

Comment 129: EPA must address the single greatest threat to the health of the Red River and the people that depend on it, which are the historic and future tailing spills. EPA's Preferred Alternative – Subalternative 3B – should include a component that removes or relocates the tailing pipeline and uses green infrastructure to create buffers and wetlands to protect the Red River from the transport of spilled tailing-contaminated soils.

Response 129: *EPA disagrees with the commenter. EPA's investigation of the nature and extent of contamination impacting the Red River was comprehensive and thorough. Based on the results of this investigation and the EPA BERA, there are multiple sources of impacts to the Red River. The most significant are the flow of acidic, metals-laden ground water to the Red River along the mine site and upstream of the mine site at zones of ground water upwelling (i.e., seeps and springs) and storm events upriver to the mine site which result in acidic water and sediment flowing into the Red River from scar-impacted tributary drainages.*

The springs along the mine site having the most significant adverse affect on aquatic life (primarily trout) are Spring 13 and Spring 39. Long-term (chronic) exposure to elevated concentrations of primarily aluminum in surface water at and downstream of these springs may cause adverse effects to exposed trout. These findings are based on surface water concentrations of contaminants, whole body fish concentrations, as well as other supplemental lines of evidence, including abundance and diversity data and laboratory toxicity test data in which trout were exposed to Spring 13 and Spring 39 water. The Selected Remedy includes seepage interception systems (French drains) at these springs to protect aquatic life.

Historic tailing spills that went into the Red River likely caused short-term adverse effects to the river. However, EPA did not observe tailing material in river bottom sediment and assumes it was transported downstream during subsequent high-flow storm events long ago. Future tailing spills into the river would also likely cause short-term adverse effects. However, the number of tailing spills documents since the early 1990s from breaks in the tailing pipeline are few, as Molycorp's improvements to the pipeline at that time significantly reduced the number of breaks. As stated above, EPA has limited jurisdiction over a compliant operating facility and forcing CMI to remove or relocate the tailing pipeline, nor does EPA see the need to do so.

Comment 130: EPA's remedy does not address the presence of buried tailing in public driveways.

Response 130: *The extent of buried tailing within the vicinity of Questa is not well documented. It has been reported to EPA that tailing was used as bedding material for the municipal water supply piping. However, EPA is not aware of tailing buried beneath driveways. EPA investigated the potential for harm from exposure to tailing material and determined that it does not pose a threat to human health (see EPA BERA, 2009). The only tailing-impacted media that present a human health risk are the sediment in the tailing ponds at CMI's tailing facility due to high concentrations of molybdenum and ground water contamination in the Tailing Facility Area. Access to the ponds by trespassers or* *recreational visitors is restricted by fencing and signage and once the facility is permanently shut down, the ponds will be drained as part of closure and covered. EPA's Selected Remedy includes covering the tailing impoundments for source containment to help facilitate the remediation of ground water and as a barrier for the protection of wildlife. EPA's selected remedy also includes removal of hot spot tailing spill areas for the protection of wildlife in the riparian area, including the tailing spill near the Lower Dump Sump. No other response actions to clean up tailing spills to protect human health are warranted at this time.*

Comment 131: The 9-mile-long tailing pipeline that runs through the riparian (floodplain) area of the Red River has been the source of numerous tailing spills over the life of the mine. Portions of tailing spills were removed from the Lower Dump Sump area in 2003, but another 3,800 yd^3 of spilled tailing remains in this area today. Tailing have also been spilled into Hunt's Pond. Local residents are not convinced that EPA has identified all areas of tailings spills within the riparian area and outside of that area. EPA's ROD should allow for the potential discovery and remediation of additional areas of tailing spills identified either during or following remediation activities. The ROD should also specify "riparian" areas and address how tailings identified outside of such areas will be remediated, particularly in those areas in close proximity to residential property. All spilled tailing material should be removed from the riparian area and within 300 ft of all residential properties to avoid possibility of contamination of private property due to potential contaminant migration and incidental exposure or residents, in particular children.

Response 131: *See response to Comment No. 130 above.*

Comment 132: There have been several tailings spills on our property throughout the years. The most recent spill that occurred was never properly cleaned, and there are still visible tailing on the ground. Although alfalfa was planted, it has failed to grow on the lower section due to the polluted soil. EPA should include our property in the clean up process so we could use it in the future.

Response 132: *See response to Comment No. 130 above.*

Comment 133: What will EPA do about contamination in the Red River? The fishing and swimming in La Cienega and Hunt's Pond is important. They are not impacted by molybdenum. The citizens of Questa deserve a clean, safe environment.

Response 133: *To address contamination in the Red River, EPA's selected remedy specifies controlling inputs of acidic, metal-laden water at seeps/springs along the site reach of the Red River and removing tailing spills along the Red River riparian area and disposing of these materials on Site.*

Comment 134: EPA has selected Subalternative 3B – Removal of Soil and Tailing Spill Deposits and On-Site Disposal for the Red River riparian area. While removing contaminated soil/tailing with on-Site disposal may achieve long-term risk reduction through removal of the source and direct exposure pathway, most members of the public do not understand what if anything is being done to address past, present or future impacts from the mine and the Red River. There are many problems with the river, including cobble and sediment cementing from water chemistry impacts, potentially caused or exacerbated by mining. Also, the conclusion of the USGS Baseline Study on the Red River indicate that there are no impacts due to mining, rather identifying natural geochemically altered areas as an additional potential source to Red River water quality and geomorphologic issues. Although EPA believes that the remedy will result in a condition that is protective of the Red River environment and those who use the river for recreational (swimming or fishing) purposes, has no mention of restoration-related activities being undertaken by ONRT. This is a complimentary effort that will also enhance remediation and restoration of the Red River.

It is recommended that EPA integrate with the restoration plan by ONRT, and recommends that ONRT release its plan in a timely manner to allow for coordination of the entire effort under CERCLA. Lack of this coordination will allow for potential technical gaps between those efforts as well as diminished cost efficiencies.

Response 134: *EPA has and will continue to work closely with the State of New Mexico and its ONRT in addressing identified Site risks to the Red River.*

Comment 135: EPA's remedy does nothing to restore the fishery in the Red River.

Response 135: *EPA's Selected Remedy addresses the Red River and its riparian area, including the water quality of the river. A riparian area means an area situated along or near the bank of a river. Additionally, EPA and the New Mexico Department of Game and Fish determined that the fish from the Red River are safe for human consumption.*

Fish tissue sampling was performed by EPA and the New Mexico Department of Game and Fish. These fish were collected from the Red River upstream of the mine site to downstream of the tailings facility. Fish were also sampled from the Red River State Fish Hatchery located below the tailing facility. The hatchery stocks approximately 44,000 rainbow trout annually to the Red River. Resident brown trout and stocked rainbow trout were collected and analyzed during the RI to help address any health concerns the community might have with eating these fish.

The fish samples were tested for primarily metals, including aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc. Measured concentrations of these metals were compared to EPA's health-based screening values for fish consumption. These screening values indicate the level that might pose an unacceptable risk to human health from eating fish.

The test results showed that concentrations of all metals except arsenic were below levels that could present a health risk. The results also showed that the arsenic was primarily in tissue samples of stocked rainbow trout that were raised at the hatchery. Further analysis of arsenic in rainbow trout tissue indicated that it was present in organic forms that have low toxicity and, therefore, posed little or no human health threat. In addition, the results *showed that the levels of inorganic arsenic were below the inorganic arsenic concentration at which EPA recommends against eating fish. Since arsenic was found primarily in stocked rainbow trout samples, the New Mexico Department of Game and Fish tested the fish feed used at the hatchery to determine if it could be the source of arsenic. The tests revealed that the food, primarily Pacific Ocean anchovies, contained elevated levels of organic arsenic. The New Mexico Department of Game and Fish took immediate steps to ensure that the feed used at the hatchery has the lowest possible amount of arsenic to assure the public safety.*

Comment 136: EPA must hold CMI accountable for restoring the Red River to pre-mining conditions. The current plan is in violation of the Clean Water Act and other acts of Congress and EPA has a duty to the Congress of the U.S. and its citizens here in Questa to enforce compliance starting immediately. In addition, if EPA cannot fulfill its obligation to require CMI to stop the pollution into the Red River, we recommend EPA require the company to build a state-of-the-art water treatment plant above the Questa Ranger Station to remove all contaminants caused by mining operations, including petroleum and industrial contaminants.

Response 136: *A primary emphasis of the EPA Superfund Program is to make those responsible for contamination take action to address identified risks to human health and the environment.*

The Clean Water Act (CWA) is the cornerstone of surface water quality protection in the United States. However, the Act neither directly addresses ground water, nor water quantity issues. The statute employs a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

The remedy selected by EPA will either capture or significantly reduce mining-related contaminant releases and, therefore, impacts of contaminants to the Red River. At the mine site, the remedy includes installation and placement of an expanded interception and ground water extraction system either at the toe of the rock piles or at the mouth of the side drainages. This expanded ground water capture system will more effectively capture and reduce the impact of leachate from the rock piles from migrating offsite and reaching the Red River alluvium. At the tailing facility, the present interception system will be upgraded and expanded to include the area south of the Change House. Seepage-impacted water collected by the CERCLA remedial systems will be treated, and the treated effluent discharge will be regulated through NPDES permitting.

Comment 137: The lower Red River is very important to fishing businesses and the Questa community. The presence of mining sediment impedes fish populations. EPA should cut off the source of this sediment and clean up the existing sediment, which would be a great benefit to the lower Red River and Rio Grande. Also, is reintroduction of aquatic species planned under EPA's remedy.

In addition, the tailings ponds of the mine sit over the sources of spring water to the Red River. At some point, these contaminants will taint the Red River water and in turn impact the Rio Grande. EPA's remedy must address seepage through the tailing.

Response 137: *EPA is working to protect the community and business enterprises that use the Red River on a regular basis. However, EPA must clarify the source f impacts to the river mentioned above. Sediment to the Red River is not contributed by the mine. Presently, and for a number of years now, storm water runoff controls at the mine site effectively eliminate sediment-laden storm water discharge to the river. Sediment impacts (yellow, murky water) are largely from the mudslides in the Straight Creek, Hanson, and Hottentott drainages that discharge directly to the river. These scar-impacted drainages are upstream of the mine site. Other upstream drainages that contribute sediment are in or near the town of Red River. And, as shown by the RI, these sediment loading events have drastic acute effects to fish and macroinvertebrates in the Red River. EPA's remedy does* *not address these upstream sediment sources, but will control the discharge of acidic, metals-laden ground water to the Red River at springs along the mine site. EPA's remedy does not plan active measures to reintroduce aquatic organism to the river. However, EPA's quarterly sampling during the site characterization shows fairly rapid recolonization of macroinvertebrates and fish in areas of healthier habitat after significant storm events. EPA is hopeful for steady improvement of the overall river system upon completion of EPA's source control remedy components, which could take a number of years.*

EPA's Selected Remedy will also collect and treat seepage-impacted ground water south and southeast of the tailing facility. Extensive ground water monitoring well networks will be sampled to evaluate the effectiveness of the ground water remedial systems. The systems will be evaluated by EPA as part of the five-year review process to determine protectiveness of the remedy.

Comment 138: The Red River is an excellent fishery, but one cannot think of eating any fish caught in the river because of the contamination.

Response 138: *See response to Comment No. 135 above.*

Comment 139: Amigos Bravos is disappointed in the alternatives provided for the protection and cleanup of the Red River. Protecting the health of the Red River is a critical factor in protecting the health of Questa residents and visitors. Since the inception of open-pit mining, water quality on the Red River has diminished, as has the native Blue Ribbon trout fishery. The major factor leading to the degradation of the Red River is the impacts from tailing spills. Tailing residues are pervasive throughout the area bordering the tailing pipeline and in the river itself.

Response 139: *Protection of the Red River comprises a significant component of the Site remedy. Specifically, the remedy calls for addressing contamination in the Red River by taking response actions at the Mine Site Area to control contaminated ground water* *discharges to the river, and by the removal of tailing spills in the Red River riparian area including the Dump Sump areas where tailings have been dumped for tailing pipe maintenance.*

In regards to water quality, data collected during the RIindicates that two of the most critical factors controlling the water quality of the Red River are the springs along the mine site and storm events. See response to Comment No. 129 above.

Comment 140: It seems that EPA and the state agencies here in New Mexico will be charged with restoring the Red River fishery. The recent changes in leadership at ONRT during critical settlement talks with CMI leaves concerned citizens wondering what direction the settlement is headed. Many are concerned that these negotiations may result in insufficient funds to adequately restore the fishery and watershed health. This would not be an issue if the Red River fishery was addressed by totally comprehensive restoration plan by EPA.

Response 140: *Based on discussions with ONRT, EPA understands that the recent changes in leadership there have not affected the outcome of the negotiations with CMI on the Natural Resources Damage Assessment (NRDA) settlement for the Site. The consent decree for the settlement is scheduled to be lodged in U.S. District Court shortly. After the Court approves the consent decree, the Natural Resources Trustees (Trustees) for the CMI/Molycorp case – the State of New Mexico and the U.S. Departments of Agriculture and Interior – will prepare a draft restoration plan/environmental assessment that will propose projects that can be implemented to restore injured natural resources. Members of the public will have 30 days to comment on or recommend additional projects for the draft restoration plan. In addition, a public meeting will be held during the comment period. The Trustees will respond to public comments in a final document that will identify the restoration projects selected by the Trustees. ONRT will announce draft and final restoration plans on its Web site and in the local Questa news media.*

Comment 141: Please explain what a "copper block" is and how it helps livestock in the riparian areas?

Response 141: *A "copper block" is actually a "salt lick." It is an approximate 2-foot square block of salt that has been enriched with copper, an essential mineral. Cattle and other large herbivorous mammals (e.g., deer and elk) lick the blocks and uptake copper as a nutrient. The copper blocks are commonly used to supplement the diet of animals that graze in areas with high molybdenum concentrations in soil and plants. The molybdenum interferes with the copper uptake of these animals and creates a copper deficiency called molybdenosis. This ruminant disease is characterized by weight loss, depigmentation, reproductive impairment, and even death. CMI currently provides copper blocks to landowners for the purpose of preventing this condition in their cattle.*

Comment 142: For the eight-acre area south of Dam 4 in the riparian area, EPA is proposing to excavate that impacted soil material from there and then cap it with a two or three foot cover?

Response 142: *The area in question is south of Dam 1, not south of Dam 4. EPA's Selected Remedy requires the molybdenum-impacted soil south of the tailing facility (in the riparian area) to be excavated. Please note that the resulting excavation will be backfilled with clean soil, rather than capped.*

Comment 143: According to EPA's characterization, "The area south of the tailing facility is characterized by primarily molybdenum contamination (0.75 to 596 mg/kg) in surface soil, with the highest concentrations occurring near the Outfall 002 discharge point and the Red River. There are historical reports of sick and dying livestock in this area from molybdenosis, a copper deficiency caused by increased uptake of molybdenum. The area of soil with molybdenum concentrations exceeding 11 mg/kg is approximately 8 acres or about 26,000 yd^3. The local residents recommend that all tailing and mine waste in the riparian area and south of the tailing facility be removed from the floodplain of the Red River to prevent ongoing contamination from residual tailing deposits.

Response 143: *The molybdenum-contaminated soil south of the tailing facility will be removed from the meadow and disposed on Site to protect wildlife and livestock. Tailing spills along the Red River riparian corridor with elevated levels of molybdenum will also be removed and disposed on Site to protect wildlife.*

Comment 144: Should veterinarians routinely monitor cattle for molybdenosis or other metal-deficiency to be sure the copper blocks are effective.

Response 144: *The achievement of cleanup levels is expected to reduce risk to wildlife (deer, elk, and birds) and livestock (cattle, sheep) from exposure to molybdenum in soil and via plant uptake that could result in molybdenosis. The decision to monitor cattle for molybdenosis or other metal deficiency is up to the individual who owns the livestock, if they feel the copper blocks are not working.*

Comment 145: My land is located north of Dam 1 and it is irrigated via ditches. Before Molycorp's [now CMI's] improvements, the irrigation water would naturally run off to the south. However, now that water backs up. It is not clear why that happens – it is not right. During the summer months when we irrigate, the water backs up and runs all the way to my property. CMI's operations staff needs to re-engineer the drainage so it works properly. Paul George (of CMI) visited my land last summer and he put a little layer of rock onto my land to try to drain it, and it partially worked. But, flooding still occurs to the point that the four-foot high fences were nearly submerged.

Response 145: *EPA thanks the commenter for bringing this issue to EPA's attention. The improvements the commenter speaks of may be part of CMI's maintenance of the eastern diversion channel (i.e., irrigation ditch). It is not part of any response action directed by EPA under CERCLA. Therefore, at this time EPA suggests that the commenter continue to work with CMI to correct the drainage problem. Since EPA has selected a remedy that includes the installation of piping to convey irrigation water in the eastern diversion channel, EPA believes it appropriate to evaluate the drainage problem during remedial* *design if it has not been corrected by that time. If the cause of the flooding can be identified, the problem can be corrected.*

Comment 146: Is there impacted tailing seepage underneath the *acequia* beds or in the fields to the south of the tailing facility?

Response 146: *In the meadow south of the tailing facility, ground water is very near the surface (only 2-3 feet) and there are several springs in the area where ground water upwells to ground surface. This ground water is likely impacted by tailing seepage in some areas. Additionally, the shallow soil (0-2 feet) in the area is contaminated with molybdenum and ground water monitoring wells also show elevated levels of molybdenum at depth. However, the human health risk from exposure to tailing seepage is through consumption (drinking) and EPA is not aware of anyone that drinks the ground water from the springs or shallow ground in this meadow. The Selected Remedy includes remediation of the ground water south of the tailing facility. The risk from exposure to contaminated soil is only to wildlife and livestock, which is also being addressed by the Selected Remedy. Finally, water samples collected from the acequias did not contain metals at concentrations considered to be harmful.*

Comment 147: The Citizens Ditch Acequia System is served by four main acequias and many laterals, including North Ditch, Molino Ditch, Middle Ditch, and South Ditch. Irrigation water for the *acequias* is diverted directly off the Red River. These four ditches have all been impacted by tailings spills directly into the ditches over the last 40+ years as a result of mining operations yet these spills and their impacts are not addressed. Eagle Rock Lake is fed off of our ditch system. As a result the *acequias* have experienced the same impact as the lake. The ditch users are of the opinion that the sustainable agricultural uses of our lands and parciantes are not being addressed as part of EPA's cleanup plan and are being overlooked by the tourism related impacts of Eagle Rock Lake. Please consider this request to evaluate the impacts from past tailings spills into our *acequias* and the need for reclamation/remediation of our ditch system. In addition, there is a need to monitor surface water quality from water diverted directly onto the land and the associated impacts to crops and livestock. Water from the Red River is key to the future of the residents of Questa.

Response 147: *EPA is aware that both Eagle Rock Lake and the acequia ditches are fed from the Red River. The lake has its own diversion structure off the Red River and its own inflow ditch. Operationally, the two systems are believed to be somewhat different. River flow to the lake is nearly constant, while surface water diversion to the acequias is intermittent and seasonal (during the growing season). Therefore, significantly more water flows to the lake than the ditches. In addition, the ditches are routinely cleaned (or maintained). EPA is aware that sediments and vegetation are removed from the ditch and stockpiled on the levees of the ditches, albeit likely on an irregular schedule. The lake has been drained and cleaned once in its many year history. These operational differences result in the amount of tailing-impacted sediment and spilled tailing that could be/have been conveyed to the acequias and lake, and the amount that has or could accumulate in water bodies. EPA sampled both Eagle Rock Lake and the acequias during the RI between 2002 and 2004. Three ditches were sampled and characterized multiple times at multiple locations along the ditches. Surface water and sediment were collected. Based on this sampling, there was no indication of contamination in the ditch samples. Contamination was detected in sediment samples collected from Eagle Rock Lake. Therefore, Eagle Rock Lake is included in EPA's Selected Remedy.*

4.2.5 Eagle Rock Lake

Comment 148: EPA has proposed Engineering Controls at the inlet structure of Eagle Rock Lake to reduce future sediment load from entering the lake. Who will be burdened with the long-term cost of maintenance and repair of this control to ensure the longevity of the remedy?

Response 148: *Various performance guarantee mechanisms will be negotiated with the PRP(s) within the consent decree for implementation of the remedy. These mechanisms will ensure that long-term care maintenance and repair funding is in place.*

Comment 149: The community encourages EPA to prioritize the clean up and expedite Eagle Rock Lake and the Red River Riparian area. These pieces are relatively easy to design and relatively easy to clean up. We can do good environmental work, and also put folks to work.

Response 149: *The sequencing of the design and remediation components will be addressed in remedial design.*

Comment 150: What type of contamination is in the sediment in Eagle Rock Lake?

Response 150: *The sediment in Eagle Rock Lake has been impacted by aluminum, cadmium, copper, manganese, nickel and zinc (see Section 5.13, Part 2, of this ROD).*

Comment 151: How has EPA sorted out the natural contribution of metals from the upstream scars to the lake sediment from what might have been contributed from the mining operations?

Response 151: *EPA has not estimated what percentage of contamination in Eagle Rock Lake sediment is mining related and what percentage is from the natural scars, nor does EPA intend to. That was not a target of the investigation and, in all likelihood, would be very difficult if not impossible to complete. However, EPA did assess the nature of the contamination in Eagle Rock Lake sediment by conducting a statistical comparison of the sediment data to upper Fawn Lake sediment data. Upper Fawn Lake, which is located in the upper Red River Valley, is the reference background surface water body for Eagle Rock Lake. Based on such statistical comparisons during the RI and risk assessment, contamination in Eagle Rock Lake sediment was significantly above reference background concentrations for several metals and posed a threat to benthic macroinvertebrate populations.*

EPA recognizes that there are sources of contamination from natural hydrothermal scars at and near the mine site that likely contributed some contamination to the Red River as well as Eagle Rock Lake. Additionally, the presence of highly mineralized zones at and in the vicinity of the mine site may also have contributed some contamination to those surface water bodies. However, based on the findings of the RI, as well as the USGS Baseline Study (Report No. 8), mining-related contamination from the Site contributed to the contamination in Eagle Rock Lake sediment. Therefore, the Selected Remedy will remove the mining-related contamination to reduce the risk to benthic macroinvertebrate populations. In removing the mining-related contamination, natural contamination will also be removed as an unavoidable, but environmentally-favorable, consequence of the response action.

Comment 152: Under EPA's proposed remedy, some contaminated sediment will be removed from Eagle Rock Lake and others will be capped with other material. During that process, do they have to drain the lake?

Response 152: *Hydraulic dredging of Eagle Rock Lake sediment is the selected remedy. Capping of sediments was considered in the FS but was not selected as part of the remedy. Capping the sediments would result in contaminants remaining in place, the cap needing long-term maintenance and potentially replacement, as well as the reduction of the overall depth of the lake which would likely increase summer water temperatures and alter oxygen levels.*

Hydraulic dredging to remove the sediment will be performed from a barge. The depth of sediment dredging will be approximately three feet. The sediment will be pumped to a staging area near the lake. The staging area will need to be of sufficient size to temporarily impound the dredged sediment. A temporary berm will be constructed around the staging area to contain the sediment. The sediment will then be mechanically dewatered by a hopper in the staging area to facilitate drying. Excess water will be temporarily impounded then allowed to flow back into the lake. Sediment will be allowed *to dry in the staging area until an appropriate moisture is reached that will allow for haulage and disposal.*

Comment 153: After dredging all the sediment in Eagle Rock Lake, does EPA have a method of preventing any additional sediment from coming into that lake? Regardless of source, will EPA simply eliminate all sediment from going into that lake?

Response 153: *Inlet controls will be installed to manage storm water entering the lake. Engineering controls will be included on the inlet structure to the lake to reduce the sediment load from entering the lake during storm events or other high-flow conditions that entrain sediment in the river. Storm events generate a considerable sediment load in the river that originates from drainages upstream of the mine site, and controls on the inlet will be designed to close the headgate if the sediment load increases. Closing the headgate will be accomplished through the use of specific conductance and turbidity probes that monitor the river water and close the headgate if prescribed values are exceeded.*

Comment 154: Is it just the surface layer of sediment in Eagle Lake that is contributing ill effects to the bottom organisms that the fish eat?

Response 154: *See response to Comment No. 155 below.*

Comment 155: What is the source of toxic constituents? It seems to be implied that they are within the entire section of lake sediments. How are these toxic constituents distributed, in what form, and how do they become dissolved in the lake water? There have been multiple studies of the sediments in Eagle Rock Lake.

Response 155: *EPA, USGS, Molycorp and ONRT have all investigated the sediment at Eagle Rock Lake. During the RI, sediment was sampled near the inlet, middle, and outlet of the lake. Sediment cores were collected and analyzed by USGS as part of its Baseline Study, as well as by Molycorp in an independent study and ONRT. Sediment cores were taken from surface to total depths ranging from 1.5 feet to nearly 5 feet. Geochemical* *analyses of the Molycorp sediment cores showed metals concentrations are highest in the upper 2 feet of the core. The upper 1-2 feet of the core also exhibited an aluminum-rich, semi-gelatinous floc material. Sediment sampling performed during the RI showed the floc material to coat the lake bottom substrate.*

Based on these data, EPA has estimated the upper 2 feet of sediment across the entire lake bottom to be contaminated with metals. The source of the contamination is (1) the acid-rock drainage and metals leaching from the mine site transported via low-pH (acidic) ground water and surface water, (2) tailing spill deposits in the Red River and along the river's floodplain, and (3) natural hydrothermal scar drainage and mineralized rock along the mine site and upriver from the mine site. Dissolved metals in acidic ground water enter the Red River at seeps and springs along the mine site reach as well as upriver from the mine site and are transported to Eagle Rock Lake through in inlet. Metals attached to solids are also transported to Eagle Rock Lake in suspension during storm events and then settle out and become re-deposited in the lake sediments. Although the lake sediments are contaminated with several COCs (metals), aluminum is the only COC identified in the surface water of Eagle Rock Lake.

The USGS Baseline Study indicated a pattern of increasing metals concentrations, including molybdenum, in the sediment core from the early 1960s. This increase correlates with the start of open pit mining and dumping of waste rock in tributary drainages at the mine site. USGS concluded from its geochemical studies that the addition of tailing material spilled from pipeline breaks is most likely responsible for some of the spikes in trace-element concentrations." CMI has refuted some of the findings of the USGS Baseline Study Report (Report No. 8).

Comment 156: Would it be possible to cover (or cap) the bottom sediment so that no high-metal sediment would be exposed to water, assuming a dissolution process is at work, rather than remove all the sediment from Eagle Lake?

Response 156: *See response to Comment No. 152 above.*

Comment 157: What type of dredging is proposed for remedial actions at Eagle Rock Lake: hydraulic dredging from a barge, or drain the lake then excavation?

Response 157: *Hydraulic dredging has been selected because it will have less impact to the lake and recreational use of the lake. Additionally, this type of dredging will be quicker than draining and excavating sediment, since the sediment may take several months to naturally dry to a point where it can be excavated.*

4.3 INSTITUTIONAL CONTROLS

Comment 158: Will EPA further explain what a conservation easement is and what has been deeded to the Village of Questa? Will the village inherit these contamination problems?

Response 158: *A Deed of Conservation Easement (Conservation Easement) is a form of proprietary institutional control. Institutional controls are non-engineered instruments, such as administrative and legal controls, that may help minimize the potential for human exposure to contamination and/or protect the integrity of a remedy if they are effectively maintained and enforced. Institutional controls are intended to reduce exposure to contamination by limiting land or resource use and guide human behavior at a site.*

The Conservation Easement recorded by CMI at the Records for Taos County in May 2009 is intended to prohibit residential use of the mine site property, including the mill area. It is also intended to restrict the use of surface water and ground water, as well as certain construction activities to protect any remedial or reclamation measures required by the EPA or the State of New Mexico. CMI conveyed the Conservation Easement to the Village of Questa and identified the EPA, NMED, and NMEMNRD as third party beneficiaries. By its conveyance, CMI is not giving the property to the village as it is not a transfer of ownership of the property. However, the village is taking on the responsibility of managing those lands for conservation purposes, and the village will be responsible for *monitoring the intended land use for the easement. The Village of Questa does not inherit the contamination problems at the Site by being a party to the easement.*

Although CMI has recorded these proprietary controls, EPA has elected not to include them with the Selected Remedy as they are not necessary to ensure protectiveness (see Section 14.0 of the ROD). This is a change from the Preferred Alternative presented in the Proposed Plan. Rather, EPA has chosen government controls for the Selected Remedy, another type of IC, to reduce exposure to Site contamination. Temporary well drilling restrictions will be sought from the New Mexico Office of the State Engineer to prevent exposure to contaminated ground water while the cleanup of ground water is performed. These well drilling restrictions will be for CMI's property and other land where ground water is contaminated. EPA will also consider enforcement tools with institutional control components to enhance protectiveness, such as requirements in a consent decree or unilateral administrative order to restrict exposure to contaminated media before and during implementation of the remedy. Such tools may include provisions requiring EPA notification prior to a property transfer. EPA has also contemplated using local ordinances, permits, and/or zoning by the local or county governments to protect the integrity of the remedy after it is constructed.

Comment 159: What is an "institutional control" that limits the current and future drinking water wells. However, the specific "controls" are not stated. Do these institutional controls include a clause mandating that CMI pay for testing of private and village municipal wells, including provisions for split-samples by NMED? It will take decades to clean up this Site, and contaminants may migrate to other wells.

Response 159: *The institutional control chosen by EPA to limit exposure to contaminated ground water is a temporary well drilling restriction to be imposed by the New Mexico Office of the State Engineer while ground water is being cleaned up. The well drilling restriction will be imposed on CMI's property as well as other land where there is known ground water contamination. It will not apply to existing wells, but only new well drilling.*

This government control will not include a clause mandating that CMI pay for testing of private and village municipal wells or provisions for split-sampling by NMED. However, EPA has included ground water quality monitoring as a component of the Selected Remedy for both the Mine Site Area and Tailing Facility Area. Such monitoring will allow EPA to delineate any further movement of contamination in ground water while the cleanup is ongoing. Additionally, EPA will offer to sample any private water well within a mile of the Site if so requested by the property owner and if the well is in a potential pathway for ground water contamination. Currently, to EPA's knowledge, there are no private water wells with ground water contamination that are being used as a drinking water supply. EPA has also included in the Selected Remedy the temporary provision of an alternate water supply or point-of-use treatment system (e.g., filter at tap) to any person using ground water as a drinking water supply where Site-related contaminant levels exceed drinking water standards or EPA health-based criteria. EPA believes the ground water monitoring program combined with private well sampling and provisions for temporary alternate water supplies will protect the community during implementation of the ground water remedy.

4.4 COMMUNITY ISSUES

Comment 160: The community insists that a thorough and complete clean up of the Site is needed to minimize our problems in the future.

Response 160: *EPA is committed to protecting human health and the environment at this Site. The selected remedy when implemented will provide long-term protection to the community.*

Comment 161: The community strongly urges EPA to require Chevron Mining to hire locally for staffing the remedial efforts. The preferred remedy is likely in the range of $200 to $700 million worth of work. It would be tragic to have someone other than the people in the local area staff this work. Can EPA require local employment? Over 240 staff were laid off from the mine, and this local employment is needed to bring revenues to our small town and Taos County. We are the community that has been impacted, so it from an environmental justice standpoint, local contractors and local residents should be hired, rather than bringing in out-of-state contractors.

Response 161: *If a settlement (consent decree) is successfully negotiated for the PRP(s) to perform the cleanup work or EPA directs the PRP(s) to perform the work under a unilateral administrative order (see response to Comment No. 38 above), the PRP(s) will make decisions concerning the hiring of contractors and subcontractors to complete the remedy. The amount of work that has to be done at this Site equates to a major construction project and it is highly likely that the cleanup effort will create jobs. However, EPA does not have any authority to mandate a company to hire local resources but will encourage it to do so if appropriate.*

Comment 162: Taos County has passed Resolution No. 2010-14, which states under Section 2 that the County respectfully requests that CMI and EPA identify the development of a local work force as a top priority in its attempt to reach a mutually acceptable resolution, thereby creating employment opportunities for those most profoundly impacted by the environmental effects of the mining operations.

Response 162: *EPA acknowledges the passing of Resolution No. 2010-14 by Taos County. See response to previous comment regarding employment opportunities.*

Comment 163: Is there any chance of subsidies, alternative funding mechanisms, or waivers to help our local contractors with the bonding or insurance requirements? This would help West Taos County contractors to be retained to the reclamation and in turn preserve or boost the local economies of Questa and Taos County.

Response 163: *It is highly unlikely that bonding or insurance requirements could be subsidized or waived. These financial tools ensure that contractors perform to a certain standard of prudence and quality to avoid rework. It may be possible to divide the work* *into smaller pieces in some areas to minimize insurance and bonding requirements, but EPA cannot require that of the CMI, if it is performing the cleanup.*

Comment 164: What is the opportunity for public involvement during and after the ROD? Does the public review the ROD?

Response 164: *Typically, the ROD is not released as a draft document for public review. Once signed by EPA, it represents EPA's decision on the remedy and it is final. After issuance of the ROD, EPA plans to meet with the public and other stakeholders to review the Selected Remedy and discuss the significant changes from the Preferred Alternative presented in the Proposed Plan. In addition, EPA will seek community involvement throughout the cleanup process, which consists primarily of the remedial design and remedial action. As part of this effort, EPA will meet with the public during the remedial design as well as during implementation of the remedy. For more information concerning EPA's community involvement activities please refer to the Superfund Community Involvement Handbook at http://www.epa.gov/superfund/community/cag/pdfs/ci_handbook.pdf.*

Comment 165: The Village recommends that a stakeholder review board be convened. Participants would comprise of technical experts representing key stakeholders to evaluate the findings of the follow on technical work. The review board would provide recommendations.

Response 165: *If EPA is successful in negotiating a settlement for the PRP(s) to implement the remedy, such work will be solely under the direction and decision making of EPA. Additionally, EPA plans to assemble its own team of experts for this project. However, EPA has every intention of involving key stakeholders in the remedial design and remedial action process, including the Village of Questa and the R3G. Such involvement would include review of documents and attendance at meetings by key technical representatives, as determined appropriate by EPA. To coordinate this effort, EPA plans to hold several meetings with stakeholders prior to the start of the remedial design work to* *discuss the details and degree of stakeholder involvement. The first meeting will likely be scheduled soon after issuance of the ROD so that EPA can present the Selected Remedy and address any questions or concerns stakeholders may have regarding work to be performed and next steps in the cleanup process.*

Comment 166: The technical advisors to the R3G have had difficulty participating in important meetings and receiving first draft material upon which to comment. Does EPA intentionally exclude them? It seems EPA Region 6 typically says "this is the way the EPA works". However, these same technical advisors have worked on other Superfund mining sites in other regions, and this issue was quickly resolved. Because negotiating, planning, and design are still ahead of us, this situation should be resolved.

Response 166: *EPA made a significant effort to involve the R3G and other stakeholders throughout the RI/FS process, as described in detail in Section 3.0, Part 2, of this ROD. At the start of the RI/FS, EPA agreed to provide draft final documents to stakeholders, including the public, for review and comment. Soon thereafter EPA formed the Questa Community Coalition (QCC) to enable technical representatives from the R3G, Amigos Bravos, the Village of Questa and other key stakeholders to meet with EPA, the State of New Mexico and CMI to discuss the RI/FS. EPA has every intention of seeking involving by the R3G and other stakeholders, including the public, throughout the remedial design and remedial action. See response to previous comment on meetings to be held and review of documents.*

Comment 167: EPA needs to include a committee of native Questenos to be part of the decision making process in every phase of the clean-up. In addition, EPA needs to make the citizens of Questa and Taos County aware of the mandatory federal protocols in place to proceed with the clean-up of this Superfund site.

Response 167: *EPA has involved the local community at the appropriate milestones of the RI/FS, as dictated by federal guidelines. In fact, EPA has exceeded the requirements with numerous additional public meeting, community availability sessions, and Informational*

Bulletins in an attempt to keep the local residents informed and engaged in the process, findings and path forward. Also, as mandated, EPA has made the require milestone documents available though the local repository. To the extent that these documents have been used, EPA appreciates the involvement of the general public and local government officials at these meetings and the contributions to the proposed actions by submitting comments throughout the process. EPA will continue to involve the citizens of Questa and Taos County throughout the remedial design and remedial action.

Comment 168: Why does EPA only recognize the R3G as the only viable organization which can offer advice or direction during the clean-up? The group is self-appointed, rather than formed by an open or legitimate democratic process. And, because it is funded by EPA, the integrity of the group and its ability to truly represent the indigenous citizens of Questa is compromised.

Response 168: *While EPA will continue to work closely with the R3G, the community group awarded the Technical Assistance Grant (TAG), EPA will include all stakeholders in the public input process consistent with its Community Engagement Initiative. EPA has conducted multiple information and availability sessions that were open to all residents in Taos County. These sessions have resulted in EPA receiving valuable input from members of the Questa community other than the R3G. For example, EPA had a conversation with a local resident not affiliated with R3G or its predecessor group, the Rio Colorado Reclamation Committee (RCRC), which led to further investigations and ultimately a proposed clean up of the area south of the tailings facility. Therefore, EPA encourages the commenter to participate in future community involvement activities that EPA will conduct during remedial design and the implementation of the remedy.*

Comment 169: Does the public have access to the analytical results from samples collected from the Site? Can the public determine independently what is elevated or what analytical tests were conducted?

Response 169: *All of the analytical data collected as part of this investigation is included in the Administrative Record. There are 1,600 documents included in the record, and it exists on DVD at the Village of Questa municipal offices. EPA encourages the public to review it. For summary information, the RI Report discusses the areas of the Site, the media impacted, the type and concentration of contaminants, and the extent of impacts.*

Comment 170: The RCRC questions why there was no representation from EPA or CMI at the last meeting for the public. There was no one to take note of our concerns. EPA representatives in Dallas, Texas, do not seem to care about the residents of Questa. Instead, the Proposed Cleanup Plan is for the benefit of the mining company responsible for much of this contamination, as well as the corrupt politicians. The Plan is what CMI wants to hear.

Response 170: *EPA is not aware of any federally-sponsored meeting that was not attended. Between December 2009 and February 2010, EPA held three public meetings that EPA, the State of New Mexico, CMI, and other stakeholders attended which provided information concerning Site operations, the process of remedy selection, and EPA's preferred remedy for the Site. Specifically, these meetings were conducted January 21 (two meetings) and February 23, 2010 (one meeting) in Questa, NM. Over 200 people collectively attended the meetings.*

EPA was notified of two RCRC meetings that were held during the formal Public Comment Period on EPA's Proposed Plan. However, EPA elected not to attend those meetings because EPA had already conducted the previous three public meetings and any comments made to EPA at the RCRC meetings would have to have been documented by a Court Reporter in meeting transcripts for the Administrative Record.

Comment 171: What type of opportunities will exist long-term in Questa? How can the leadership of Questa encourage kids to stay and live in Questa and earn a living? What type of education do you think they should pursue - post mining activity

Response 171: *EPA anticipates that engineering, sciences, and trade disciplines would provide skill to support the remedy. With remediation activities there would be earth work, construction, design, monitoring, and maintenance of water treatment systems for the long term. EPA also has a Superfund jobs initiative, which is a jobs training program. EPA can look into this program once cleanup activities begin.*

EPA is committed to ensuring the remedy is implemented so that protection of human health and the environment for the citizens of Questa will be achieved. EPA anticipates that the quality of life for the residents of Questa will be enhanced as a result of the remedy and will lead the leadership of Questa to encourage the development of educational and commercial opportunities for future generations.

Comment 172: The community is concerned about existing contamination in close proximity to the local school. Questa has got an 80.4 percent [*not sure this number was recorded accurately as 80 percent seems like a high number; however, this cannot be confirmed*] percent graduation rate; these kids are not learning. We believe it is related to the dust is coming off the tailing facility. We have many kids in special education. The school board cares for those kids. EPA gives us a bunch of promises for action, start times, clean up goals, but nothing has happened.

Response 172: *As part of the RI, EPA performed air monitoring along the perimeter of the tailing facility, and CMI has continued with the air monitoring program ever since. The air data collected show particulate levels to be low and not at a level that would pose potential harm. ATSDR also concluded in its 2005 Public Health Assessment that wind-blown dust coming off the tailing facility did not present any health issues at that time. However, EPA recognizes that the tailing dust has been a problem for the Questa community historically and EPA is still concerned that dust blown from the tailing facility could pose health concerns if not adequately controlled. Therefore, EPA has included air monitoring at the perimeter and beyond the perimeter of the tailing facility as part of the Selected Remedy. EPA also specified in the ROD that CMI will be required to prepare and implement a contingency plan for better dust suppression if air monitoring data show* *exceedances of air quality standards for particulate matter of 10 and 2.5 microns in size (i.e., PM_{10} and $PM_{2.5}$) beyond the perimeter of the tailing facility.*

The Selected Remedy includes placement of a soil cover on top of the tailing impoundments and revegetation, which will reduce wind-blown tailing dust for the long term. However, the cover will not be constructed until the permanent cessation of tailing disposal operations. In the interim, current or improved dust suppression measures will be relied upon to reduce air particulates and protect the community.

Comment 173: One resident commented on an unauthorized placement of rubble and boulders on his/her former property along the mine site reach of the Red River by mine personnel to prevent flooding of State Highway 38. Details of placement and observed impacts to the property and river flow from a historic perspective were provided. It was reported that nothing would grow on the material and it altered the flow of the river.

Response 173: *EPA appreciates the commenter providing this historical information.*

Comment 174: During the remedial action phase, there will be an impact on all the village roads. Is there a provision for CMI to set aside funding to maintain roads for the Village of Questa?

Response 174: *During remedial design, various issues such as restrictions on road use, site access, impacts on current infrastructure, and health and safety concerns will be addressed and incorporated into remedial action activities. If it is determined that maintenance or repairs will be required on roads in the Village of Questa due to increased truck traffic or other activities, then appropriate mechanisms will be put in place to ensure that the necessary maintenance activities will be implemented.*

Comment 175: Between 2002 and 2006, the Village Council discovered there were some public supply water lines that were bedded in tailing. There were efforts to address some of the lines, but not all the tailing bedding was removed and replaced. Who is responsible for covering the cost of replacing the bedding in lines that are active?

Response 175: *The Village of Questa is responsible for maintaining the municipal water supply distribution system. EPA investigated the potential impact of Questa water supply lines bedded in tailing by sampling the water at several residential taps. The analytical results showed the tap water met all drinking water standards. Therefore, the Selected Remedy does not include replacement of the bedding material for the water supply pipes.*

Comment 176: The entire community in the greater Questa area are aware that community advocacy groups including Amigos Bravos and the R3G have historical knowledge of the mine's operations and discharges, and that they have concerns regarding the details of EPA's proposed remedy for the Site. The community-at-large requests that EPA pay special attention to the concerns of these organizations.

Response 176: *EPA has received comments regarding the proposed remedy from various advocacy groups, including Amigos Bravos and the R3G. EPA has thoroughly considered their input as well as all other comments received from the public in developing the remedy. EPA has also worked closely with Amigos Bravos and the R3G throughout the RI/FS and community involvement process to date and will continue to do so through the remedial design and remedial action phases of the project.*

Comment 177: The community requests that EPA include an additional Alternative that incorporates closure of the tailing facility. Excluding an alternative that addresses closure of the tailing facility allows pollution of groundwater to continue indefinitely. Without a closure alternative, EPA's remedy may be out of compliance with CERCLA's statutory requirements to be protective of human health and the environment, utilize permanent solutions and alternative treatment technologies, and satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principle element. For these reasons, the current method for disposing and treating tailing should be terminated and the tailing facility should be closed and future mine-waste disposal discontinued. The tailing facility should then be capped and reclaimed as planned

Response 177: *As stated above, the tailing facility has been permitted for operation by the State of New Mexico, and is currently operating under permit (DP-933). EPA has very limited jurisdiction over a compliant, operating facility.*

4.5 RED RIVER STATE FISH HATCHERY

Comment 178: There have been people living at the fish hatchery for over 50 years, and they have been drinking water from that immediate area for many, many years. What is being done to determine if the potable water source is contaminated?

Response 178: *The source of potable water used at the Red River State Fish Hatchery is the ground water from Spring 18 which originates about a half mile upstream of the hatchery, within the Red River Gorge, and is formed by the upwelling or flow of ground water from the basal bedrock (volcanic) aquifer. The hatchery is located about a mile downriver of the tailing facility. The aquifers in the areas of the springs are impacted by tailing seepage.*

Based on the analytical results from monthly sampling of the ground water by NMED since December 2009, the molybdenum concentrations were just below the preliminary remediation goal of 0.08 milligrams/liter. Preliminary remediation goals are initial cleanup goals that are protective of human health and the environment. Based on NMED's data, trends in molybdenum concentrations over time are increasing. Recently, at the request of hatchery personnel, CMI began providing bottled water to the hatchery since June 2010. At this time, the EPA is not aware of anyone being exposed to contaminants in ground water at levels above federal/state standards or the EPA's health-based criteria.

NMED is currently monitoring water quality at the hatchery residential taps or other structures. A monitoring program will be implemented during the remedial action. It will *be developed during the remedial design and shall include, at a minimum, analysis of molybdenum, sulfate, uranium, and other contaminants.*

Performance monitoring will be conducted, during the remedial action, downgradient (i.e., south and west) of Dam No. 4 and south of Dam No. 1 to assess the effectiveness of the remedial actions on reducing contaminant concentrations in the ground water to cleanup levels in the basal bedrock (volcanic) aquifer, the source of potable water at the hatchery. Monitoring will include all seeps and springs in these areas. The performance monitoring program will be developed during remedial design.

Temporary actions will be taken to protect any persons using ground water as a drinking water supply in areas where Site-related contaminant levels in ground water exceed federal or New Mexico drinking water standards (MCLs) or the EPA's health-based criteria. Such action may be provision of an alternate water supply to the affected homes or businesses, or installation and maintenance of point-of-use treatment systems (e.g., filter at tap) in the homes or businesses. The actions will continue until ground water cleanup levels have been attained. If concentrations of molybdenum or other contaminants increase to levels which exceed the EPA's health-based criterion, an alternate water supply will be provided, or a point-of-use treatment system will be installed, at the hatchery until ground water cleanup levels are attained.

Additionally, because the Selected Remedy results in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted no less often than each five years after the start of the remedy to ensure that it is, or continues to be, protective of human health and the environment. The five-year reviews will include, among other things, a review of the water quality sampling data.

Comment 179: What is the source of the fish hatchery water, and how does it get to the hatchery? Are the fish in the hatchery being raised in clean water?

Response 179: *See response to Comment No. 178 above*

4.6 REMEDIAL INVESTIGATION

Comment 180: EPA should delay the ROD and spend more time characterizing the Site. RCRC is extremely concerned with EPA's RI efforts and their conclusion. At the start of the Superfund process, EPA publically announced there was contamination at the Site, now after ten plus years of study, EPA is trying to say there is no contamination worth the effort of requiring CMI to clean up the Site. RCRC is convinced that EPA-Region 6 is attempting to cover-up for CMI, minimize the effects the contaminants have had on the residents and children of Questa and surrounding areas. We request EPA postpone issuing the ROD until all issues affecting the community and its citizens are addressed with more consideration.

Response 180: *EPA disagrees with the commenter on these statements. Further, EPA does not believe that issuance of the ROD should be delayed as it will only delay the cleanup of the Site.*

The ROD is a legal document that certifies that the remedy selection process was carried out in accordance with the Superfund statute and regulations. Among other things, it is a substantive summary of the technical rationale and background information used in EPA's selection of a final remedy, and a technical document that outlines the technical aspects, the remedial action objectives, and cleanup levels for the Selected Remedy. EPA's ROD was prepared from the information gathered during the RI/FS, which was performed with the strict oversight and direction of EPA.

The Selected Remedy complies with the mandates of CERCLA §121 and the regulatory requirements of the NCP. The Selected Remedy is protective of human health and the environment, complies with federal and state ARARs for the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. The Selected Remedy also satisfies the *statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment).*

Comment 181: A number of residents in the community have a very hard time believing that damage to the Red River and surrounding area is from natural scar materials entering the river from upstream locations. Instead, we residents believe that Molycorp is responsible for the horrible condition of the Red River and the present danger that the stocked fish living in the river are a health risk to anyone eating them. Determining otherwise is merely a clear message that the EPA is not addressing community concerns and needs to be re-staffed.

Response 181: *During the RI, EPA determined that the Red River has been impacted by the mining operations conducted by Molycorp and CMI and has selected a remedy in the Record of Decision for the Red River, riparian, and south of the tailing facility area. However, the EPA also determined that mudflows from natural hydrothermal alteration scars flow directly into the river and severely impact the aquatic habitat of the river. Additionally, the EPA and the New Mexico Department of Game and Fish have determined that the fish in the Red River are safe for human consumption.*

Within the Red River drainage basin are natural areas of hydrothermally altered, brecciated, and highly erosive rock that are locally referred to as natural hydrothermal alteration scars. At least 20 scars are present within tributary drainages along the north side of the Red River Valley, extending from near the town of Red River through the mine site and west to the village of Questa. Upstream of the mine site, the scar-impacted drainages include Straight Creek, Hot-n-Tot Creek, and Hanson Creek. Scars are typically characterized by yellow-stained, easily eroded materials that support little or no vegetation. Field paste pH values range from less than 2.5 to 3.2. These scars are significant in that they represent source areas for debris flows that pose a substantial geologic hazard and have altered the topographic form of the Red River drainage. During *storm events, acidic flow and sediment drain from these scar-impacted tributaries to the Red River and severely impact the aquatic habitat of the river.*

Fish tissue sampling was performed by the EPA and the New Mexico Department of Game and Fish. These fish were gathered from the hatchery. Stocked rainbow trout were collected and analyzed during the remedial investigation to help address any health concerns the community might have with eating these fish. The results of analyses of these fish showed that concentrations of all metals except arsenic were below levels that could present a health risk. Further analysis of arsenic in rainbow trout tissue indicated that it was present in organic forms that have low toxicity and, therefore, posed little or no human health threat. The source of the organic arsenic was determined to be the fish feed used at the hatchery. The New Mexico Department of Game and Fish took immediate steps to ensure that feed used at the hatchery has the lowest possible amount of arsenic to assure the public safety.

For protection of wildlife and livestock in the area south of the tailing facility and wildlife in the Red River riparian corridor, the component of the Selected Remedy for the Red River and riparian and south of the tailing facility area is removal of soil and tailing spill deposits and on-site disposal. The major components of the Selected Remedy for these areas are:

- *Excavate soil contaminated with molybdenum south of tailing facility and tailing spill deposits along the Red River riparian corridor, including the large tailing pile at the Lower Dump Sump;*

- *Dewater soil in area south of tailing facility and stabilize excavated soil;*

- *Transport and dispose excavated soil and tailing at the tailing facility; and*

- *Backfill excavations with alluvial soil.*

Red River water quality is being addressed through response actions at the mine site area to reduce contaminants entering the river from ground water at seeps and springs, including source control measures for the waste rock piles. However, the following performance monitoring of the Red River is included as a component of the Selected Remedy for the Red River, riparian, and south of tailing facility area:

- *Perform physical, chemical and biological monitoring of the Red River to assess effectiveness of response actions at the Mine Site Area on improving Red River surface water quality and protecting aquatic life.*

Additionally, because the Selected Remedy results in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted no less often than each five years after the start of the remedy to ensure that it is, or continues to be, protective of human health and the environment. The five-year reviews will include, among other things, a review of the Selected Remedy for the Red River and riparian and south of the tailing facility area.

Comment 182: Was there any consideration to evaluate the acequia system and any rehabilitation that might be necessary related to impacts that have occurred in the past?

Response 182: *The EPA is aware that the community is concerned of exposure to tailing from the numerous historic tailing spills from pipeline breaks which resulted in tailing being deposited in the Red River and the acequias, or irrigation ditches, which receive water from the Red River. These concerns were communicated to the EPA through the community outreach efforts performed during the Remedial Investigation and Feasibility Study (RI/FS).*

During the RI/FS, the EPA collected surface water and sediment samples for analyses from several acequias and irrigation return flow ditches and select reference background areas that had not been affected by mining operations. The analytical parameters selected for *analysis of surface water and sediment samples generally included metals, inorganic chemicals, biological oxygen demand and chemical oxygen demand, hexavalent chromium, particle size distribution, acid volatile sulfide/simultaneously extracted metal, volatile and semi-volatile organic compounds, polychlorinated biphenyls, explosives, and dioxins/furans.*

Surface water and sediment from the acequias and irrigation return flow ditches were characterized. The acequia and irrigation return flow water had neutral pH with values ranging from about 6.5 to 8. Specific conductance values for the irrigation return flow were somewhat higher than the acequia water and indicate that the irrigation return flow mixes with shallow ground water south of the tailing facility near the Red River. The water table is less than a foot below the ground's surface where the samples were collected. Several metals were initially identified as human health and ecological contaminants of potential concern for surface water and sediment in each of these areas, based on comparison to the EPA's screening level criteria. However, based on the EPA's baseline human health and ecological risk assessments, there are no contaminants of concern in the surface water and sediment of any of the acequias or irrigation return flow ditches that pose a risk to human health or the environment.

Additional sampling was performed by the EPA in 2005 after concerns were expressed by two Questa residents that ditch water quality on their properties had an unusual cloudy appearance and surficial foamy substance. The EPA collected surface water samples from the North (Embargo) and South irrigation ditches. Sampling was also conducted upstream and downstream of these properties in close proximity to the property boundaries and at headgate structures that divert water from the Red River into the irrigation ditches. Analytical results of samples collected at selected locations from the North and South irrigation ditches indicate that low levels of diesel-range organics (DROs) were detected in several samples. However, higher concentrations of DRO were detected downstream of the headgate indicating that the source of DRO in the South Ditch surface water is most likely not mine site-related. DRO was also detected at low levels in Cabresto Creek upstream from where it confluences with the North Ditch. Unlike the South Ditch, *Cabresto Creek drains an area undisturbed by mining activities and as such, was used as a reference area to collect samples for the RI/FS. The low level of DRO present in the sample suggests that the source of this compound may be also due to farming activities along or near Cabresto Creek. No gasoline-range organics were detected in any samples and most of the metals were either not detected, or were qualified concentrations in all of the samples. The metals that were detected were measured at concentrations well below human health risk-based screening levels for the surface water media.*

Comment 183: EPA is saying there is no contamination in the acequias that are sourced from Red River, yet the insects in Eagle Rock Lake supposedly are dying. People are irrigating off the acequias for ranching and gardens, and EPA is saying there is no contamination in that water that is going into the garden produce. Can you show me where EPA took samples along the acequias, when the samples were taken, and will there be any follow-up sampling?

Response 183: *The EPA is aware that the community is concerned of exposure to tailing from the numerous historic tailing spills from pipeline breaks which resulted in tailing being deposited in the Red River and the acequias, or irrigation ditches, which receive water from the Red River. These concerns were communicated to the EPA through the community outreach efforts performed during the Remedial Investigation and Feasibility Study (RI/FS).*

During the RI/FS, the EPA collected surface water and sediment samples for analyses from several acequias and irrigation return flow ditches and select reference background areas that had not be affected by mining operations. The location of these areas can be found in the Remedial Investigation Report included in the Administrative Record for the Site which is available for review by the public at the city of Questa offices. The analytical parameters selected for analysis of surface water and sediment samples generally included metals, inorganic chemicals, biological oxygen demand and chemical oxygen demand, hexavalent chromium, particle size distribution, acid volatile sulfide/simultaneously *extracted metal, volatile and semi-volatile organic compounds, polychlorinated biphenyls, explosives, and dioxins/furans.*

Surface water and sediment from the acequias and irrigation return flow ditches were characterized. The acequia and irrigation return flow water all had neutral pH with values ranging from about 6.5 to 8. Specific conductance values for the irrigation return flow were somewhat higher than the acequia water and indicate that the irrigation return flow mixes with shallow ground water south of the tailing facility near the Red River. The water table is less than a foot below the ground's surface where the samples were collected. Several metals were initially identified as human health and ecological contaminants of potential concern for surface water and sediment in each of these areas, based on comparison to the EPA's screening level criteria. However, based on the EPA's baseline human health and ecological risk assessments, there are no contaminants of concern in the surface water and sediment of any of the acequias or irrigation return flow ditches that pose a risk to human health or the environment.

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For protection of wildlife and livestock in the area south of the tailing facility and wildlife in the Red River riparian corridor, the component of the Selected Remedy for the Red River and riparian and south of the tailing facility area is removal of soil and tailing spill deposits and on-site disposal. The major components of the Selected Remedy for these areas are:

- *Excavate soil contaminated with molybdenum south of tailing facility and tailing spill deposits along the Red River riparian corridor, including the large tailing pile at the Lower Dump Sump;*
- *Dewater soil in area south of tailing facility and stabilize excavated soil;*
- *Transport and dispose excavated soil and tailing at the tailing facility; and*
- *Backfill excavations with alluvial soil.*

Red River water quality is being addressed through response actions at the mine site area to reduce contaminants entering the river from ground water at seeps and springs, including source control measures for the waste rock piles. However, the following performance monitoring of the Red River is included with the component of the Selected Remedy for the Red River, riparian, and south of tailing facility area:

- *Perform physical, chemical and biological monitoring of the Red River to assess effectiveness of response actions at the Mine Site Area on improving Red River surface water quality and protecting aquatic life.*

Additionally, because the Selected Remedy results in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and *unrestricted exposure, a statutory review will be conducted no less often than each five years after the start of the remedy to ensure that it is, or continues to be, protective of human health and the environment. The five-year reviews will include, among other things, a review of the Selected Remedy for the Red River and riparian and south of the tailing facility area.*

Comment 184: EPA's proposed remedy does not address the presence of buried tailings in the Questa water system, (bedding), acequias, and public driveways.

Response 184: *As stated by the commenter, EPA's Selected Remedy does not address the presence of buried tailings in the Questa water system (e.g., the bedding), acequias, or public driveways. EPA believes that the potential risk to human health from exposure to tailing (direct contact or incidental ingestion) is below levels which are considered to be harmful by EPA. EPA has not identified tailing within the acequias or under driveways; however, during the remedial investigation, EPA collected surface water and sediment samples for analyses from several acequias and irrigation return flow ditches. The EPA has also sampled several private water wells at the request of the residents. It should be noted that if tailing exists under driveways it would not be available for human exposure and would not present a risk to human health.*

EPA is aware that the community is concerned of exposure to tailing from the numerous historic tailing spills from pipeline breaks which resulted in tailing being deposited in the Red River and the acequias, or irrigation ditches, which receive water from the Red River. These concerns were communicated to EPA through the community outreach efforts performed during the Remedial Investigation and Feasibility Study (RI/FS).

During the RI/FS, EPA collected surface water and sediment samples for analyses from several acequias and irrigation return flow ditches and select reference background areas that had not been affected by mining operations. The analytical parameters selected for analysis of surface water and sediment samples generally included metals, inorganic chemicals, biological oxygen demand and chemical oxygen demand, hexavalent chromium, *particle size distribution, acid volatile sulfide/simultaneously extracted metal, volatile and semi-volatile organic compounds, polychlorinated biphenyls, explosives, and dioxins/furans.*

Surface water and sediment from the acequias and irrigation return flow ditches were characterized. The acequia and irrigation return flow water all had neutral pH with values ranging from about 6.5 to 8. Specific conductance values for the irrigation return flow were somewhat higher than the acequia water and indicate that the irrigation return flow mixes with shallow ground water south of the tailing facility near the Red River. The water table is less than a foot below the ground's surface where the samples were collected. Several metals were initially identified as human health and ecological contaminants of potential concern for surface water and sediment in each of these areas, based on comparison to the EPA's screening level criteria. However, based on the EPA's baseline human health and ecological risk assessments, there are no contaminants of concern in the surface water and sediment of any of the acequias or irrigation return flow ditches that pose a risk to human health or the environment.

EPA is aware that residents of the village of Questa are concerned with the possibility that tailing was used as bedding material for the municipal water supply pipes that could potentially contaminate the drinking water in their homes if the pipes were damaged (cracked) and allowed tailing to slough into the line.

Monthly sampling and analysis of the ground water demonstrates that the municipal wells operated by the village of Questa are not contaminated and are in compliance with drinking water quality standards. During the remedial investigation, the EPA offered to sample any private well located within two miles of the mine site or tailing facility or along the tailing pipeline if requested by the owner of the well. At the December 2004 community meeting in Questa, several residents informed the EPA of their interest in having their private wells sampled. Over twenty other residents asked to have their private wells sampled, but did not want EPA or the state to perform the sampling. The Village of Questa offered to sample those residents' private wells. EPA sampled several private wells in July

2005 as requested by the residents. The laboratory analytical results, provided to the property owners in August 2005, showed no exceedances of federal or state drinking water quality standards. The EPA is aware that the Village of Questa cancelled the scheduled sampling of private wells for the more than twenty residents who requested that the Village of Questa perform the work.

Also, in February 2000, the Village of Questa, working with the U.S. Forest Service, was conducting activities to remove water and silt from Hunt's Pond. These activities led to the discovery of tailing mixed with organic material beneath two feet of black organic matter. Molycorp excavated the tailing mixture from the pond and transported it to the tailing facility for disposal. According to Molycorp, the source of the tailing was likely the result of a tailing spill incident in the late 1960s or early 1970s. On November 17, 2003, the Taos County Soil and Conservation District (SCD) excavated a trench from Hunt's Pond to the Red River in order to drain water and sediment from the pond. The purpose was to remove algae and other organic matter from the pond. The contractor for SCD performing the excavation notified Molycorp of the discovery of tailing within the trench. Molycorp officials visited the site and reported observing a material that "appeared to be tailing" at three locations in the trench: a thin 1- to 2-inch deep layer on the bottom of the trench, and a one-foot thick band along both walls of the trench near the bottom of the excavation. The tailing material was removed from the trench and disposed at the tailing facility. A small sample was taken to the Molycorp assay lab for analysis and the results showed the molybdenum sulfide content was consistent with typical tailing.

Because the Selected Remedy results in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted no less often than each five years after the start of the remedy to ensure that it is, or continues to be, protective of human health and the environment. The five-year reviews will include, among other things, a review of any new information related to contamination from the tailing.

Comment 185: Has EPA located and does EPA plan to remediate the used oil dumped that was used at the power plant? Those power plant motors held over 500 gallons of oil and the spent oil had to be contained or disposed of somewhere. Former employees know that the company had a truck and would take the oil somewhere and dump it. There were thousands of gallons out of that power plant for the period of time the power plant was running.

Response 185: *In a letter dated August 15, 2003, the RCRC technical advisor notified the EPA and NMED of an allegation made by former employees of Molycorp that there were buried petroleum waste dumps at the mine site. The EPA, NMED, and Molycorp discussed the allegation with the technical advisor and a Site visit was conducted with the resident making the allegation to identify the area of alleged dumping. A comparison of the dumping area and the remedial investigation sampling locations was performed to determine if any additional sampling was necessary. Based on that comparison, the EPA determined that no additional sampling was required beyond what had already been performed. On April 26, 2004, EPA provided the RCRC technical advisor with the preliminary organics data from surface water and ground water samples collected in the vicinity of the alleged dumping area, as well as all other known landfills at the mine site. The analytical data showed low levels of petroleum contamination which did not warrant further action.*

In 2004, Molycorp removed two underground storage tanks containing gasoline and used oil and 53 old aboveground storage tanks, along with visibly stained soil associated with past releases from the tanks under the direction and oversight of NMED. The underground and aboveground storage tanks were located in the Aboveground Storage Tank Containment Area at the old open pit shop (former truck shop) at the mine site. Soil was contaminated with gasoline- and diesel-range organics (GROs and DROs), volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). The maximum depth of excavation in the vicinity of the aboveground storage tanks was 12 feet. Confirmatory soil sampling from the aboveground storage tank excavations indicated residual concentrations of DROs ranged from 30 to 2,000 milligrams/kilogram. The *maximum depth of excavation beneath the underground storage tanks was 25 feet. Confirmatory sampling from the underground storage tank excavations showed low levels of some VOCs and PAHs. The NMED required no further action. All petroleum-contaminated soil and tanks were shipped off-Site for disposal at a permitted facility in Colorado.*

Comment 186: The cumulative effect of point source and non-point source contamination on the entire affected Red River watershed with regard to the surface water, groundwater, soils, plant uptake, and aquatic life needs to be addressed. Attention must be given to existing regulatory standards for safety to life forms.

Response 186: *EPA is not planning to investigate the cumulative effects of point source and non-point source contamination on the entire Red River watershed. Under its Superfund authority, EPA's investigation focused on the areas of the watershed that could have been impacted by the mining operations conducted by Molycorp and CMI and performed limited off-site sampling for background or reference evaluations. EPA agrees that other sources of contamination to the Red River watershed exist, including but not limited to, other abandoned mines and hydrothermal scars. Characterization of these other source areas is beyond the scope of this response.*

Comment 187: Regarding biological monitoring and biological criteria for water quality, it seems that EPA has minimized cold water aquatic criteria but human health criteria are prominent. As you know, the criteria for fisheries are more stringent for many contaminants of concern than for human health (drinking water). Copper is a prime example; relatively little work was done on copper in EPA's study, and copper concerns seem to be minimized. The toxicity of aluminum is clear and reasonably addressed by the aluminum total maximum daily load (TMDL), but other possibly toxic metals should be part of the reclamation plan.

Response 187: *EPA agrees with the commenter that state water quality standards or criteria or federally recommended water quality criteria established under the Clean*

Water Act for protecting aquatic life are often more stringent that those standards or criteria established for protecting human health. However, EPA disagrees that "relatively little work was done…." for select metals in the RI. Significant sampling and analysis of the surface water, sediment, aquatic biota within the Red River was completed. Hundreds of Red River samples were collected and analyzed for metals and other inorganics (including target analyte list metals). Analysis included both total metals and dissolved metals, as appropriate. Sampling was performed between Fall 2002 and Summer 2004 from 45 sampling stations that spanned from the headwaters of the Red River, past the mine site and tailing facility to the Red River State Fish Hatchery. Concentrations of copper, cadmium, lead, zinc, aluminum and 15 other metals and inorganic chemicals were measured and compared to EPA screening level criteria comprised of toxicity reference values, numeric state water quality standards and federally recommended water quality criteria. Concentrations of those metals that were hardness dependant were adjusted to specific Red River water hardness values measured upstream, along, and downstream of the site to ensure the variable hardness in the Red River was accounted for in the toxicity evaluations.

Additionally, the ecological risk assessment performed by EPA evaluated multiple lines of evidence to assess potential adverse effects (survival, growth, reproduction) to aquatic life and aquatic-dependent life of the Red River.

Based on the findings of the RI and EPA's BERA, aluminum, copper and cadmium were identified as COCs for Red River surface water. However, the risk posed by copper and cadmium is less significant than aluminum. Therefore, EPA has only selected a cleanup level for aluminum in Red River surface water. The remedial measures selected to reduce aluminum concentrations in the river (i.e., drain collection systems at Springs 13 and 39) will also reduce the amount of copper, cadmium, and other metals that enter the river at these zones of ground water upwelling.

Comment 188: Uranium is present in tailing seepage south of Dam No. 1, but was not adequately addressed in the RI/FS and risk assessment processes. Uranium levels consistently exceed the drinking water standard (MCL = 0.03 mg/L) in three monitoring wells (MW-26, MW-29, and MW-9A), three extraction wells (EW-5A, EW-5D, and EW-6), the East Seep, and Seep Barriers 001 and 003. These wells and seeps are situated in the upper alluvial aquifer south of Dam No. 1. Background levels of uranium in the upper alluvial aquifer, as characterized by monitoring wells upgradient and east of the tailing facility (MW-20 and MW-21), generally have uranium concentrations less than or equal to 0.01 milligrams per liter (mg/L). Upper alluvial wells having “elevated” uranium concentrations (about 0.02 mg/L), coincide with the mapped tailing seepage contaminant plumes south of Dam No. 1, in the east drainage southeast of Dam No. 4, and in the Change House area. These elevated uranium concentrations clearly show that the source of the uranium is tailing seepage.

Response 188: *EPA agrees with the commenter that uranium is present in the tailing seepage south of Dam No. 1 and that it was not adequately addressed in the Remedial Investigation and Feasibility Study and risk assessments. However, the uranium levels have not consistently exceeded the federal maximum contaminant level (MCL) of 0.03 milligrams/Liter (mg/L) in three monitoring wells, MW-26, MW-29, and MW-9A, as noted by the commenter. Over a two-year period, from the second quarter of 2008 to the fourth quarter of 2009, only monitoring well MW-9A shows uranium concentrations consistently above the MCL for this entire period. Concentrations in the other wells fluctuated above and below the standard. At MW-26, the uranium concentrations have been above the standard in only 2 of 7 sampling events. Additionally, the two most recent sampling events show that the uranium concentrations have fallen well below the standard, to 0.011 and 0.016 mg/L. There has been less of a fluctuation in MW-29, where concentrations have departed only slightly from the MCL. Recent data show the uranium concentrations are at or slightly above the standard at 0.031 mg/L.*

With the exception of one data point below the MCL in the Barrier 001 Seepage interception system, concentrations of uranium in the East Seep, Barrier 003, and extraction wells EW-5D and EW-6 are consistently above the MCL. The data in EW-6 and

Barrier 003 appear to exhibit a downward trend, while concentrations in EW-5D appear to be increasing.

EPA also agrees with the commenter that the source of uranium contamination in the ground water to the south of the tailing facility is due to seepage from the impounded tailing. This conclusion has been acknowledged by CMI in the report titled, "Characterization of Uranium Concentrations in Water at the Questa Mine Tailing Facility" (February 26, 2009). However, both the uranium and sulfate plumes appear more extensive than depicted in this report.

In addition to uranium contamination in the upper alluvial aquifer, there is some indication that the deeper bedrock aquifer system is also contaminated with uranium. This conclusion is based on elevated levels of uranium in MW-1, which is completed in the basal volcanic bedrock. Uranium concentrations in this well have exceeded the MCL several times during 2008 and 2009. Elevated sulfate concentrations above the NMED standard of 600 mg/L are also present in this well.

EPA believes that the Selected Remedy will adequately mitigate uranium contamination, as well as other contaminants in the alluvial aquifer south of the tailing facility. However, further investigation and monitoring of uranium contamination in ground water at the tailing facility, as well as the mine site, will be conducted as part of EPA's CERCLA response action described in the ROD. The existing ion exchange treatment plant located south of Dam No. 4 will be used for treatment of extracted ground water. A new treatment facility will also be constructed if necessary. Modifications may be necessary if contaminants in ground water, in addition to molybdenum, require removal (e.g., uranium). Ground water monitoring and general site maintenance will continue as a part of the Selected Remedy. The monitoring program will be reassessed during the remedial design and modified if required by EPA. The ground water monitoring program will, at a minimum, be consistent with the monitoring requirements of Ground Water Discharge Permit DP-933 and include all wells at the tailing facility area. Seeps and springs will *also be monitored. Radionuclides (e.g., uranium, thorium) will be added to the list of analytical parameters to be monitored.*

EPA believes that the Selected Remedy will address the uranium contamination in the alluvial and basal bedrock (volcanic) aquifers. The Outfall 002 seepage interception system located south of Dam No. 1; which consists of a combination of drains, seepage barriers, and extraction wells; and the Outfall 003 seepage interception system; which includes seepage barriers across the drainage on the eastern slope of Dam No. 4 and an extraction well EW-1; will be upgraded to reduce or eliminate seepage bypass. The upgrade to the Outfall 002 system includes installation of new ground water extraction wells across the Dam No. 1 arroyo just downgradient of the location of the existing lower 002 seepage barrier. The upgrade to the Outfall 003 system includes the replacement of the upper 003 seepage barrier with a new seepage barrier that extends approximately 30 feet below the existing barrier. Ground water extraction will be performed southeast of Dam No. 1 to capture contamination in the alluvial aquifer. It is assumed that five extraction wells will be installed in the MW-14 and MW-17 area along an east-west line, approximately 240 feet apart, to create a continuous zone of ground water capture over the 1,200 feet of potentially affected aquifer. Water treatment will be performed at the tailing facility and will include the water collected from the Outfall 002 and Outfall 003 seepage barriers and extraction wells.

Additional ground water characterization will be performed in pre-design for the basal bedrock (volcanic) aquifer beneath and/or west of the western tailing impoundments, as well as in the volcanic aquifer and/or alluvial aquifer downgradient (i.e., south) of Dam No. 1, to evaluate the need for expanding the ground water component of the remedy. This additional characterization includes installing a well(s) to replace former temporary piezometer TPZ-5B and monitoring for radionuclides (e.g., uranium and thorium). If the characterization indicates concentrations above the remediation goal for molybdenum or other contaminants, ground water extraction would be included to address these areas.

Performance monitoring will be conducted downgradient of the historic tailing spill area, southeast of Dam No. 1, to assess the effectiveness that piping of irrigation water in the eastern diversion channel has on reducing contaminant concentrations in the ground water to cleanup levels in the area of monitoring wells MW-4 and MW-17. Performance monitoring will also be conducted downgradient (i.e., south and west) of Dam No. 4 and south of Dam No. 1 to assess the effectiveness of the remedial actions on reducing contaminant concentrations in the ground water to cleanup levels in the alluvial and basal bedrock aquifers. Monitoring will include all seeps and springs in these areas. The performance monitoring program will be developed during remedial design.

Additionally, because the Selected Remedy results in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted no less often than each five years after the start of the remedy to ensure that it is, or continues to be, protective of human health and the environment. The five-year reviews will include, among other things, a review of the performance monitoring data gathered for the tailing facility area.

Comment 189: The limited RI data collection time frame is based is not adequate to characterize the ever-changing conditions at this active mine. The Village requests that the EPA's proposed remedy define a long-term, enforceable process of environmental monitoring that is tied to additional actions as needed, for the duration of active mining. The monitoring program should be targeted toward assessing the effectiveness of implemented remedies. The proposed remedy should also define a process for implementing additional or enhanced remedial measures as needed to achieve remedial action objectives, if the remedies fail to keep up with changing conditions.

The Questa Mine is an active facility. Large quantities of tailing and impacted water will continue to be delivered to the tailing impoundment for many years or decades to come. No one knows what will happen as active mining continues. The Village is concerned that this ROD may be the final opportunity to set up an enforcement program that requires gathering and evaluating environmental data as the basis for evaluating the effectiveness of protective measures that are implemented under the ROD. If measures that are implemented are found to be ineffective due to changing conditions, mechanisms must be defined for implementation of different or enhanced mitigation measures in the future.

Response 189: *EPA's ROD is based on the information gathered during the extensive and detailed RI/FS and human health/ecological risk assessments. EPA believes that this information sufficiently characterizes the active mine site and justifies EPA's Selected Remedy. EPA agrees with the commenter that the Selected Remedy must define a long-term enforceable process of environmental monitoring that is tied to additional actions as needed for the duration of active mining and that the monitoring program should be targeted toward assessing the effectiveness of implemented remedies. EPA also agrees with the commenter that the Selected Remedy should also define a process for implementing additional or enhanced remedial measures as needed to achieve remedial action objectives if the remedies fail to keep up with changing conditions and that if the measures that are implemented are found to be ineffective due to changing conditions, then mechanisms must be defined for implementation of different or enhanced mitigation measures in the future.*

The Selected Remedy for the Mine Site Area will include performance monitoring to assess if the store and release/evapotranspiration cover system has the capacity to limit net percolation by storing precipitation solely within the non-acid generating cover system for a period long enough for water to be removed by evaporation and transpiration and that any net percolation will not cause an exceedance of ground water standards. A performance criterion will be developed during the remedial design phase for the store and release/evapotranspiration cover system to achieve the remedial action objectives for the Mine Site Area. This criterion will focus on reducing net percolation through the non-acid generating cover system to a level that would allow attainment of ground water remediation goals and be protective of ground water.

The Selected Remedy for the Mine Site Area will include performance monitoring to assess the success of plant growth on borrow material that will cover waste rock piles. A *remediation goal for molybdenum uptake from borrow material to plants shall not be at levels that inhibit attainment of revegetation success standards or exceeds risk-based concentrations for herbivorous native wildlife. Performance criteria will be developed using existing and new data from laboratory studies on plant uptake and toxicity using cover material as well as field monitoring results. The timeframe for developing the performance criteria is at the start of the remedial design and continuing through implementation and monitoring of the remedy. Examples of some parameters likely to require field monitoring on a 5-year basis include cover material molybdenum concentrations, plant molybdenum concentrations, and revegetation success.*

The Selected Remedy for the Mine Site Area will include performance monitoring to assess the effectiveness of the seepage interception and ground water extraction well systems on attaining cleanup levels in alluvial, colluvial, and bedrock ground water. Monitoring will include colluvial and bedrock ground water monitoring in all mine site tributary drainages. Monitoring will also include all seeps and springs in the Mine Site Area. The performance monitoring program will be developed during remedial design.

The Selected Remedy for the Tailing Facility Area will include performance monitoring downgradient of the historic tailing spill area, southeast of Dam No. 1, to assess the effectiveness that piping of irrigation water in the eastern diversion channel has on reducing contaminant concentrations in the ground water to cleanup levels in the area of monitoring wells MW-4 and MW-17. Performance monitoring will also be conducted downgradient (i.e., south and west) of Dam No. 4 and south of Dam No. 1 to assess the effectiveness of the remedial actions on reducing contaminant concentrations in the ground water to cleanup levels in the alluvial and basal bedrock (volcanic) aquifers. Monitoring will include all seeps and springs in these areas. The performance monitoring program will be developed during remedial design.

The Selected Remedy for the Tailing Facility Area will include performance monitoring to assess if the store and release/ evapotranspiration cover system has the capacity to limit net percolation by storing precipitation solely within the non-acid generating cover system *for a period long enough for water to be removed by evaporation and transpiration and that any net percolation will not cause an exceedance of ground water standards. A performance criterion will be developed during the remedial design phase for the store and release/evapotranspiration cover system to achieve the remedial action objectives for the Tailing Facility Area. This criterion will focus on reducing net percolation through the non-acid generating cover system to a level that would allow attainment of ground water remediation goals and be protective of ground water.*

The Selected Remedy for the Tailing Facility Area will include an early detection monitoring program within and at the margins of the tailing piles to provide early detection of any potential acid generation and metal leaching. These monitoring programs will be developed during the remedial design. Pyrite and other sulfide-bearing minerals are known to be present in the tailing at levels sufficient to generate acid. At this time, the tailing appears to be sufficiently buffered with some carbonates and hydrated lime to preclude acid-generating conditions. However, over a longer time period, should these relatively soluble materials be leached by deep seepage processes or applied process waters then acid producing conditions may prevail. Although soil cover and vegetative canopy should minimize this risk, EPA believes it prudent to include such monitoring.

The Selected Remedy for the Tailing Facility Area will include the collection of quarterly piezometer data and performance of annual inspections of the tailing facility dams to meet requirements of the New Mexico Office of the State Engineer until it is demonstrated that the tailing dams have been dewatered.

The Selected Remedy for the Red River, Riparian, and South of the Tailing Facility Area will include performance monitoring which includes the physical, chemical and biological monitoring of the Red River to assess the effectiveness of response actions at the Mine Site Area on improving Red River surface water quality and protecting aquatic life.

The Selected Remedy for Eagle Rock Lake will include the performance of physical, chemical and biological monitoring to assess long-term effectiveness of the Eagle Rock Lake remediation.

Additionally, because the Selected Remedy for all of the areas of the Site results in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted no less often than each five years after the start of the remedy to ensure that it is, or continues to be, protective of human health and the environment. The five-year reviews will include, among other things, a review of the Selected Remedy for the Mine Site Area; Mill Area; Tailing Facility Area; Red River, Riparian, and South of the Tailing Facility Area; and Eagle Rock Lake; to ensure that the Selected Remedy is performing as intended. The recommendations in the five-year review report could include a modification of any aspect of EPA's Selected Remedy if the remedial actions are not meeting the remedial action objectives or cleanup goals for the Site.

Also, any changes to the Selected Remedy described in the ROD, because of changed conditions at the Site or if the Selected Remedy is not performing as intended would be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences, or a ROD Amendment, as appropriate and consistent with the applicable regulations. After a ROD is issued, new information may be received or generated that could affect the implementation of the Selected Remedy described in the ROD, or could prompt the reassessment of that remedy. The information could be identified at any time immediately prior to, during, or after the implementation of the Selected Remedy. When a fundamental change is made to the basic features of the Selected Remedy in the ROD with respect to scope, performance, or cost, EPA is required to develop and document the change consistent with the ROD process outlined in the NCP. This entails the issuance of a revised Proposed Plan that highlights the proposed changes. An amended ROD that documents the change(s) follows the Proposed Plan.

4.7 HUMAN HEALTH AND THE ENVIRONMENT

Comment 190: Based on EPA's HHRA (DocID #869500), BERA (DocID #869493), and EPA's Technical Memorandum – Ecological Chemicals of Concern (COCs) to be Addressed by the Chevron Mining Inc. (CMI) Feasibility Study (DocID #9116671) and consideration of in-place and planned institutional controls, identified risks do not justify a finding of imminent and substantial endangerment. Without such a finding, the remedial measures proposed by EPA cannot be supported on the basis of risk to human health or the environment. Specifically, EPA's Proposed Cleanup Plan (USEPA 2009a) identifies four exposure scenarios that present what it characterizes as "unacceptable risks" to human health and four scenarios that "show the greatest ecological risk." However, careful analysis of each of these reveals that, based on EPA's risk assessments when considered with existing remedial measures and institutional controls, there is either minimal or no threat to human health or the environment from any of them.

Response 190: *EPA disagrees with the commenter. Both the HHRA and BERA show areas of the Site that exceed standards and risk-based values that demonstrate risk to various receptors. These are the areas across the Site that have been targeted for remedial action.*

Comment 191: The RI and FS have documented impacts to the Red River from mining operations. How does impacted surface water affect those residents (i.e., people's health and property) along the river? Is it enough contamination for major health problems?

Response 191: *The potential harm to human health is primarily with ground water across the Site and the soils at the mill. Metals are the primary concern in groundwater. Both natural and mine-related impacts are documented as contributing to groundwater contamination. Polychlorinated biphenyls (PCBs), are toxic materials that have been spilled on the surface soil at the mill. However, these contaminants are relatively immobile and, therefore, are only likely to be a concern for current future workers in that area. EPA found no human health risks that were related to human exposure to surface water, fish* *(from the river), or sediment in the Red River. Therefore, there should be no detrimental impact to residents along the Red River. Impacted property has only been documented in one small area south of the tailing facility. This condition occurred through the migration and spring discharge of impacted groundwater from the tailing facility. However, this is very isolated and addressed in the selected remedy.*

Comment 192: EPA has stated in several forums that the residents of Questa and surrounding areas are at no further risk of health problems as long as they have stopped drinking from contaminated wells. This is just not true. Our family lived in Questa for many years and moved away in 2004. We have both developed numerous medical conditions directly related to the elevated levels of various heavy metals contained in our well - a fluorosis-related condition that requires skin grafts to the gums potential kidney and liver problems. Another documented case is a family living in below Dam No.1, whose child had to have a kidney transplant last year, and their well showed elevated levels of certain heavy metals. The doctors have no explanation except for the heavy metal exposure. No one is safe living long-term in this area until all groundwater, surface water, (including *acequias*), soil, fish, and air are brought completely back to pre-mining levels.

Response 192: *EPA and the collective regulatory community, including the State of New Mexico and ATSDR, have collected health-based data over the years in Questa. EPA relies on ATSDR to investigate, evaluate and report on current human impacts that exist in an area, which was completed in Questa. The findings indicate that there were no community-wide impacts from mining-related contamination from potable water from the municipal water system or from airborne dust. In addition, Ms. Len Flowers of the New Mexico Human Health Services also tested residents that voluntarily participated in State-run testing and found similar results.*

EPA believes that these isolated health impacts, as the resident points out, likely exist, and EPA is very sympathetic to those that have experienced health problems in and around the community. However, defining the origin or cause of these health affects is unclear. EPA has analyzed hundreds of thousands of samples and incorporated these results in the *human health and the ecological risk assessments. These assessments confirm the results of the ATSDR and NM Human Health Services studies. There are many conditions that lend to poor health in humans, including lifestyle, foods, genetics, as well as potential impacts natural and mine-related contamination. In addition, antecdotal information on health impacts, which EPA has received over the eight years of this CERCLA effort, is difficult to incorporate into evaluations, conclusions, and decisions. EPA is committed to protecting human health and the environment at this Site and confidently believes that the process is in place to meet that objective.*

Comment 193: My land has a shallow well formerly used for consumption. When contamination was suspected, I personally addressed my concerns. EPA never addressed my concern. My concern is for the health of present day residents and for future generations of my family. Also, there is concern for restoration of my well.

Response 193: *Both EPA and New Mexico offered several times to sample residents' wells upon request. EPA sampled a number of wells and residential taps, as did New Mexico. Findings were presented to home owners. EPA is not aware of any impacted wells as a result of this testing. Although there is a possibility of impacted residential wells, CMI (formerly Molycorp) paid for a safe, public drinking water system, and for all residents to be connected to that system. Currently, EPA is not aware of any resident of Questa that is no connected to the public water system for potable water. With a reliable source of potable water, it is doubtful that any well rehabilitation efforts will be performed. These wells are typically safe for irrigation, but not human consumption. Use of these wells may help clean up the shallow aquifer, once source control measures are in place.*

Comment 194: With all of the reported soil contamination around Questa, how safe are our yards for our children and grandchildren to play and grow gardens?

Response 194: *In 2003, as part of the RI, EPA collected samples of green beans, lettuce, and zucchini from three local gardens located south, east, and northeast of the tailing facility that may have been affected by wind-blown tailings or by the use of tailings* *material for soil conditioner in gardens. Samples were also collected from three reference locations and from a local supermarket. Slightly elevated concentrations of molybdenum concentrations in beans in the south garden and manganese concentrations in the other two gardens were measured. Concentrations of all other metals tested were comparable to the reference gardens. Despite the higher concentrations of molybdenum and manganese in selected gardens, the potential for adverse health effects are unlikely based on a risk evaluations and comparisons to levels determined to be safe to ingest.*

Comment 195: What does EPA plan to do to help the community? Our personal well was contaminated. Our vegetable garden is sparse. I am worried about eating anything from the garden, and the wind-blown tailing dust irritates my eyes, nose, and asthma.

Response 195: *EPA shares the concern of all Questa residents who may have been exposed to mining-related contaminated. It is EPA's intent to clean up the Site to levels that will provide a safe environment for the community of Questa.*

If a private well is known to be contaminated, EPA recommends using an alternate water supply. At this time, EPA is not aware of anyone using water from a contaminated well for drinking. However, EPA has included as part of the Selected Remedy the provision of a temporary alternate water supply or point-of-use treatment system (i.e., filter at tap) to protect any person using ground water as a drinking water supply in areas of Site-related ground water contamination. EPA has included in the Selected Remedy the sampling of private wells at the request of residents if the well in near known ground water contamination and along its path of migration.

As stated in response to Comment No. 201 above, sampling and analysis of garden vegetables grown in the area of the tailing facility showed that the potential for adverse health effects from eating the vegetables is unlikely (see EPA BERA [CDM 2009]).

Regarding dust, CMI has employed a variety of dust control measures since the last quarter of 2005. Analysis of air monitoring data collected along the perimeter of the *tailing facility during the RI show these measures to be fairly effective in controlling dust blowing off the tailing facility; although EPA has documented an occasion event where significant dust was observed to blow from the facility. CMI operates six air monitoring stations at the tailing facility on a voluntary basis; one is located at the northeast end of the impoundments near the elementary school. The stations measure particulate matter of 10 microns or less in diameter (PM_{10}) in the ambient air, which includes dust, soot, smoke, and liquid droplets. Although EPA is not aware of any significant dust issues since CMI began the current dust control measures, EPA remains concerned with this issue and has included an air monitoring program as part of the Selected Remedy.*

Comment 196: The community is concerned that EPA's remedy does not sufficiently address health and ecological risks in the Village of Questa, which has been affected, but lies outside of the Superfund site area.

Response 196: *EPA has characterized the nature and extent of contamination at the CMI mining, milling and tailing disposal facilities, as well as all other areas were contamination has come to be located. In accordance with the NCP, the boundary of the Site is not the boundary of CMI's property, but the boundary defined by where site-related contamination is located. The RI and risk assessment were comprehensive in identifying all possible sources of mining-related contamination, contaminate migration pathways, and potential human and ecological receptors that could be exposed to such contamination. Conceptual site exposure models that were prepared at the start of the investigation show the extent of the study (see Section 5.0, Part 2 of this ROD). EPA is confident that the Selected Remedy, once completed, will protect the people that live in and around the Village of Questa.*

Comment 197: The contamination issues should be addressed and cleaned up throughout the community, because some day our property will go to our children and we want to leave them a safe inheritance to pass on to future generations. These are critical issues; please act on them!

Response 197: *It is the desired intent of EPA to remediate the Site to a level that protects the community of Questa and which provides a safe environment for its future generations.*

4.8 PRELIMINARY REMEDIATION GOALS

Comment 198: Several preliminary remediation goals selected by EPA are not scientifically supportable and, in a number of cases, there are multiple preliminary remediation goals for the same substance. Sulfate and fluoride are not COCs in ground water at the tailing facility, as determined by EPA (USEPA 2009), and concentrations in ground water are below EPA's human health screening level concentration of 1,500 and 2.2 mg/L, respectively. A fluoride concentration of 1 mg/L is also below the New Mexico numeric ground water criterion of 1.6 mg/L, which is a health-based standard. The 0.5 mg/L manganese value is only slightly greater than the New Mexico numeric ground water criterion and preliminary remediation goal of 0.2 mg/L. The molybdenum concentration of 1.3 mg/L is greater than the EPA Proposed Cleanup Plan preliminary remediation goal of 0.05 mg/L. A proposed ground water preliminary remediation goal based on the National Academy of Sciences molybdenum upper tolerance limit, is 1.0 mg/L. This is also the New Mexico irrigation standard for molybdenum – a number protective of the most sensitive receptor for molybdenum and cattle. The concentration of 1.3 mg/L for molybdenum is slightly higher than the 1.0 mg/L level National Academy of Science equivalent drinking water level. The sulfate value of 1,000 mg/L is above the numeric criterion of 600 mg/L but well below the original screening level criterion used by EPA in the RI process, and therefore no preliminary remediation goal has been developed for sulfate because it was not identified as a COC in the RI. Treatment of ground water with already low concentrations of metals as exists at the tailing facility may require multiple treatment trains, at a greater cost, for little environmental benefit, risk reduction, or reduction in the mobility and toxicity of metals. The existing pumpback system could accommodate the anticipated increased amount of water, the pumpback water is unlikely to have a water quality impact on the volcanic aquifer, and discharge at Outfall 002 can continue to meet NPDES permit (Admin. Record – DocID No. 9113627) requirements and continue to be protective of the aquatic ecosystem in the Red River.

Response 198: *Contaminants of concern (COCs) identified in this ROD include those chemicals of concern determined to pose a threat to human health and the environment in EPA's HHRA and BERA, as well as other contaminants which exceed the State of New Mexico's numeric water quality standards identified as ARARs for this CERCLA response action. Although these other contaminants may not pose a health threat to environmental receptors, they must be addressed by the Selected Remedy to satisfy the threshold criterion for compliance with ARARs under CERCLA § 121(d).*

The COCs identified for ground water at the tailing facility, their concentration ranges, cleanup levels and basis for cleanup are depicted in Table 2, below. These COCs warrant response action under CERCLA.

EPA disagrees with the commenter's opinion that treatment of contaminated ground water at the tailing facility will result in little environmental benefit and, therefore, CMI should be allowed to continue its current practice of pumping back contaminated water to the facility. EPA also disagrees with the commenter's opinion that the pumpback water is unlikely to have an impact on the bedrock (volcanic) aquifer. Tailing seepage leaks from the tailing impoundments and contaminates ground water in both the alluvial and volcanic aquifers. The contaminated ground water has impacted private water wells over the years as well as the water supply (via springs) to the Red River State Fish Hatchery. As a result, residences in the area of ground water contamination have been connected to the Questa municipal water distribution system. Although the concentrations of molybdenum in hatchery tap water (sourced by springs from the volcanic aquifer) is just below the EPA's health-based cleanup level of 0.08 mg/L, the trend in concentration is increasing. At the request of the hatchery personnel and the New Mexico Department of Game and Fish, CMI currently provides bottled water to the hatchery, where a number of full time employees and their families reside.

Table 2
Contaminants of Concern
Tailing Facility Ground Water

COC	**Concentration Ranges (mg/L)**	**Cleanup Level (mg/L)**	**Basis for Cleanup**
Fluoride	*0.38 – 2.4*	*1.6*	*Compliance with NM ARAR (Human Health Standard)*
Iron	*<0.1 – 17*	*1.0*	*Compliance with NM ARAR (Domestic Water Supply)*
Manganese	*<0.01 – 2.0*	*0.2*	*Compliance with NM ARAR (Domestic Water Supply*
Molybdenum	*<0.001 –3.2*	*0.08*	*EPA Health-Based Criterion (TBC)*
Sulfate	*152 – 1,480*	*600*	*Compliance with NM ARAR (Domestic Water Supply Standard)*
Total Dissolved Solids	*184 – 2,870*	*1,000*	*Compliance with NM ARAR (Domestic Water Supply Standard)*
Uranium	*<0.001 – 0.085*	*0.03*	*Compliance with NM ARAR (MCL)*

Based on the findings of the RI, EPA has determined that there is a hydrologic connection between ground water and surface water at the Tailing Facility Area, as seepage-impacted ground water enters into the Red River at seeps and springs. A direct correlation has been observed between the level of mining, milling and tailing disposal operations and the concentration of contaminants (primarily molybdenum) in the volcanic aquifer and, subsequently, the seeps and springs entering into the Red River. When tailing disposal operations increased from 2006 to 2008, and additional water was placed into the impoundments, molybdenum concentrations in seeps and springs along the Red River Gorge also increased. This discharge of pollutants from seeps and springs to the Red River without a permit issued under the Clean Water Act is unlawful. 33 U.S.C. § 1311(a).

In light of these ongoing impacts to ground water and surface water and the risks to human health from the continued operation of the tailing facility and practices for water disposal, EPA has decided that active ground water remediation and treatment of collected water are the best cleanup options. Allowing the continued practice of pumping back contaminated water to the impoundments is not a solution to the problem of water disposal, but one that worsens the problem. Based on CMI water balance calculations, approximately 75 percent of the water placed into the unlined impoundments is unaccounted for and assumed to percolate downward through the tailing to ground water. By treating contaminated water collected at the tailing facility (as well as the mine site), the volume of water which CMI disposes at the impoundments would be reduced, thereby reducing the volume of seepage that leaks from the facility and contaminates ground water.

EPA has elected not to remediate the volcanic aquifer at this time because the current and likely future use of the aquifer is limited due to the remoteness of the area. However, if molybdenum concentrations in the volcanic aquifer continue to increase and ultimately exceed the New Mexico numeric standard for molybdenum (1.0 mg/L) additional CERCLA response actions would be warranted for the volcanic aquifer to meet the standard, which is an ARAR to the Selected Remedy.

Comment 199: There are serious flaws in EPA's methodology used to develop the molybdenum PRGs and there are inconsistencies in EPA's selection of PRGs. Despite the importance of the PRGs in focusing clean-up efforts, the process for selecting groundwater PRGs for the Mine Site was not defined. A number of the PRGs identified are based on flawed calculations and/or inappropriate toxicity information. Of particular concern are the molybdenum groundwater PRG (0.05 mg/L) and the molybdenum soil PRG for the protection of deer and elk at the tailing facility (41 mg/kg). There are credible PRGs that are more appropriate for use in the Proposed Cleanup Plan (USEPA 2009a).

- The ground water preliminary remediation goal is based on a significantly flawed 50-year old epidemiology study (Kovalskiy 1961) that has generally been found to be invalid and has not been used in subsequent molybdenum safe dietary intake determinations by US and International Agencies.

- The site-specific ground water preliminary remediation goal was incorrectly derived.
- There are alternative federal and scientifically supportable standards that should be used in its place.

The current EPA molybdenum oral reference dose (RfD) is a 17-year old value finalized in August 1993, making it one of the older values in the IRIS database. It is based solely on a 50- year old study in an Armenian geoprovince by Kovalskiy et al. (1961) published in the *Zhurnal Obshchei Biologicheskii* and entitled “Changes of purine metabolism in man and animals under conditions of molybdenum biogeochemical provinces” (Kovalskiy 1961). The human study upon which the molybdenum RfD is based suffers from numerous deficiencies detailed in subsequent paragraphs.

Since publication in IRIS in 1993, various US and international regulatory agencies have found the Russian Kovalskiy study (USEPA 2008) invalid and unusable. Since the derivation of the EPA molybdenum oral RfD 17 years ago, two other highly credible scientific organizations have set safe levels for molybdenum: the US National Academy of Science (NAS) and the European Commission Scientific Committee (ECSC). Both of these organizations have set molybdenum Tolerable Upper Intake Levels (ULs), which is the highest daily nutrient intake level that is likely to pose no risk of adverse health effects for almost all individuals. The process used for derivation of a UL is identical to that used for derivation of an oral RfD (NAS 2002). The ECSC on Food (European Commission 2000) extensively reviewed the molybdenum literature, including the Kovalskiy study, and concluded that “there are no chronic studies in man which can be used for risk assessment.” Similarly, when the US National Research Council first reviewed the Kovalskiy publication in 1977 it concluded: “because of deficiencies in the study, inadequate data exist to identify a causal association between excess molybdenum intake in normal, healthy individual and any adverse health outcomes” (NRC 1977). In 2000, the NAS Food and

Nutrition Board and Institute of Medicine (IOM) developed a Dietary Reference Intake for molybdenum (NAS 2002). This group of distinguished scientists reviewed the Kovalskiy study and concluded: "that serious methodological difficulties are noted with this particular study including possible analytical problems in the assessment of blood and urinary copper levels and the very small size of the control group in contrast to the molybdenum exposed group. Other studies in humans do not support the existence of this particular adverse manifestation in association with elevated dietary intakes of molybdenum."

After extensive review of all of the molybdenum toxicity literature the NAS/IOM also concluded that:

> *Molybdenum compounds appear to have low toxicity in humans. More soluble forms of molybdenum have greater toxicity than insoluble or less soluble forms. There are limited toxicity data for molybdenum in humans; most of the toxicity data are for animals...... In monogastric laboratory animals, molybdenum has been associated with reduced growth or weight loss, renal failure, skeletal abnormalities, infertility, anemia, diarrhea, and thyroid injury (Vyskocil and Viau, 1999). Since none of these effects have been observed in humans, it is impossible to determine which ones might be considered most relevant to humans* (NAS 2002).

Further lowering the credibility of the IRIS RfD is the fact that the European Medicines Agency (EMEA), in its recent derivation of a safe molybdenum level in pharmaceuticals, did not use either the Kovalskiy study or the EPA IRIS RfD (EMEA 2008).

EPA did not conduct a sufficiently thorough review of molybdenum toxicity literature before deriving the site-specific preliminary remediation goal. The Final HHRA for the Molycorp Mine Site (Docid # 869500) and the Proposed Cleanup Plan (USEPA 2009a) cite specific target organs (i.e. kidney, liver and G.I. tract) for molybdenum that no other regulatory organization, including the EPA IRIS, has identified as target organs for molybdenum toxicity. Review of the molybdenum toxicity literature supports the contention that the only credible toxicity endpoints for molybdenum are either gout-like metabolic effects in humans and/or an ill defined effect on oestrus activity and embryogenesis in laboratory animals. These are the only molybdenum health effects noted by the Agency for Toxic Substances and Disease Registry (ATSDR) in their 2005 Public Health Assessment of the Questa Mine (Docid # 9103796). The use of inappropriate target organ endpoints further lowers the confidence that CDM and the EPA Region 6 performed the necessary thorough and critical analysis of the toxicity of the major COPC for the Site. A brief review of the pertinent molybdenum toxicity information that should have been included in the final HHRA (Docid # 869500), but was not, is provided below.

- **General** – The toxicity of molybdenum varies considerably, depending on the chemical form and animal species evaluated. Soluble molybdenum compounds are more toxic than insoluble compounds. The form of molybdenum produced by the Questa mine is molybdenum disulfide, which is much less soluble than the compounds typically used in animal studies (e.g. ammonium molybdate, sodium molybdate, and molybdenum trioxide). One animal study demonstrated that absorption after oral consumption of molybdenum disulfide was 0% compared, to 80% plus for soluble forms (Fairhall 1945, as cited by Vyskocil 1999).

  The most thorough review for both the human and animal molybdenum data to date is Vyskocil's 1999 "Assessment of Molybdenum Toxicity in Humans" (Vyskocil, 1999). Two other very thorough molybdenum toxicity reviews were published by the European Commission Scientific Committee on Food in 2000 (European Commission 2000) and the US Food and Nutrition Board in 2002 (NAS 2002). As with the IRIS monograph, none of these review publications conclude that the kidney, liver, or GI tract are primary target organs for molybdenum toxicity.

- **Human Studies** – In humans, excess molybdenum appears to increase the activity of xanthine oxidase, which is a molybdenum dependent enzyme that is responsible for the conversion of tissue purines to uric acid (Walravens 1979; NAS 2002).

In the Kovalskiy et al. 1961 evaluation of the population in Armenia, aching joints and symptoms resembling gout were the primary symptoms reported in an adult population with a high intake of molybdenum in food (Kovalskiy 1961). As previously discussed, this study was used by the EPA in its derivation of an oral RfD. As described above, the National Research Council's 1977 review of the Kovalskiy publication concluded that "because of deficiencies in the study, inadequate data exist to identify a causal association between excess molybdenum intake in normal, healthy individual and any adverse health outcomes" (NRC 1977, NAS 2002). The European Commission Scientific Committee on Food (European Commission 2000) review of the molybdenum literature included the Kovalskiy study, and similarly concluded that "there are no chronic studies in man which can be used for risk assessment."

In a 2005 case report (Selden 2005), a worker involved in the heating and grinding of molybdenum metal presented to his family physician with gout-like symptoms. He had elevated molybdenum levels in his hair (0.033 mg/100g hair vs. reference of 0.002 to 0.006) and his work place. A reconstruction of his work routine indicated elevated concentrations of molybdenum dust in the air approaching 10 mg Mo/m3. After removal from the work environment, his gout-like symptoms eventually resolved. The authors concluded that this was the first definitive observation of gout-like symptoms associated with occupational molybdenum exposure.

A 2007 study sponsored by the USDA was conducted to assess why there was a lack of human toxicity reported in the literature due to molybdenum exposure. Five males consumed as much as 1.49 mg molybdenum per day for 24 days. Various clinical and physiological parameters were evaluated throughout the study. The study concluded that "with increasing intake, adsorption and urinary molybdenum excretion increased, whereas the fraction deposited in tissues decreased", and that "the physiological adaptations to changing intake…may help prevent Mo toxicity" in humans (Novotny and Turnlund 2007). In this and the other human studies reviewed there was no indication that the kidney, liver, or G.I. tract are target organs for molybdenum toxicity.

- **Animal Studies** – Vyskocil's (1999) comprehensive review of the molybdenum animal data concluded that the most common response at lower molybdenum sub-chronic animal exposures is growth depression. At higher doses, developmental and other effects including testicular degeneration, diarrhea, anorexia, and weight loss, may occur. Another common effect observed across species was bone and joint abnormalities. In the most well conducted study of molybdenum toxicity in the kidney to date, Bompart et al. (1990) exposed rats to very high concentrations of soluble molybdenum (40 and 80 mg ammonium molybdate/kg/day) for 12 weeks. The study concluded that "neither dose was able to induce significant hypertensions in treated animals" and that "chronic high doses of molybdenum induce delayed body weight gain with mild chronic renal failure." Finally "high doses are required to induce a significant effect, and the nephrotoxicity of molybdenum remains moderate when compared to other heavy metals." Molybdenum induced nephrotoxicity is clearly only seen in animals at highly toxic doses and the kidney is not a realistic target organ for environmental exposures.

  The most well conducted reproductive study to date is by Fungwe et al. (1990). This study assessed the effects of soluble molybdenum in drinking water on female rats. Molybdenum did not appear to affect fertility but significantly prolonged the oestrus cycle when fed at doses of > 10 mg/liter. Histological data suggested that these doses also delayed fetal esophageal development, transfer of fetal haemopoesis to bone marrow and myelination in the spinal chord. The authors concluded that molybdenum may influence "oestrus activity and embryogenesis" (Fungwe *et al.*, 1990). Because of the good study design and dose response information, this study was used by both the European Commission Scientific Committee on Food and the U.S, Food and Nutrition Board in their risk assessments to determine a molybdenum tolerable UL in humans.

In conclusion, a more thorough review of the human and animal toxicity literature would have identified, at a minimum, increased blood uric acid levels as the key human toxicity observed after molybdenum exposure. The critical effect noted by the EPA in its IRIS file for molybdenum is uric acid blood levels.

- **Derivation of the EPA Site-Specific Molybdenum Groundwater PRG –** The site-specific molybdenum ground water preliminary remediation goal was derived using an inappropriate receptor and exposure factors for drinking water. Drinking water standards are derived using a very specific process, which involves: 1) identification of an oral RfD for which there is a high level of scientific confidence – usually a chronic animal or human study, and 2) conversion of the RfD to a drinking water equivalent level (DWEL) which is used to support the development of the standard. Conversion of the RfD to the corresponding DWEL is based on 2 liter water consumption by a 70 kilogram adult. However, the site-specific molybdenum ground water preliminary remediation goal was calculated using consumption of 1.5 liters per day by a 15 kilogram child. This change in receptor deviates from the normal EPA protocol, and accounts for nearly all of the difference between the site-specific PRG of 0.05 mg/L and the DWEL of 0.20 mg/L. Since the molybdenum RfD is from a lifetime exposure study and is based on effects seen only in adults, the water consumption factor should be based on the adult value of 2 liters per day and an adult weight of 70 kilograms.

  The site-specific molybdenum ground water preliminary remediation goal is inconsistent with the 2009 EPA Drinking Water Equivalent Level of 0.20 mg/L (USEPA 2009b) which is a drinking water health advisory value used for compounds with no promulgated MCL. In addition, the site-specific molybdenum ground water preliminary remediation goal is inconsistent with 2009 EPA Drinking Water Regional Screening Level. The EPA Region 3, 6, and 9 “Regional Screening Levels”, or RSLs, were developed under an Interagency Agreement as an update of the EPA Region 3 Risk Based Concentration (RBC) Table, the EPA Region 6 Human Health Medium-Specific Screening Level (HHMSSL) Table, and the EPA

Region 9 Preliminary Remediation Goal Table. The RSLs were first published in 2008, and replaced these tables for each region (USEPA 2009c). These screening levels are designed to assist those involved in decision-making concerning CERCLA hazardous waste sites with determining whether levels of contamination found at the site may warrant further investigation or site cleanup, or whether no further investigation or action may be required (USEPA 2010).

The tap water RSL value for molybdenum is 0.18 mg/L, consistent with the previous (DocID #869500) Region 6 HHMSSL. RSLs are designed to be conservative screening levels, most often used as a first evaluation of an issue to see if there is even a potential problem. Generally, if it does not exceed the RSL, risk is not even calculated; and when it does exceed the RSL, site specific factors are generally considered to calculate a more realistic PRG.

Consumption of a typical multivitamin regimen results in an exceedance of the daily amount of molybdenum allowed under the site-specific preliminary remediation goal. Molybdenum is an essential nutrient critical for the function of several enzyme systems; deficiency causes a potentially deadly neurological syndrome. The recommended daily allowance (RDA) of molybdenum is 45 µg/day (NAS 2002). However, a daily dose of most multivitamins contains between 50 to 250 µg molybdenum (Drugs.com 2010; EMEA 2008). Drinking 1.5 liters of water at the site-specific preliminary remediation goal results in exposure to 75 µg/day of molybdenum, a level at the lower end of what the multivitamin consuming population is exposed. The European equivalent of the U.S. Food and Drug Administration has set an upper limit for molybdenum in pharmaceutical compounds taken on a daily basis for a lifetime of 250 µg/day (EMEA 2008). The site-specific preliminary remediation goal is unrealistic when compared to the UL used by the FDA for multivitamins and the daily exposure limits set by the EMEA.

The existing 2009 EPA Drinking Water Equivalent Level (DWEL) for molybdenum is 0.20 mg/L, as reported in the 2009 Edition of the Drinking Water

Standards and Health Advisories (USEPA 2009b). The existing EPA Region 6 molybdenum drinking water RSL is 0.18 mg/L, which was derived using the appropriate adult receptor, rather than a child (USEPA 2009c). The existing NMED tap water screening level is 0.18 mg/L, which appears either to be the Region 6 drinking water RSL or derived in a similar manner (NMED 2009).

- **Development of a Groundwater PRG Based on the NAS/ECSC Upper Intake Level** – The ECSC established a tolerable UL for molybdenum using a 9-week rat study (Fungwe et al.1990). The study in rats was considered pivotal by the ECSC because of its satisfactory design, the use of an adequate number of test animals, the demonstration of a clear dose-response relationship, and clear toxicological endpoints. The study NOAEL was 0.9 milligrams per kilogram body weight per day (mg/kg bw-day) for reproductive toxicity. Derivation of the UL included an uncertainty factor of 100:

    - Factor of 10 to protect sensitive human sub-populations with inadequate copper intake or with deficient copper metabolism in view of the species differences in antagonism between molybdenum and copper, and
    - Another factor of 10 to cover the lack of knowledge about reproductive effects of molybdenum in humans and incomplete data on the toxicokinetics in man.

  Because the exposure in this 9-week rat study is sufficient to cover the relevant period of fetal development, a further uncertainty factor was unnecessary. This resulted in a UL of approximately 0.01 mg/kg bw-day, which is equivalent to 0.6 mg/day for adults, and is protective of pregnant and lactating women (European Commission 2000). The NAS/IOM also developed a UL for molybdenum and, like the ECSC, used the Fungwe et al., 1990 study of adverse reproductive effects in female rats and the NOAEL of 0.9 mg/kg bw-day (NAS 2002). NAS/IOM identified a lower uncertainty factor of only 30, because the NAS determined that recent information suggested that molybdenum does not have any effect on copper metabolism in humans (Turnlund and Keyes 2000). The resulting adult UL was 2 mg/day (NAS 2002). This UL is currently used by Canada, Australia, and New Zealand. The NAS derived molybdenum UL of 2 mg/day (or 0.030 mg/kg-day for a 70 kg adult) has a more rigorous scientific basis than the current EPA RfD and should be used in its place.

The molybdenum drinking water PRG derived using the NAS UL would be 1.0 mg/L, the same value as the New Mexico molybdenum irrigation standard for groundwater, a standard protective of the most sensitive receptor to molybdenum toxicity, cattle.

The NAS UL based drinking water value (1 mg/L) is a more appropriate site-specific PRG as would be either of the two similar EPA values (DWEL or RSL) or the NMED value.

Response 199: *CMI has summarized a substantial amount of more recent research on molybdenum toxicity. At some time, EPA's Office of Research and Development, National Center for Environmental Assessment may use some of this information to reconsider the RfD for molybdenum and either withdraw the current RfD or replace it with one based on more current information. Until that time, site–specific risk assessments will continue to use molybdenum toxicity criteria on IRIS in estimating hazards and for calculating PRGs.*[96] *Preliminary remediation goals directly based on the risk assessment will continue to be one input to risk management decisions.*

Other issues in the comment, for example those issues involving standards from other countries and the USEPA Drinking Water Equivalent Level (DWEL), can be considered in risk management. Such issues were in fact taken into consideration and some adjustment was made to the preliminary remediation goal. Specifically, child water ingestion rate was decreased to 1 L/d and the PRG was increased to 0.08 mg/L. Other adjustments, or the substitution of a target from another source, were not made, based on such considerations

[96] EPA OSWER Directive 9285.7-53, 2003

as the anticipation that water ingestion rates for Questa and the mine site would be higher than typical rates because of the high, arid climate. Such judgments are appropriate and consistent with EPA policies and guidelines.

Finally, the issue of bioavailability which is discussed by CMI, is not likely to be of significance for molybdenum in ground water. Differences in molybdenum concentrations in filtered and unfiltered samples were small, suggesting that most of total molybdenum, as represented in unfiltered samples, was not in particulate form. This finding is typical for adequately developed wells where turbidities are not excessive.

Comment 200: CMI does not agree with the factors that were used by EPA to derive a preliminary remediation goal of 41 mg/kg for protection of deer and elk at the tailing facility (Administrative Record Document Identification No. 9116671). The factors listed below were used by EPA to derive the preliminary remediation goal.

- Mule deer and Rocky Mountain Elk as target receptors.

- A low observed adverse effects concentration (LOAEC) of 2,500 mg/kg and a no observed adverse effects concentration (NOAEC) of 1,000 mg/kg on a wet plant weight basis to derive a toxic reference value. The NOAEC used in EPA's Proposed Cleanup Plan is based on an inappropriate endpoint for use in determining a wildlife toxicity reference value. The study endpoints – mild anorexia and occasional diarrhea – are not the typical ecologically relevant endpoints.

  EPA recommends use of endpoints more relevant to population effects for wildlife toxicity reference values, specifically, reduced growth, impaired reproduction, and increased mortality as adopted by EPA in Ecological Risk Assessment (USEPA 2005).

  A NOAEC of 1000 mg Mo/kg diet from wet weight diet (plants) should be converted to dry weight soil concentration using the Site-specific geomean bioaccumulation factor of 0.9. This results in a soil-based NOAEC value of 1,111 mg/kg.

- The Quintile approach to address the uncertainties associated with the difference between the NOAEC and the LOAEC.

- A bioaccumulation factor of 1.3 to convert from a wet plant weight basis to dry soil weight basis. Bioaccumulation factor calculations should include recent data collected from SOT and/or use the bioaccumulation factor geomean for the tailing facility of 0.9 to be consistent with other calculations in the EPA BERA.

- A uncertainty factor of 30 (10 for sub-chronic to chronic and a uncertainty factor of 3 to account for the variability among deer). Applying an uncertainty factor of 30 (uncertainty factor of 10 for extrapolation from acute to chronic data multiplied by an uncertainty factor of 3 to account for the variability among deer) results in a preliminary remediation goal of 37 mg/kg.

- A factor of 100% related to forage range. A determination of risk should take into account the forage range of the receptors of concern (deer and elk). Given that the tailing facility is currently an operating facility, 30% is conservative and appropriate.

- A factor of 100% related to bioaccessibility. Derivation of the preliminary remediation goal should take a bioaccessibility factor of at least 50% into account. Taking these factors into account would result in a deer/elk preliminary remediation goal of 247 mg/kg and a hazard quotient of less than 1 for exposure of terrestrial animals to molybdenum in soil and tailing at the tailing facility.

Based on these factors as discussed below, a more appropriate deer/elk preliminary remediation goal based on a full use of Site data would be 247 mg/kg.

Response 200:

- *<u>Study Endpoints</u>: The commenter noted that weight loss and diarrhea are not typical study endpoints for establishing a no observed adverse effects concentration (NOAEC) and a low observed adverse effects concentration (LOAEC). These study endpoints serve as indicators of adverse effects that over time would be expected to impair growth and potentially increased mortality. The study was a short term study and longer duration exposures would likely result in more severe effects. Given the short term duration of the study, these endpoints are considered suitable for establishing a conservative NOAEC and LOAEC.*
- *<u>Mean Bioaccumulation Factor</u>: The commenter proposed using a bioaccumulation factor of 0.9 instead of 1.3. The mean bioaccumulation factor of 1.3 was calculated from 16 co-located soil and plant samples from Exposure Area 7. Using the information from Exposure Area 7 provides a reliable estimate of the bioaccumulation factor.*
- *<u>Forage Range</u>: The commenter proposed using a usage factor of 30% due to the tailing facility being an operating facility. The EPA BERA assumed 100% foraging since the tailing facility will provide a large amount of suitable foraging and wintering areas for deer and elk after closure, cover placement and revegetation. The tailing facility is sufficiently large (nearly two square miles) to allow such an assumption. Therefore a usage factor of 100% is warranted.*
- *<u>Bioaccessibility</u>: The commenter proposed using a bioaccessibility factor of 50%. There is no evidence to indicate that anything less than 100% bioaccessibility is appropriate for molybdenum exposures to deer and elk. The studies supporting the NOAEC and LOAEC were based on molybdenum dietary exposures with no adjustments for reduced bioaccessibility. Therefore a bioaccessibility factor of 100% is warranted.*

EPA recognizes that modifying foraging range and bioaccessibility results in a less conservative and higher preliminary remediation goal, but support is not provided for the *conclusion made by the commenter that the proposed alternative preliminary remediation goal of 247 mg/kg is "more appropriate."*

Comment 201: Two preliminary remediation goals for the same substance are cited in the Proposed Cleanup Plan (USEPA 2009a), which will result in confusion as to what to use. The preliminary remediation goals are based on New Mexico numeric groundwater criteria, risk-based values from EPA's HHRA (DocID #869500), pre-mining values from the USGS Background Study (Table 6-2, Nordstrom 2008), and reference concentrations from the RI Report (DocID #872954). For example, the preliminary remediation goals for zinc include the New Mexico numeric criterion of 10 mg/L and the risk-based value of 3.1 mg/L from the HHRA (DocID # 869500). Having two preliminary remediation goals would result in subjective evaluation of remedial actions and their performance at attaining remedial goals. The preliminary remediation goals proposed as the cleanup level should be identified.

A similar issue occurs for some of the pre-mining concentrations that were calculated in the Background Study performed by the USGS (Table 6-2, Nordstrom 2008) for each of the drainages beneath the roadside rock piles. This was necessary because of the different geology in the drainages, which impacts water quality. However, in Table 2 of the Proposed Cleanup Plan (USEPA 2009a), the preliminary remediation goals have been combined for these drainages, resulting in a range of values for colluvial water beneath the roadside rock piles. Use of the drainage-specific, pre-mining preliminary remedition goal values presented in the FS Report (Admin. Record – DocIds Nos. 873842 and 9116332) or the high-end value of the range of the preliminary remediation goals in Table 2 of the Proposed Cleanup Plan (USEPA 2009) is proposed. Alternatives to evaluate remedial action performance when there is more than one PRG for a substance, or if preliminary remediation goals are expressed as a range rather than a single number, is confusing and does not provide certainty.

The rationale used to present more than one preliminary remediation goal needs to be consistently applied. Lower risk-based values have been used as the basis for preliminary remediation goals when they were lower than the New Mexico numeric criteria for ground water, but have not been included if they are higher. Examples are molybdenum and aluminum. EPA's Proposed Cleanup Plan (USEPA 2009a) states that EPA used the risk-based molybdenum value of 0.05 mg/L as the ground water PRG rather than selecting the state's numeric irrigation criterion of 1 mg/L. However, in the case of aluminum, the PRG of 5 mg/L contained in Table 2 of the Proposed Cleanup Plan (USEPA 2009a) is based on the state's numeric criterion for irrigation use, but the risk-based PRG from the HHRA (Admin. Record – DocID No. 869500) is higher at 10 mg/L and is not included as a preliminary remediation goal. Following EPA's practice, the preliminary remediation goal for aluminum should also include the risk-based value of 10 mg/L for consistency, but it does not. Another example is chromium. The preliminary remediation goal of 0.05 mg/L is based on the state's numeric criterion (human health). However, the risk-based preliminary remediation goal from the HHRA (Admin. Record - DocID No. 869500) is significantly higher at 12 mg/L.

Also, preliminary remediation goals for pH are not included in Table 2. The USGS Baseline Study (Table 6-2, Nordstrom 2008) developed pre-mining values for colluvial and bedrock waters at the mine site, and reference pH values have been estimated for the alluvial groundwater. These pH values were approved as preliminary cleanup levels and should be included as preliminary remediation goals in Table 2 (USEPA 2009a).

A health-based value of 0.013 mg/L for beryllium in ground water is presented in Table 2. The USGS Baseline Study (Table 6-2, Nordstrom 2008) estimated pre-mining beryllium concentrations for Capulin Canyon that are correctly identified as preliminary remediation goals in Table 2. However, the Background Study (Table 6-2, Nordstrom 2008) also estimated pre-mining values for beryllium for the other drainages, which have been omitted as preliminary remediation goals in Table 2. They include 0.06 mg/L for colluvial water in Goathill Gulch, 0.02 to 0.07 mg/L for colluvial water in the roadside rock pile drainages, and 0.08 mg/L for all bedrock ground water except in Capulin Canyon. These values were contained in Tables 1 and 2 of CMI's October 17, 2008 letter to EPA and NMED on proposed background concentrations (Admin. Record – DocID No. 873792, transmittal letter only, attachment not included). They were not identified in Table 4 of that letter

(Admin. Record – DocID No. 873792, transmittal letter only, attachment not included) because beryllium has no New Mexico numeric groundwater criterion and EPA dropped it from the list of constituents. Since then, EPA added beryllium's health-based value as a PRG. However, this value should be replaced by the pre-mining values identified above for accuracy and consistency. Preliminary remediation goals for the tailing facility ground water (USEPA 2009a, Table 6, p. 45) are based on New Mexico numeric groundwater criteria or risk-based values from the HHRA (DocID #869500). Some of the same inconsistencies incorporated in the preliminary remediation goals selection for tailing facility groundwater were also used for the mine site preliminary remediation goals. In addition to aluminum and chromium, higher risk-based PRGs have been estimated for cobalt, iron, manganese, and nickel in the HHRA (DocID #869500). However, these higher values which are protective of human health are not considered as PRGs for tailing facility groundwater.

It should be noted in Table 6 (USEPA 2009a) that PRGs for tailing facility groundwater have been identified for constituents that are not constituents of concern and were found to pose no human health risk. These constituents include sulfate, TDS, and fluoride. This is important because sulfate, along with molybdenum, is a driver for remediation south of Dam No. 1. A constituent that is found by EPA to pose no unacceptable risk to human health should not be driving remediation.

Response 201: *EPA acknowledges there were some inconsistencies in the preliminary remediation goals presented in the Proposed Cleanup Plan. The final cleanup levels for ground water and their rationale are presented in the tables 12-11 for the Mine Site Area and 12-16 for the Tailing Facility Area.*

4.9 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Comment 202: The language cited by EPA in its Proposed Cleanup Plan (USEPA 2009a) as a groundwater cleanup ARAR is actually a regulatory interpretation and a regulatory interpretation cannot be an ARAR. The Proposed Cleanup Plan (USEPA 2009a) contains two statements concerning ARARs for groundwater that are contrary to the NCP and to EPA's guidance on what constitutes an ARAR. Specifically, the "New Mexico Water Quality Act regulations of Section 20.6.2.4000 NMAC" state that: such regulations require abatement of ground-water pollution to meet water quality standards at any place of withdrawal for present or reasonably foreseeable future use, which include[s] those areas of groundwater contamination beneath waste to be left in place (i.e., waste rock, tailing) (USEPA 2009a, p. 36, emphasis added).

Further elaborating on this conclusion, the next paragraph states that: As identified preliminary ARARs for this CERCLA response action the location of point of compliance (POC) for attaining ground-water standards is all ground water at the Site, including ground-water beneath the waste rock and tailing that will be left in place (USEPA 2009a, p. 36, emphasis added).

While the "place of withdrawal" compliance standard in 20.6.2.3103 NMAC may be an ARAR, the quoted language "areas of ground-water contamination beneath waste to be left in place" is an interpretation and an interpretation of law, is not an ARAR for three reasons:

- An ARAR must be a promulgated state law. A site-specific *interpretation* of law is not promulgated and, therefore, cannot be an ARAR.
- ARARs must be applicable consistently at all CERCLA sites, but the interpretation at issue makes the application of the underlying statute determinable on a case-by-case basis. Therefore, it cannot be an ARAR.
- The interpretation is the subject of an ongoing appeal and, as unsettled law, cannot be an ARAR.

Response 202: *CMI misconstrues the two quoted statements made by EPA. In the fourth paragraph on page 36 of the Proposed Cleanup Plan, under the heading, Remedial Action Objectives, EPA referred to NMED's water pollution abatement regulations and stated,* *"Further, such regulations require abatement of ground-water pollution to meet water quality standards at any place of withdrawal for present or reasonably foreseeable future use, which include those areas of ground-water contamination beneath waste to be left in place (i.e., waste rock, tailing)." The second statement quoted by CMI appears in the next paragraph: "Therefore, based on these New Mexico Water Quality Act ground-water regulations, as identified preliminary ARARs for this CERCLA response action, the location of point of compliance (POC) for attaining ground-water standards is all ground water at the Site, including ground-water beneath the waste rock and tailing that will be left in place."*

The first part of the first statement is a correct statement of what the regulations require. The second part, which begins with "which include," is aninterpretation of the effect of the state regulations when applied in the context of waste rock piles and tailings. The second statement is also an interpretation of the regulations. Contrary to CMI's assertions, in neither of these statements or anywhere else in the Proposed Cleanup Plan did EPA assert, state, suggest or imply that these interpretations are ARARs. Clearly, they are not ARARs.

Comment 203: While the Act and cited regulations use the phrase "place of withdrawal for present or reasonably foreseeable future use" in determining where groundwater standards must be met to obtain permits or complete abatement, the New Mexico WQCC has not adopted regulations defining the phrase or specifying criteria to be used when applying the phrase on a case-by-case basis. In fact, the WQCC explicitly rejected the regulatory interpretation now characterized by EPA as an ARAR (WQCC Order 2006).

The WQCC's ground water discharge permit regulations provide that the NMED is to approve a discharge permit application if "the person proposing to discharge demonstrates that approval of the proposed discharge plan, modification or renewal will not result in either concentrations in excess of the standards of 20.6.2.3103 NMAC or the presence of any toxic pollutant *at any place of withdrawal of water for present or reasonably foreseeable future use*, except for contaminants in the water diverted . . . " (20.6.2.3109.C(2) NMAC, emphasis added). Most recently, in response to the Court of

Appeals decision in Phelps Dodge Tyrone the WQCC adopted criteria for determining the place of withdrawal (See *Phelps Dodge Tyrone, Inc. v. Water Quality Control Commission*). The WQCC concluded that the following criteria were appropriate for making the determination (WQCC, Decision and Order on Remand, pp. 78-79):

1. Site hydrology and geology (Conclusions of Law No. 15);
2. Quality of ground water prior to any discharge from a facility (Conclusions of Law No. 16);
3. Past and current land use in the vicinity of a facility (Conclusions of Law No. 17);
4. Future land use in the vicinity of a facility (Conclusions of Law No. 18);
5. Past and current water use in the vicinity of the facility (Conclusions of Law No 19);
6. Potential future water use and potential future water demand in the vicinity of the facility (Conclusions of Law No. 20); and
7. Population trends in the vicinity of the facility (Conclusions of Law No. 21) (WQCC, Decision and Order on Remand, pp. 78-79).

Certainly, no such evaluation has been performed by EPA or NMED for either the mine site or tailing facility. Absent such an evaluation, NMED cannot say as a matter of State law and EPA cannot declare as an ARAR whether any particular place on the mine site or tailing facility is a place of withdrawal for present or reasonably foreseeable future use. Moreover, it is improper and inconsistent with the WQCC's findings in *Phelps Dodge* to assert that any place at the mine site and tailing facility is such a place of withdrawal without the appropriate assessment. The Order has, however, been appealed to the Court of Appeals so the status of NMED's interpretation of "places of withdrawal" and EPA's adoption of it is:

- The meaning of "places of withdrawal" is currently before the New Mexico Court of Appeals and so it is unresolved.

- If the WQCC prevails in its interpretation of the term, it will still be unknown whether the WQCC will adopt a rule containing its seven criteria for applying the rule on a case by-case basis or will not adopt a rule but apply the criteria to each discharge permit or will adopt different criteria for each discharge permit.
- If the WQCC does not prevail, the WQCC and NMED will have to reconsider the term "places of withdrawal" in light of the Court of Appeals decision.
- In any case, NMED cannot and has not attempted to apply the term to determine where compliance is to be determined at the Questa mine in the context of CMI's various discharge permits or in any other context.

Response 203: *The WQCC has issued two decisions in the Phelps Dodge Tyrone (Tyrone) case cited by CMI in its discussion of place of withdrawal. In the first decision, issued in 2004, the Commission concluded that the entire mine site was a place of withdrawal. Tyrone appealed that decision to the New Mexico Court of Appeals which reversed the WQCC regarding place of withdrawal and remanded the case for the Commission to determine appropriate factors defining the relevant standard for place of withdrawal.*

On February 4, 2009, the Commission issued its decision after remand, holding that a seven-factor criteria must be applied in determining place of withdrawal. The Commission's decision after remand has been appealed to the Court of Appeals.

CMI asserts that an evaluation of the seven-factor criteria has not been performed by EPA or NMED. CMI submitted its comments in March, 2010. NMED performed the seven-factor evaluation in September, 2010. The evaluation is identified in the ROD as a TBC.

CMI asserts that, because the Commission decision after remand is on appeal, the meaning of place of withdrawal is "unresolved." However, the Commission's decision has not been stayed and thus is in full force and effect.

4.10 FIVE-YEAR SOLAR FACILITY AND COVER DEPTH PILOT STUDY

Comment 204: According to EPA's Proposed Plan, the "definition of success" accepted by EPA, NMED and MMD for the pilot is the following:

- Annual Net Percolation: *Chevron Mining shall provide a demonstration that the proposed cover depth will be protective of ground water. A successful demonstration will show that the cover system has the capacity to limit net percolation by storing precipitation within the cover system for a period long enough for water to be removed by evaporation and transpiration and that any net percolation will not cause an exceedance of groundwater standards.*

  This requires two tests, both of which are likely to provide spurious data: (1) determination of the net percolation rate within the cover system, and (2) characterization and prediction of the fate and transport of contaminants within the tailings themselves based on percolation through the cover system and as a result of any rise of groundwater levels within the tailings related to connected aquifers. New Mexico regulations recognize that a period of at least 12 years is required to demonstrate a sustainable ecosystem, and many revegetation experts agree that it may take a period significantly longer than a decade, perhaps stretching over centuries post-revegetation, to establish a sustainable ecosystem and be able at that point to determine the likely future percolation rate established within any cover system. Present state-of-the-art geochemical testing and prediction techniques are limited in their accuracy and ability to represent post-mining water quality, and at best serve as an indicator as to future potential for contamination to increase or decrease over time, with short-term changes in water quality possible at any point presently or in the future. These performance criteria may not be achievable due to the long-term requirements for data collection and the potential for changing conditions and/or regulations (e.g., water standards) in the future.

- Molybdenum Uptake in Vegetation: *No significant difference, as determined by an analysis of variance (ANOVA) test with a p-value of 0.05, between molybdenum concentrations measured in above-ground foliage collected from three or more locations from the 1-, 2-, and 3-foot cover test plots. T-tests shall show no significant differences between 1 and 3 feet of cover and between 2 and 3 feet of cover to demonstrate the adequacy of the 1- and 2-foot covers.*

- COPC Concentrations in Soil*: No significant difference, as determined by an analysis of variance (ANOVA) test with a p-value of 0.05, in COPC concentrations in composite soil samples collected from three or more locations in the 1- and 2-foot cover test plots and composite samples collected from the 3-foot cover test plot. The composite samples shall be taken from 0 to 3 inches beneath the ground surface. T-tests shall show no significant differences between 1 and 3 feet of cover and between 2 and 3 feet of cover to demonstrate the adequacy of the 1- and 2-foot covers.*

The thicker the soil cap, the more likely successful re-vegetation will be established and the less likely metals will be taken up through plant roots to the above-ground portion of the plant. Any soil cap less than 3-feet cannot be considered permanently protective. A thinner cover would require Institutional Controls to maintain it. It is recommended that EPA require additional samples (at least ten) be taken from each test plots and to a depth of at least 18 inches on each plot. All tests should be done over a period of at least 12 years to produce data more representative of the long-term performance that will be required of the final cover and to be consistent with New Mexico Mining Act requirements to demonstrate a sustainable ecosystem over this time period.

Response 204: *The established measures of success of the cover project, cited by the commenter, were included in the report titled, "Demonstration Solar Facility and Alternative Cover Depth Project for Chevron Questa Mine Tailing Facility" and were agreed upon by the EPA, MMD, and NMED in a joint letter dated November 13, 2009.*

The EPA agreed that if a 1-foot or 2-foot thick cover is demonstrated to be successful in the five-year pilot, the CERCLA remedy would be modified accordingly.

The EPA agrees with the commenter that a thicker cover could promote successful revegetation and could inhibit the uptake of metals by the vegetation. The EPA does not agree that a period of at least twelve years is needed to produce the data needed for the final cover. The final cover depth and the length of the pilot project will be determined by the ability of the cover to meet the requirements of the Selected Remedy. The EPA will not approve the final cover depth if it is not protective of human health and the environment over the long-term and if it does not meet the requirements of the Selected Remedy described in the Record of Decision. The commentator's recommendation for additional sampling locations is valid, but is more appropriately addressed during the remedial design.

Performance monitoring will be conducted to assess if the store and release/evapotranspiration cover system has the capacity to limit net percolation by storing precipitation solely within the non-acid generating cover system for a period long enough for water to be removed by evaporation and transpiration and that any net percolation will not cause an exceedance of ground water standards. Additional performance criterion will be developed during the remedial design phase for the store and release/evapotranspiration cover system to achieve the remedial action objectives for the tailing facility area. This criterion will focus on reducing net percolation through the non-acid generating cover system to a level that would allow attainment of ground water remediation goals and be protective of ground water.

An early detection monitoring program will be performed within and at the margins of the tailing piles to provide early detection of any potential acid generation and metal leaching. These monitoring programs will be developed during the remedial design. Pyrite and other sulfide-bearing minerals are known to be present in the tailing at levels sufficient to generate acid. At this time, the tailing appears to be sufficiently buffered with some carbonates and hydrated lime to preclude acid-generating conditions. However, over a *longer time period, should these relatively soluble materials be leached by deep seepage processes or applied process waters then acid producing conditions may prevail. Although soil cover and vegetative canopy should minimize this risk, the EPA believes it prudent to include such monitoring.*

Air monitoring will be performed at the tailing facility. Currently, CMI conducts a voluntary air monitoring program (PM_{10} monitoring) at six air monitoring stations located along the perimeter of the CMI property boundary. This ongoing monitoring program will be reassessed and modified during the remedial design and incorporated into the remedy. Air monitoring will include PM_{10} and $PM_{2.5}$ monitoring, as well as chemical monitoring if deemed appropriate by EPA. Air monitoring stations will include those that are currently operated and any additional air monitoring stations to be located along the perimeter of the tailing facility and/or beyond the perimeter of the facility as required by EPA. A contingency plan for dust suppression will be developed and implemented in the event of mining-related exceedances of ambient air quality standards beyond the property boundary that threaten human health.

Because the Selected Remedy results in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted no less often than each five years after the start of the remedy to ensure that it is, or continues to be, protective of human health and the environment. The five-year reviews will include, among other things, inspections of the final cover to ensure that it is performing as intended (e.g., source containment). The five-year reviews will also include inspections of the vegetation designed to optimize the effectiveness of the cover to reduce infiltration and percolation through the underlying tailing to protect ground water, promote evapotranspiration from the cover system, and provide cover stability and protection from wind and water erosion. The recommendations in the five-year review report could include a modification of any aspect of the EPA's Selected Remedy if the remedial actions are not meeting the remedial action objectives or cleanup goals for the Site.

Additionally, any changes to the Selected Remedy described in the EPA's ROD, because of changed conditions at the Site or the Selected Remedy is found not to be performing as intended, would be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences, or a ROD Amendment, as appropriate and consistent with the applicable regulations. After a ROD is signed, new information may be received or generated that could affect the implementation of the Selected Remedy, or could prompt the reassessment of that remedy. The information could be identified at any time immediately prior to, during, or after the implementation of the Selected Remedy. When a fundamental change is made to the basic features of the Selected Remedy in the ROD with respect to scope, performance, or cost, the EPA is required to develop and document the change consistent with the ROD process outlined in the NCP. This entails the issuance of a revised Proposed Plan that highlights the proposed changes. An amended ROD that documents the change(s) follows the Proposed Plan.

Comment 205: Although several Agencies support the solar energy pilot project at the tailing facility, there is concern that a one-foot cover depth is not sufficiently protective in the long term, even if it is deemed "successful" in a short term evaluation period. The five–year evaluation period is not likely sufficient to judge either vegetation success or uptake of molybdenum and other contaminants from the underlying tailing material.

Response 205: *EPA agrees that with the commenter that a five-year evaluation period may not be sufficient to determine revegetation success or the uptake of molybdenum and other contaminants from the underlying tailing material and that a 1-foot cover depth may not be sufficiently protective in the long-term. The length of the pilot project will be determined by the ability of the cover to meet the requirements of the Selected Remedy. EPA will not approve the final cover depth if it is not protective of human health and the environment over the long-term and if it does not meet the requirements of the Selected Remedy described in the Record of Decision.*

Performance monitoring will be conducted to assess if the store and release/evapotranspiration cover system has the capacity to limit net percolation by storing *precipitation solely within the non-acid generating cover system for a period long enough for water to be removed by evaporation and transpiration and that any net percolation will not cause an exceedance of ground water standards. A performance criterion will be developed during the remedial design phase for the store and release/evapotranspiration cover system to achieve the remedial action objectives for the tailing facility area. This criterion will focus on reducing net percolation through the non-acid generating cover system to a level that would allow attainment of ground water remediation goals and be protective of ground water.*

An early detection monitoring program will be performed within and at the margins of the tailing piles to provide early detection of any potential acid generation and metal leaching. These monitoring programs will be developed during the remedial design. Pyrite and other sulfide-bearing minerals are known to be present in the tailing at levels sufficient to generate acid. At this time, the tailing appears to be sufficiently buffered with some carbonates and hydrated lime to preclude acid-generating conditions. However, over a longer time period, should these relatively soluble materials be leached by deep seepage processes or applied process waters then acid producing conditions may prevail. Although soil cover and vegetative canopy should minimize this risk, EPA believes it prudent to include such monitoring.

Air monitoring will be performed at the tailing facility. Currently, CMI conducts a voluntary air monitoring program (PM_{10} monitoring) at six air monitoring stations located along the perimeter of the CMI property boundary. This ongoing monitoring program will be reassessed and modified during the remedial design and incorporated into the remedy. Air monitoring will include PM_{10} and $PM_{2.5}$ monitoring, as well as chemical monitoring if deemed appropriate by EPA. Air monitoring stations will include those that are currently operated and any additional air monitoring stations to be located along the perimeter of the tailing facility and/or beyond the perimeter of the facility as required by EPA. A contingency plan for dust suppression will be developed and implemented in the event of mining-related exceedances of ambient air quality standards beyond the property boundary that threaten human health.

Because the Selected Remedy results in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted no less often than each five years after the start of the remedy to ensure that it is, or continues to be, protective of human health and the environment. The five-year reviews will include, among other things, inspections of the final cover to ensure that it is performing as intended (e.g., source containment). The five-year reviews will also include inspections of the vegetation designed to optimize the effectiveness of the cover to reduce infiltration and percolation through the underlying tailing to protect ground water, promote evapotranspiration from the cover system, and provide cover stability and protection from wind and water erosion. The recommendations in the five-year review report could include a modification of any aspect of EPA's Selected Remedy if the remedial actions are not meeting the remedial action objectives for the Site.

Additionally, any changes to the Selected Remedy described in EPA's ROD, because of changed conditions at the Site or the Selected Remedy is found not to be performing as intended, would be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences, or a ROD Amendment, as appropriate and consistent with the applicable regulations. After a ROD is signed, new information may be received or generated that could affect the implementation of the Selected Remedy, or could prompt the reassessment of that remedy. The information could be identified at any time immediately prior to, during, or after the implementation of the Selected Remedy. When a fundamental change is made to the basic features of the Selected Remedy in the ROD with respect to scope, performance, or cost, EPA is required to develop and document the change consistent with the ROD process outlined in the NCP. This entails the issuance of a revised Proposed Plan that highlights the proposed changes. An amended ROD that documents the change(s) follows the Proposed Plan.

Comment 206: It has been documented that Chevron Technology Ventures working with CMI, EPA and the New Mexico regulatory agencies, plans to construct a 1 megawatt solar energy facility on the northeastern portion of the tailing facility. While there is support for the pilot test, the pilot must not be allowed to compromise the 3-ft cover soil depth. Also, from a technical viewpoint, the use of the Site as an industrial facility (solar power generation) and wildlife area are not compatible and should not be attempted at the same time. Provided the remedy is maintained in a manner protective of human health and the environment, as well as mindful of local opinions and desires, there will likely be enough of a contribution to the local economy to only utilize the tailings facility to produce renewable energy as a post-mining lad use without simultaneously obtaining a post-mining land use that supports wildlife.

It is recommended that the ROD require a longer demonstration period, even if it causes technical and administrative difficulties in addressing vegetation related performance issues. It is further recommended that CMI consider and the agencies allow a different type of cover system more consistent with industrial use, including a zero-infiltration system such as asphalt or other impermeable surface that also resists erosion and dust creation.

Response 206: *EPA agrees with the commenter that the solar facility must not be allowed to compromise the 3-ft cover soil depth, or any other cover depth for the final cover at the tailing facility. The currently approved post-mining land use under the New Mexico Mining Act and Mining Permit TA001RE is wildlife habitat. Upon closure, the area must be reclaimed to a condition that allows for re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding areas, consistent with the approved post-mining land use of wildlife habitat. However, that designation is subject to change, and a change in the designation is likely necessary to accommodate the solar energy plant. EPA agrees with the commenter that a longer demonstration may be required; however, EPA believes that the Record of Decision should not be as prescriptive as the commenter recommends. The length of the pilot project will be determined by the ability of the cover to meet the requirements of the Selected Remedy. EPA will not approve the final cover depth if it is not protective of human health and the environment over the long-term and if it does not meet the requirements of the Selected Remedy described in the ROD. EPA also believes that a different cover system will need to be considered if the final cover is not* *meeting the remedial action objectives for the Site and is not performing as intended in the Selected Remedy.*

Performance monitoring will be conducted to assess if the store and release/ET cover system has the capacity to limit net percolation by storing precipitation solely within the non-acid generating cover system for a period long enough for water to be removed by evaporation and transpiration and that any net percolation will not cause an exceedance of ground water standards. A performance criterion will be developed during the remedial design phase for the store and release/ET cover system to achieve the remedial action objectives for the tailing facility area. This criterion will focus on reducing net percolation through the non-acid generating cover system to a level that would allow attainment of ground water remediation goals and be protective of ground water.

An early detection monitoring program will be performed within and at the margins of the tailing piles to provide early detection of any potential acid generation and metal leaching. These monitoring programs will be developed during the remedial design. Pyrite and other sulfide-bearing minerals are known to be present in the tailing at levels sufficient to generate acid. At this time, the tailing appears to be sufficiently buffered with some carbonates and hydrated lime to preclude acid-generating conditions. However, over a longer time period, should these relatively soluble materials be leached by deep seepage processes or applied process waters then acid producing conditions may prevail. Although soil cover and vegetative canopy should minimize this risk, EPA believes it prudent to include such monitoring.

Air monitoring will be performed at the tailing facility. Currently, CMI conducts a voluntary air monitoring program (PM_{10} monitoring) at six air monitoring stations located along the perimeter of the CMI property boundary. This ongoing monitoring program will be reassessed and modified during the remedial design and incorporated into the remedy. Air monitoring will include PM_{10} and $PM_{2.5}$ monitoring, as well as chemical monitoring if deemed appropriate by EPA. Air monitoring stations will include those that are currently operated and any additional air monitoring stations to be located along the perimeter of *the tailing facility and/or beyond the perimeter of the facility as required by EPA. A contingency plan for dust suppression will be developed and implemented in the event of mining-related exceedances of ambient air quality standards beyond the property boundary that threaten human health.*

Because the Selected Remedy results in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted no less often than each five years after the start of the remedy to ensure that it is, or continues to be, protective of human health and the environment. The five-year reviews will include, among other things, inspections of the final cover to ensure that it is performing as intended (e.g., source containment). The five-year reviews will also include inspections of the vegetation designed to optimize the effectiveness of the cover to reduce infiltration and percolation through the underlying tailing to protect ground water, promote evapotranspiration from the cover system, and provide cover stability and protection from wind and water erosion. The recommendations in the five-year review report could include a modification of any aspect of EPA's Selected Remedy if the remedial actions are not meeting the remedial action objectives for the Site.

Additionally, any changes to the Selected Remedy described in EPA's ROD, because of changed conditions at the Site or the Selected Remedy is found not to be performing as intended, would be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences or a ROD amendment, as appropriate and consistent with the applicable regulations. After a ROD is signed, new information may be received or generated that could affect the implementation of the Selected Remedy, or could prompt the reassessment of that remedy. The information could be identified at any time immediately prior to, during, or after the implementation of the Selected Remedy. When a fundamental change is made to the basic features of the Selected Remedy in the ROD with respect to scope, performance, or cost, the EPA is required to develop and document the change consistent with the ROD process outlined in the NCP. This entails the issuance of a revised Proposed Plan that highlights the proposed changes. An amended ROD that documents the change(s) follows the Proposed Plan.

Comment 207: The public needs more information on the proposed concentrating photovoltaic (CPV) solar facility to be built on 20 acres in the northeast corner of the tailing facility.

Response 207: *A one-megawatt solar energy facility demonstration is being constructed on the northeastern portion of the tailing facility by Chevron Technology Ventures, in conjunction with Chevron Mining Inc., in 2010 under a permit amendment to New Mexico Ground Water Discharge Permit DP-933. The pilot demonstration will be conducted for a period of five years. The solar facility includes 173 solar panels, electrical distribution systems, control buildings, weather stations and other related equipment, and access roads. The solar project will be located on approximately 21 acres of surface area which has been partially reclaimed with an interim six-inch soil cover and vegetation after tailing disposal ceased in 1980. The solar energy plant will utilize concentrated photovoltaic technology and is scheduled to be completed and operational by the end of 2010.*

The report titled, "Demonstration Solar Facility and Alternative Cover Depth Project for Chevron Questa Mine Tailing Facility" (November 18, 2009, EPA Document ID # 9116685), concerning the solar pilot project, is available to the public for review in the Administrative Record which is maintained at the information repository at the village of Questa offices.

Comment 208: Solar facility plans are considerations that should be made a part of this restoration plan. Do not compartmentalize this plan outside the purview of the contamination issues.

Response 208: *EPA agrees that the solar facility plans are considerations that should be made a part of this restoration plan or cleanup plan for the Site.*

Consistent with EPA's 2010 Superfund Green Remediation Strategy and EPA Region 6's 2009 Clean and Green Policy, the Selected Remedy will be implemented in a manner that *promotes green remediation efforts and reduces the environmental footprint of the cleanup to the maximum extent possible, while adhering to NCP requirements and related statutes. Green remediation practices will be developed during remedial design and updated throughout the performance of the Selected Remedy to ensure that green remediation technologies and practices are considered and implemented where practicable and available. The Selected Remedy will be designed and constructed to conserve natural resources, minimize waste generation and reduce energy consumption to the maximum extent possible.*

Green remediation strategies developed at the Site will also focus on the use of renewable sources of energy as one way to reduce greenhouse gas emissions and fossil fuel energy consumption in Site operations. Water treatment plants will have to be operated at the mine site and tailing facility for decades; the mine site water treatment plant to be operated possibly in perpetuity. In light of the renewable solar energy project for the 1-megawatt concentrated photovoltaic solar facility being constructed at the tailing facility by Chevron Technology Ventures as a 5-year pilot demonstration, EPA will encourage CMI to use such renewable energy to power its water treatment plant if successful. Should the pilot solar project be successful and implemented as a long-term source of renewable energy, it would be expected to provide a positive impact to the local community in terms of job creations, reduction in energy costs to consumers, and valuable reuse of contaminated lands. CMI has also indicated an interest in exploring potential renewable energy options at the mine site, which may be used to operate the water treatment facility at the mine site. EPA will seek to maximize use of renewable energy in implementing the Selected Remedy, with a goal of using 100 percent of renewable energy to power Site operations. However, such goal will not take priority over meeting established cleanup goals and objectives of the Selected Remedy.

Comment 209: EPA described plans for a solar facility pilot test at the tailing facility. Plans for the solar facility introduce additional consideration, such as stabilizing the site, transmission of energy and/or its storage potential, infrastructure requirements and purpose. Will cooling be necessary? What level of EMFs (electromagnetic field background radiation) would large transmission systems produce? Are site-specific heat gains expected? What are the consequences to local forests and woodlands, including seasonal or ongoing temperature variation, fire hazard ratings, insect/disease incidence? Is habitat fragmentation addressed?

Response 209: *Answers to these questions cannot be provided since they have not been considered by EPA, nor are they, for the most part, relevant to the Selected Remedy. The solar facility pilot demonstration is not part of the Selected Remedy, but a future land use consideration by CMI. These questions should be directed to CMI if the pilot demonstration is deemed successful and the facility continues to be operated on a permanent basis. The placement and operation of a solar facility atop the tailing impoundments as a current or future land use, like any other potential future land use, must not adversely impact EPA's Selected Remedy for the Tailing Facility Area, which includes a 3-foot thick soil cover for the tailing impoundments.*

The cover depth pilot demonstration being conducted by CMI in combination with the solar facility demonstration has relevance to the Selected Remedy. If CMI can demonstrate to the satisfaction of EPA that a 1- or 2-foot thick cover depth is also protective, EPA has agreed to change the thickness of the cover in the remedy.

4.11 RED RIVER WATERSHED RESTORATION

Comment 210: Collaboration within the entire watershed by management agencies is needed for a basin-wide clean-up strategy. These agencies include existing Rio Grande Watershed Restoration Action Strategy groups; Upper, Middle and Lower Rio Grande restoration teams; the Rio Grande Roundtable (Colorado); and the Taos County Regional Water Plan, as well as additional jurisdictions involved in watershed planning from the headwaters to the delta of this major watershed to evaluate comprehensive ground water configuration and precipitation patterns. Ideally, representatives involved in the clean-up would participate in assigned collaborative planning teams, lending both their expertise and experience to the overall watershed outlook.

Response 210: *EPA agrees with the commenter that collaboration between regulatory and non-regulatory stakeholders with an interest in the Rio Grande Watershed is the best approach for a basin-wide cleanup strategy. Although EPA has performed such collaboration, it has been focused primarily on the tributary Red River Watershed, where Site-related contamination has been detected. EPA's field team performed a reconnaissance of the Red River from its headwaters near the town of Red River to its confluence with the Rio Grande in 2002. Based on this reconnaissance and extensive sampling of Red River surface water, sediment and aquatic biota during the RI showed that mining-related impacts to the Red River did not extend past (downstream of) the Red River State Fish Hatchery.*

Over the last 10 years, EPA has worked closely with the federal and State of New Mexico natural resources trustee agencies to coordinate RI/FS and natural resource damage assessment (NRDA) activities from a watershed restoration perspective. These agencies included the U.S. Department of the Interior (DOI), U.S. Fish and Wildlife Service, U.S. Forest Service, DOI's Bureau of Land Management, and the New Mexico Office of the Natural Resources Trustee. EPA has also coordinated with the U.S. Forest Service on its CERCLA cleanup activities at abandoned mine sites upriver from the Site near the headwaters of the Red River as well as the Clean Water Act Total Maximum Daily Load (TMDL) program for impaired segments of the Red River. These efforts are discussed in more detail in Section 4.0 of the ROD.

Although EPA has actively sought a dialogue and collaboration with all affected stakeholders during the last 10 years of Site remedial activities, the agencies mentioned by the commenter are unknown to EPA. Nevertheless, EPA would welcome any dialogue and collaborative effort with these agencies as the CERCLA cleanup process moves forward.

Comment 211: EPA and the State of New Mexico must become a part of the solution with regard to the entire Red River and Rio Grande Watershed. The Agencies must view this issue holistically and work collaboratively with all of the governing and non-governmental offices to restore and plan for future stewardship of the water.

Response 211: *See response to previous comment.*

4.12 NATURAL RESOURCES

Comment 212: Many of the items affecting trust resources are temporally dependent upon mine closure (i.e., rock piles cover/re-grade, tailings facility cover, maintaining water levels in the mine below the Red River, etc.). These actions will have long term impacts on the exposure pathways and release of contaminants to be left in place. As such, the US Fish and Wildlife Service (FWS) will monitor the progress of the implementation of this remedial activity and future mine closure actions. Please keep the FWS informed of any changes made to remedial alternatives and the 5-year review process.

Response 212: *EPA appreciates the commitment of FWS to monitor the progress of the implementation of the remedial activities and future mine closure actions. EPA will continue coordination with the FWS concerning any changes made to the remedial alternatives and the 5 Year Review process.*

4.13 FINANCIAL ASSURANCE

EPA received 10 separate comments from individual stakeholders groups on the topic of financial assurance; namely, who is responsible for payment now and into the future and how the funding is secured? In addition, there were over 100 residents that signed a cover letter concurring with Amigos Bravos comments on EPA's Proposed Plan, one of which was the need for financial assurance for the remedy. This topic is only presented once below, along with several other related comments.

Comment 213: Who pays the cost of remediating this Site? Is it Superfund?

Response 213: *Superfund cleanup is either paid for by the parties responsible for contamination or by the Superfund Trust Fund. Under the Superfund law, EPA is able to make those companies and individuals responsible for contamination at a Superfund site perform, and pay for, the cleanup work at the site. EPA negotiates with the responsible parties to get them to pay for the plans and work that has to be done to clean up the site. If an agreement cannot be reached, EPA issues orders to responsible parties to make them clean up the site under EPA supervision. EPA may also use Superfund Trust Fund money to pay for cleanup costs, then attempt to get the money back through legal action. In this case, EPA will negotiate with Chevron Mining Inc. to pay for the cleanup work.*

Comment 214: Regarding the Sierra Club v. Johnson lawsuit, the court found in favor of the plaintiffs (July 2009) requiring regulations and financial assurance from industries handling hazardous waste. EPA announced that it would be requiring financial assurance from the mining industry.

Without the financial resources in place to guarantee water collection and treatment in perpetuity, financial assurance is as critical to the cleanup plan as are institutional controls, monitoring wells, source containment criteria, etc. Therefore, financial assurance must be explicitly discussed in the ROD, and a timeline must be provided for when financial assurance will be established. Calculations for financial assurance must be based on cost estimates developed in the PCP, and should be derived through calculation methods and assumptions consistent with methods used by MMD and NMED. Financial assurance instruments should not be based on third-party, self, or corporate guarantees.

If financial assurance is not addressed in the ROD, it will be inadequate and flawed, and Amigos Bravos' interests, expressed in the lawsuit (above) and in past participation in state regulatory processes will be harmed.

Response 214: *EPA negotiates financial assurance requirements in its Superfund settlements and orders. The settlements and orders require potentially responsible parties (PRPs) to demonstrate adequate financial ability to complete the cleanup work that they* *are obligated to perform. More specifically, the financial assurance mechanisms supplied by PRPs typically provide EPA with a source of funds that the Agency can use to ensure funding for cleanup work in the event EPA ever needs to "take over" the work under the relevant settlement or order. In this case, the EPA will negotiate with Chevron an enforceable document (i.e., Consent Decree) which will contain requirements concerning financial assurance. For more information, please see http://www.epa.gov/compliance/cleanup/superfund/negotiate-fa.html#fa*

Comment 215: It is our interpretation that Section 108(b) of CERCLA gives EPA the authority to require that classes of facilities maintain financial responsibility consistent with the degree and duration of risk associated with the production, transportation, treatment, storage or disposal of hazardous substances.

Presently the Site has financial assurance for mine reclamation and closure totaling approximately $167 million with the New Mexico Environment Department and New Mexico's Mining and Minerals Division as beneficiaries. With EPA's estimated cost of $517 to $883 million for the preferred alternative (based on feasibility study-based cost estimating methods), the existing financial assurance is significantly less than adequate for the Site.

R3G is aware of EPA's draft guidance for hard rock mine site reclamation and financial assurance and that other EPA regions (e.g., Regions 9 and 10) have developed informal or formal interim policy, as well as adopting and implementing the draft guidance. Recent ROD's and Consent Decrees have reflected these decisions by EPA.

It is, therefore, recommended that EPA Region 6 use the draft guidance for hard rock mine site financial assurance and also require financial assurance as part of the Molycorp Mine Site ROD. In addition we make the following recommendations:

- New Mexico has a well established methodology for estimating financial assurance that is consistent with EPA draft guidance – EPA should coordinate with NMED and MMD in the cost estimation using the basic assumptions used by EPA in the Plan.

- EPA should provide technical assistance to NMED in the establishment of assumptions and cost estimate methodology for long-term water treatment and other long-term costs such as for site operations and maintenance and institutional controls and related programs.
- New Mexico has established interest and inflation rates for the Net Present Value (NPV) estimation of financial assurance requirements that reflect a conservative approach and should be utilized by EPA for this site.
- EPA should not allow any form of third-party, corporate, or self-guarantee consistent with federal regulations concerning corporate financial obligations and should only allow real forms of financial assurance that can be readily convertible to cash to be used in the establishment or estimation of financial assurance.
- EPA in the ROD should require that adequate financial assurance be estimated and established within 90 days of the date of ROD finalization.

Response 215: *EPA is aware of the current financial assurance provided to NMED and MMD. EPA also acknowledges the recommendations provided by the commenter to improve the financial assurance requirements. All of this information will be considered during development of the financial assurance requirements of the Consent Decree that will be negotiated with the PRP(s).*

Comment 216: This clean up will continue for many years. How will the funding for perpetuity happen?

Response 216: *Financial assurance mechanisms will be developed and negotiated within the Consent Decree to ensure that the long-term operation and maintenance of the remedy will be funded.*

Comment 217: Will there be realistic planning and a set-aside for the restoration of the health of the community, which may include funds for epidemiological studies of concerned citizens, educational opportunities regarding preventative lifestyle as well as health care options when appropriate?

Response 217: *No. These types of planning activities and funding are beyond the EPA's authority under CERCLA. The development of a Community Measures Plan is part of the Selected Remedy and may include some level of medical monitoring or surveillance during implementation of the remedy (see response to Comment No. 46 above).*

Comment 218: Please identify sources of socioeconomic support for families and the greater community impacted by the Site, including funding and planning for epidemiology research, health care, and wellness-related education and practices.

Response 218: *As stated above, these types of planning activities and funding are beyond EPA's authority under CERCLA. Also see responses to Comment Nos. 44 and 45 above for socioeconomic issues.*

Comment 219: Will EPA require CMI to compensate property owners for polluting their properties especially around the tailing facility? Essentially, they are trespassing onto residents' properties.

Response 219: *EPA has the authority to require companies to remediate contamination released to private property through the CERCLA process. However, EPA does not have the authority to require a company to compensate local property owners for pollution that may have impacted their property.*

4.14 ENFORCEMENT

Comment 220: EPA should explain how the natural background values for the various dissolved constituents in ground water, river water, and sediments have been factored into determining (1) what constitutes acceptable and non-acceptable values and (2) what has been designated mining-related contribution to "contamination." USGS acknowledges that geological variability along the Red River contributes to different metal concentrations, some of which are above current drinking water standards. How is the USGS and background information used to decide the proportion that mining activities have contributed to the overall "contamination" and what proportion natural process have contributed? Why should CMI pay for cleanup of the naturally-produced "contamination," associated with ground water, river water, and with Eagle Rock Lake sediment? It is noted that naturally-occurring, hydrothermal alteration scars located on U.S. Forest Service land generate acid-rock drainage and metals-laden sediment that flow to the Red River. Should the USFS be held responsible for cleaning up their land's contribution to what has been deemed unacceptable risk to human and ecological receptors?

Response 220: *The clean up levels in the ROD represent promulgated federal or state numeric standards (as ARARs), EPA health-based criteria as TBCs, and natural background levels determined by statistical comparison of Site date to reference background data. The background levels (or pre-mining baseline levels from the USGS Baseline Study for ground water), were used to provide a baseline to evaluate CMI's mining-related contamination. The background concentrations for ground water and surface water take into account impacts from natural hydrothermal scars in tributary drainages upriver to the mine site.*

The purpose in sampling and evaluating reference background media during the RI, and then conducting statistical comparisons between the Site and reference background data, was to distinguish and quantify the difference between CMI's mining-related contamination and "naturally-produced" background contamination. Any concentration of a contaminant found to be above its corresponding background level was assumed to be caused by mining-related activities.

The selection of cleanup levels representing background levels, where background levels exceed ARARs or health-based criteria, allows EPA to remediate mining-related *contamination. It is EPA's policy generally not to clean up a site below background levels because EPA recognizes that such contamination is not caused by a potentially responsible party. EPA also recognizes that any effort to clean up to below natural background levels would likely not be effective in the long term.*

Regarding naturally-occurring contamination from hydrothermal scars at the Site, EPA is not requiring anyone to clean-up these impacts, unless they have been moved, altered, or otherwise handled during mining operations or some other anthropogenic activity, or have become commingled with contaminants from such operations or activities. EPA is not aware of any activity by the U. S. Forest Service in the scar-impacted tributary drainages upriver of the mine site that causes contamination or presents a threat to human health or the environment. In fact, over the last several years the U. S. Forest Service, under its CERCLA authority, has been conducting removal actions at over twenty abandoned mine sites in the upper Red River Valley to address environmental contamination (see Section 4.0, Part 2, of this ROD).

Comment 221: Although this Site is very complex, EPA must not let CMI continue delaying cleanup, as seen in the past, with continued violations of regulatory permits (*e.g.*, violations of their NPDES permits [particularly at Outfall 2 of the tailings facility]).

Response 221: *The Selected Remedy will be conducted in accordance with the project schedule(s) approved by EPA at the start of the remedial design and remedial action activities.*

Comment 222: The community believes that oversight is needed during remedy implementation and operation. CMI should pay for multiple oversight staff at the State to monitor these remedial operations.

Response 222: *EPA recognizes that the community believes that oversight is needed during remedy implementation and operation. EPA is committed to maintaining appropriate oversight during remedy implementation and operation. Appropriate payment* *of oversight costs will be negotiated during the development of the Consent Decree which will require the implementation of the remedy.*

4.15 TIMING OF REMEDIAL ACTIVITIES

Comment 223: CMI requests that EPA consider phasing the remedial actions over time. CMI objects to the timing of the remedial actions in EPA's Proposed Plan, especially as "Year 0" implementation for all remedial alternatives has the significant potential to negatively impact ongoing operations. A phased approach to remediation, such as the "tool box" approach suggested by EPA, rather than a requirement that all remediation begin in "Year 0", has generally been preferred at other sites, particularly when a very expensive ground water cleanup is proposed.

Throughout the RI/FS process, EPA was unwilling to consider the impact timing would have at an operating mine as a factor critical to developing a remedy and the subsequent interference with ongoing operations. Not considering timing as an element in remedy selection, in addition to running contrary to EPA's usual preference for phasing remediation, creates two other significant problems. Because timing was not considered in EPA's proposed remedy, 35% of total remedial costs would be incurred immediately and 55% of the costs would be incurred within the first five years. Such a cost structure and schedule is not justified by the site risk being addressed. A second critical problem with timing and consequential preference for immediate and simultaneous remediation rather than phased remediation, is that it is simply impracticable to institute many of the remedial measures at an operating mine in the time frame proposed.

Response 223: *EPA agrees with CMI that it is not practical to conduct all remedial activities simultaneously and has decided to conduct the Selected Remedy in a phased approach (see Section 4.0 and Section 12.0, Part 2 of this ROD). However, EPA does not consider it appropriate to delay or postpone efforts to protect human health and the environment because of possible interference with CMI's ongoing mining operations. Under CERCLA, EPA is mandated to protect human health and the environment and the*

Selected Remedy will be conducted in as expeditious a manner feasible given the complex nature of Site conditions and logistics of conducting such work at an operating facility. Where it is practical to conduct such activities in a phased and cost-effective approach without subjecting the public or the environment to unnecessary exposure to Site contamination, EPA will do so.

Comment 224: CMI contends that multiple operable units are a standard feature of complex remediation site like Questa. The NCP and EPA Guidance favor the designation of operable units to expedite and increase the efficiency of the remedy. Based on the Site characteristics, CMI is proposing that the Site be divided into three operable units:

- The rock piles and repositories.
- The mine and mill, including all groundwater underlying the mine, mill, and rock piles.
- The extended tailing facility area, including the area south of the tailing facility, Red River and Riparian area and Eagle Rock Lake.

The rock piles and the rock repositories associated with these units are in a discrete geographical area. More importantly, the nature of the remedial actions to be performed at the rock piles and the timing of those actions are entirely separate and distinct from those of the remainder of the Site. Specifically, the entire mine and mill site has soil, surface water, and ground water contamination issues, but only the rock piles raise safety, slope, and stability issues as well as the potential economic and future use issues raised by siting a waste rock repository. According to EPA's Proposed Cleanup Plan (USEPA 2009), in determining the final slope design for the rock piles, an entirely different set of criteria must be considered.

Finally, the schedule for remedial design and remedial action is separate from the schedules for remediation of the mine/mill and tailing facility areas.

Although, the impacted media are the same for the mine/mill and the extended tailing facility area (soil, surface water, and ground water), the two areas are separate and distinct in multiple other respects:

- They are geographically separate, linked only by the tailing pipeline.
- They will be on different remedial action schedules. For example, reclamation of the tailing facility cannot begin until mine closure.
- They have different post-mining future uses dictated by institutional controls and the MMD closeout plan process.
- They are treated separately as far as regulatory treatment by the State –different discharge permit requirements, different permitting treatment as far as air pollution control (emissions from the tailing facility are not aggregated with emissions from the mine/mill and are not included in mine/mill air permit) and different reclamation plans under Mining Act and discharge permits.
- They are treated differently as far as the institutional controls implemented by CMI in May of 2009. Although both areas are subject to restrictive covenants, the restrictive covenants are different and only the mine/mill is subject to a conservation easement.
- The nature of the ground water and surface water issues and remedial responses are different.
- Innovative renewable solar electric generation technologies are being considered for both areas, but they are entirely different technologies.

As recognized by EPA, operable units are an appropriate mechanism to facilitate remediation at large, complex sites such as Questa.

Response 224: *This aspect of Site cleanup has been discussed at length by EPA, NMED, and CMI over the past several years. EPA fully considered dividing the response actions into phases or operable units, but decided that the information collected on the nature and* *extent of Site contamination was adequate in going forward with remedy selection for all areas of the Site. EPA has, however, opted to conduct the Selected Remedy in a phased approach during remedial design and remedial action. See response to Comment No. 223 above.*

Comment 225: Even though the Questa Mine is an operating facility, EPA's proposed remedy did not take into consideration whether or how that remedy would impact ongoing operations. In fact, though CMI repeatedly requested that it do so, the agency did not allow any discussion by CMI of timing of the various remedial alternatives in the FS. Now, despite continued assurances that the remedy would consider timing and not interfere with operations, as per the Proposed Cleanup Plan, all of the proposed remedial actions are to begin at "Year 0". The impact on the mine's ability to continue normal operations was not taken into account and, even with the associated prohibitive costs, how "Year 0" construction might impact operations was not alluded to. An exception to this "Year 0" approach is EPA's proposed "tool box" approach to iterative rock pile reclamation design and application of cover at the tailing facility at cessation of tailing deposition (USEPA 2009).

CERCLA does not include timing in the NCP criteria for assessing remedial alternatives simply because it was originally intended to address closed or orphan/abandoned sites. However, Questa is not closed and is neither an orphan nor an abandoned site. Whereas implementation of the proposed remedial actions might not be problematic on a site where people are not working and onsite facilities (roads, detention basins, storage areas) are not present, that is not the case at Questa. For example, many of the roads at the mine are relatively narrow and were constructed to accommodate ongoing mine operations. The remedy anticipates use of these roads but fails to acknowledge their operational use. Depending on timing of the remedial action undertaken it may or may not be possible to use these roads as they are currently constructed. If they cannot be utilized for the remedy, the existing roads would need to be modified or new roads would be required resulting in additional earthmoving and disturbance and a cost that was neither anticipated nor evaluated.

Another area where timing has the significant potential to interfere with operations is the mill. EPA's proposed remedy would have a new water treatment plant, or plants, and the ancillary collection system and equipment as well as the sludge impoundments located at the mill. The entire mine area is topographically complex, consistent with the montane nature of the surrounding Sangre de Cristo mountains, with flat areas at a premium. Currently, available areas are used for the mill facility, product storage, warehouse, lab, maintenance and decline (conveyor belt operations), and are all constrained by the natural hillsides and State Highway 38.

These facilities are required for operation of the Questa Mine. Yet the proposed remedy includes constructing a water treatment plant, or plants, and sludge impoundments in this same area with no explanation of steps that might be taken to minimize impacts on operation. The current milling process uses lime as a depressant in the flotation process and the existing equipment includes tanks, pumps, lime storage and feed system and thickeners. Much of this equipment is similar to what would be needed for the water treatment plant. If additional water treatment is required immediately, that will preclude the use of any existing buildings or equipment that are currently used during operations. In addition, there is no imminent risk to any known current or future human receptor that would require a water treatment plant to be built immediately. Locating the sludge impoundment cells now needed for additional and immediate water treatment would require identifying an alternate location on the mine site for construction of the impoundment. The FS Report (Admin. Record – DocID Nos. 873842 and 9116332) identified sludge disposal and construction of impoundments at the North Detention Pond, which is currently a storm water management location. As the mine continues to operate, the North Detention Pond is an integral component of the storm water management system as required by DP-1055/1539 (Admin. Record – DocID Nos. 874123, 873857 and 874016), and NPDES MSGP Permit (No. NMR05GC01). Also, the current mining operations have increased the area used for stockpiling ore from the underground and required rerouting of one of the roads. This also decreases the area available for sludge disposal.

Alternate mine site locations for the sludge impoundments could require significant excavation of material, possibly waste rock pile material, to create an area suitable to build a lined impoundment of adequate size for sludge/filter cake disposal. The impoundment would require storm water runon/runoff control and possibly new access roads.

While timing would hopefully be considered in developing the remedial design, saying that all remedial alternatives would begin at "Year 0" is misleading to the public and creates false expectations that simply cannot be met. And it will not be EPA that will bear the brunt of the public's consternation when they learn this. Instead their frustration will be directed to CMI who will be accused of dragging their feet. The public deserves to be better informed and problems resolved, not created, by the remedy.

CMI is proposing a phased approach to ground water remediation that would take into account the needs of an operating mine but which could achieve ARARs and remedial action objectives in substantially the same time as the EPA proposal, yet at a significantly reduced cost. EPA is on record as favoring such a phased approach, especially where as here an expensive and complex ground water remedy is proposed. The remedy should include "phased implementation stages . . . that will be used to optimize the remedy for site conditions and increase cost-effectiveness".[97] EPA has recognized that phased approaches should be used wherever practicable as a means of achieving a cost effective remedy.[98] Because timing is a core concept for a phased approach, failure to consider it has raised serious impracticability problems for implementing EPA's proposed remedy.

Response 225: *See response to Comment No. 223 above.*

4.16 OTHER

Comment 226: The Rio Colorado Restoration Committee (RCRC) is committed to helping EPA with any activities that will protect the community and its resources, as well

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[97] USEPA. 1999. A Guide to Preparing Superfund Proposed Plans, Record of Decision, and Other Remedy Selection Decision Documents.
[98] USEPA. 1997. Rules of Thumb for Superfund Remedy Selection

as help CMI continue mining responsibly. Therefore, if EPA Region 6 is incapable or unwilling to meet the requirements of the Affected and Concerned Citizens guideline, EPA Region 6 should recues itself and allow EPA Region 8 to take over.

Response 226: *EPA acknowledges the RCRC's commitment to protecting the community and its resources. EPA Region 6 has the authority under CERCLA to conduct actions to protect human health and the environment and will continue to do so.*

Comment 227: The community is curious how long will CMI operate the mining property?

Response 227: *EPA will not speculate on how long CMI will operate the mine.*

Comment 228: Does CMI hold water rights for the ground water that is being pumped from the ground and diverted from the river?

Response 228: *EPA contacted the New Mexico Office of the State Engineer and confirmed that CMI has acquired the appropriate water rights for the diversion and use of this water in its mining and milling operations. While there are several orders and/or permits held by the Office of the State Engineer which cover the water rights for CMI's property, the most notable are the U.S. District Court, District of New Mexico, Court Order 9780, dated November 3, 1978, and the U.S. District Court, District of New Mexico, Final Judgment and Decree on Non-Federal Water Rights 72cv09780-JEC, dated December 1, 2000. For more information please see http://www.ose.state.nm.us/legal_ose_courtOrders_redRiver.html or call Steve Mastovich with the New Mexico Office of the State Engineer at 505-827-6120.*

Comment 229: The County of Taos has passed Resolution No. 2010-14, which states under Section 1 that the County urges CMI to work towards a prompt and responsible resolution of the proposed plan developed by EPA to remediate and mitigate the threats to public health and the environment caused by CMI's mining operations.

Response 229: *EPA acknowledges that the County of Taos has passed Resolution No. 2010-14 as described by the commenter.*