1118449

Five-Year Review Report

Fourth Five-Year Review Report

for

Central City/Clear Creek Superfund Site

Gilpin and Clear Creek Counties

Colorado

September 2009

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List of Acronyms

ac	"ACUTE STANDARD" means the level not to be exceeded by the concentration for either a single sample or calculated as an average of all samples collected during a one-day period.
ACD	Applicable or Relevant and Appropriate Requirements Compliance Document
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
CA	Cooperative Agreement
CCWF	Clear Creek Watershed Foundation
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIP	Community Involvement Plan
ch	"CHRONIC STANDARD" means the level not to be exceeded by the concentration for either a single representative sample or calculated as an average of all samples collected during a thirty-day period, except for temperature, which shall be based on the WAT (see WAT definition).
dis	"DISSOLVED METALS" means that portion of a water and suspended sediment sample which passed through a 0.40 or 0.45 um (Micron) membrane filter. Determinations of "Dissolved" constituents are made using the filtrate.
DMG	Colorado Division of Minerals and Geology
DOW	Colorado Division of Wildlife
DRMS	Colorado Division of Reclamation, Mining and Safety
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Difference
ft MSL	feet above mean sea level
gpm	gallons per minute
HDS	High Density Sludge
IC	Institutional Control
µg/L	microgram per Liter
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
OU	Operable Unit
PPA	Prospective Purchaser Agreement
ppm	parts per million
PRP	Potentially Responsible Party
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SCML	Secondary Maximum Contaminant Level
SHPO	State Historic Preservation Office
SSC	State Superfund Contract
TBC	To Be Considered
Trec	"TOTAL RECOVERABLE METALS" means that portion of a water and suspended sediment sample measured by the total recoverable analytical procedure.

TVS	Site-specific standards when those levels are determined to be appropriate to protect the applicable classified uses, and the available site-specific information does not indicate that one of the following alternative approaches to numeric standards would be more appropriate. Acute and chronic standards may be adopted.
UAA	Use Attainability Analysis
UAO	Unilateral Administrative Order
UCCWA	Upper Clear Creek Watershed Association
USFS	United States Forest Service
WET	Whole Effluent Toxicity
WTF	Water Treatment Facility
WTP	Water Treatment Plant
WQCC	Water Quality Control Commission
WQCD	Water Quality Control Division

Executive Summary

This document represents the fourth statutory Five Year Review. The Central City/Clear Creek Superfund Site (Site) was added to the National Priorities List in 1983. The Site consists of multiple mine waste piles, tailings impoundments, draining mine adits and impacted ground water resources within a 400-square-mile watershed. Historic mining and milling activities resulted in the watershed becoming contaminated with cadmium, copper, manganese and zinc all of which exceed water quality standards, significantly impact aquatic life and pose a threat to human health.

The Site consists of four Operable Units (OUs):

- OU 1 was designated to address acid mine drainage from five mine tunnels utilizing passive treatment. The technology was evaluated but was not considered to be feasible due to both the acreage requirements for the reactors and the inability of the technology to efficiently remove metals from the waste stream. OU 1 was amended by OU 3 and that amendment included the treatment of two of the five adit discharges. The other three mine discharges were transferred to OU 4 as this OU was focused to address sources of metals contamination within the North Fork of Clear Creek watershed. A protectiveness statement will not be issued for OU1 since the remaining three mine discharges will be evaluated with the completion of OU 4.

- OU 2 was designated to address remediation of mill tailings and mine waste rock associated with the five discharging tunnels specified in OU 1. OU 2 remedial actions are complete except for the Quartz Hill tailings impoundment which was also transferred to OU 4.

- OU 3 was designated to conduct a more comprehensive evaluation of the Clear Creek watershed including active treatment of two of the five OU 1 mine discharges.

- OU 4 focuses on sources of metals contamination to the North Fork of Clear Creek, a major tributary to Clear Creek, including waste rock and sediment controls on tributaries to the North Fork, the three remaining OU 3 adit discharges that impact the North Fork as well as the Quartz Hill tailings impoundment, located on Gregory Gulch, a tributary to the North Fork.

In addition, an amendment to the Operable Unit 3 and Operable Unit 4 Records of Decision for the Addition of an on-site repository was signed on September 25, 2006. This amendment allows materials that are subject to CERCLA response actions, such as waste rock and tailings piles, metals-contaminated sediment and water treatment solids, to be consolidated into an on-site repository. A 28.5-acre parcel in Gilpin County known as the Church Placer was acquired by the State of Colorado on October 30, 2008, for this purpose.

Several remedial actions have been performed to ensure protection of human health and to reestablish and protect a viable brown trout population. Acidic metals-laden mine waste rock piles and tailings impoundments have been addressed; two point-source discharges from draining mine adits were by the Argo Tunnel Water Treatment Plant and metals-contaminated ground water that impacted Clear Creek's water quality also was addressed by collection and conveyance to the Argo Tunnel Water Treatment Plant. Water treatment at the Argo facility has successfully reduced metals loading to Clear Creek by 99.9 percent.

The remedies completed prior to and during this five-year review period are functioning as intended and are protective. Remediation of mine waste rock piles and tailings identified for erosion control, capping or removal under OU4 was initiated in 2006 and will be completed in 2009. However, OU 4

remedial actions are not complete. The three remaining adit discharges will be treated in the future under OU4; the Quartz Hill tailings impoundment, now included under OU 4, requires stabilization or removal; and the OU4 North Fork of Clear Creek habitat, sediment reduction and channel stability improvements will be implemented in conjunction with an adjacent highway widening project.

In addition, five mine waste rock piles located at the headwaters of Virginia Canyon in Clear Creek County should be considered for removal to enhance the OU3 remedy, to eliminate further erosion of these piles and the release of metals-laden sediment to the residents of Idaho Springs and to Clear Creek. This project is economically viable with the construction of the site-wide repository. Previously, this project was not viable due to the prohibitive cost to remove and haul the waste rock to a more distant landfill.

A flow-through bulkhead, considered under OU3 for the Argo Tunnel to eliminate future surge events, should be evaluated.

A protectiveness determination of the OU 4 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including completion of the mine waste remediation and treatment of the remaining adit discharges associated with this OU. It is expected that these actions will take approximately three to five years to complete. The remedies that have been completed at the site remain protective.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name (from WasteLAN): Central City/Clear Creek		
EPA ID (from WasteLAN): COD980717557		
Region: 8	State: CO	City/County: Idaho Springs/Clear Creek
SITE STATUS		
NPL Status: ■ Final, □ Deleted, □ Other (specify)		
Remediation Status (choose all that apply): ■ Under Construction, ■ Operating, ■ Complete		
Multiple OUs? ■ Yes, □ No	Construction Complete date: 9/30/12	
Has site been put into reuse: Some properties of certain OUs have continued to be used and/or redeveloped. Please refer to text description for each OU.		
REVIEW STATUS		
Reviewing Agency: □ EPA, ■ State, □ Tribe, □ Other		
Author Name: Jim Lewis, Barbara Nabors, Warren Smith, Doug Jamison		
Author Title: Remedial Project Manager (Jim Lewis)	Author Affiliation: CDPHE/HMWMD	
Review period: May 2007 to September 2009		
Date(s) of site inspection: January 2006 upon completion of OU 4 Phase I; June 2007 project warranty inspection; August 2007 maintenance review; January 2008 upon completion of OU 4 Phase II; June 2009 Phase II warranty inspection.		
Type of Review: ■ Statutory, □ Policy (□ Post-SARA, □ Pre-SARA, □ NPL-Removal Only) □ Non-NPL Remedial Action Site, □ NPL State Tribe Lead		
Review number: □ 1 (first), □ 2 (second), □ 3 (third), ■ 4 (fourth)		
Triggering action: □ Actual RA Onsite Construction at OU#, □ Actual RA Start at OU#, □ Construction Completion, ■ Previous Five-Year Review,□ Other (specify)		
Triggering action date (from Waste LAN): 9/29/2004		
Due Date (five years after triggering action date): 9/29/2009		

Five-Year Review Summary Form, continued

Issues:

1. Gregory Incline and National Tunnel discharges and Gregory Gulch surface flow require treatment to eliminate the continued metals loading to the North Fork of Clear Creek. These flows represent the remaining sources of metals contamination to be addressed under OU 4 after completion of Phase III of the Sediment Control Measures and Mine Waste Remediation project.

2. The Remediation System Evaluation (RSE) for the Argo Tunnel Water Treatment Plant (2007) recommended an evaluation of surge protection for the Argo Tunnel. The report noted that "…a large surge event could occur during any season and could have significant impacts on the ecology of the creek and on downstream public water systems that draw water from Clear Creek. Therefore, the site stakeholders should come to agreement on how to address the potential for future surge events." The RSE recommendations are being implemented to the extent EPA funding was made available. The surge event protection evaluation should be conducted. If it is determined that surge event protection (i.e., a flow-through bulkhead) is warranted, ROD change documentation under OU4 would be necessary as this feature is not currently a ROD component.

3. Implementation of the Quartz Hill tailings impoundment project needs to be addressed per the existing design for this project.

4. North Fork of Clear Creek riparian corridor improvements in coordination with the CDOT SH 119 widening project and the corresponding remediation of waste piles and channel reconstruction and stabilization project.

Five-Year Review Summary Form, continued
Recommendations and Follow-Up Actions:

The CDPHE is developing a Proposed Plan that recommends addressing the National Tunnel and Gregory Incline discharges as well as surface water in Gregory Gulch with active treatment at a new plant due to new information arising since the OU4 ROD was signed.

Complete the evaluation of surge event protection for the Argo Tunnel.

Implement the Quartz Hill tailings impoundment project.

Continue coordination with CDOT on the SH 119 project and implementation of continued remedial actions to improve and protect the North Fork of Clear Creek riparian corridor.

Protectiveness Statement:

A protectiveness determination of the OU 4 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including completion of the mine waste remediation and treatment of the remaining adit discharges associated with this OU. It is expected that these actions will take approximately in the next three to five years. The remedies that have been completed at the site remain protective.

Other Comments:
The Silver Plume area continues to be a source of zinc loading to Clear Creek. This loading was identified as being related to unconnected mine workings located on both the west and east ends of the town of Silver Plume. The Burleigh Tunnel, located on the west end of the town, was at one time a point source discharge to Clear Creek. However, this is no longer the case. At the east end of the town, a non-point source discharge, equivalent in loading to the Burleigh Tunnel discharge, was identified as a secondary source of zinc loading and remains so. The OU 3 ROD does not call for treatment of ground water in the Silver Plume area. To the extent that Burleigh Tunnel discharge is no longer and impact, the OU3 ROD was amended to select No Action for the Burleigh Tunnel. In-stream concentrations of copper have been noted to increase on the Clear Creek mainstem between Georgetown and Idaho Springs. This increase is due, in part, to contributions from mining-impacted tributaries and small inflows from the McClelland Mine and Rockford Mine located within this reach of Clear Creek. The other part of the load most likely results from metals-contaminated ground water entering the base flow of Clear Creek along this reach of the mainstem. As a result, the concentrations of copper periodically exceed stream standards. At this time, no further response actions are planned to address copper in this reach. The Water Quality Control Division (WQCD) has lowered the stream standard for cadmium, resulting in potentially non-attainable levels for remedial actions within the Clear Creek watershed. It is highly unlikely that this reduced standard can be attained in all segments, regardless of the extent of remedial actions. The cadmium concentrations in the mainstem of Clear Creek do not affect aquatic resources and no further actions to address cadmium levels are planned. In 2005, EPA considered the removal of the Trio, Lower Clarissa, Diamond Joe, Williams/Rio Grande and Rattler Mine waste rock piles located at the headwaters of Virginia Canyon in Clear Creek County to enhance the OU3 ground water remedy associated with this drainage. These piles are subject to erosion, culminating in the transport of metals-contaminated sediment to the town of Idaho Springs and Clear Creek. EPA requested an evaluation of the piles and CDPHE prepared an evaluation report. However, at that time, the project cost was exceeded EPA funding availability. The project is now economically viable due to the ability to re-locate the mine waste to the Site-wide repository property acquired in 2008. EPA Region 8 Emergency Response Program has expressed interest in conducting a removal action for these piles. CDPHE will continue to coordinate with Region VIII on this removal project.

1.0 INTRODUCTION

The purpose of the five-year review is to determine whether remedies implemented at the Central City/Clear Creek National Priority List Site located in Clear Creek and Gilpin Counties, Colorado are protective of human health and the environment. The methods, findings and conclusions of reviews are documented in Five Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and recommendations to address them. This five-year review report summarizes the status of actions taken pursuant to the Superfund Records of Decision (RODs) for the Site. This five-year review is a statutory review required of the Site under the Comprehensive Environmental Response, Compensation Liability Act (CERCLA) Section 121 and the National Contingency Plan for Oil and Hazardous Substances (NCP).

The purpose of the five-year review is to determine whether remedial actions implemented at the Site are protective of human health and the environment and to recommend measures to attain or maintain

that protection. In addition, five-year review reports identify issues found during the review, if any, and provide recommendations to address them. In accordance with the Comprehensive Five-Year Review Guidance, EPA 540-R-01-007, June 2001 this five-year review does not reconsider decisions made during the remedy-selection process, but rather evaluates the implementation and performance of the selected remedies.

The State of Colorado Department of Public Health and Environment (CDPHE) conducted this five-year review of the remedial actions implemented at the Site under a cooperative agreement with the United States Environmental Protection Agency (EPA) (V 978401-01). This review was conducted from March 2009 through September 2009. This report documents the results of the review. EPA Region 8 assisted in this review.

This is the fourth five-year review for the Site. The first five-year review, completed in March 1994, was triggered by the 1989 remedial actions at the Argo tailings and waste rock pile and the Gregory Incline tailings pile. A second five-year review was completed in March 1999. The third five-year review was completed in March 2004. In keeping with the requirements of CERCLA §121 (c) and the NCP, the subsequent five-year review is triggered by the signature date of the previous five-year review.

The CDPHE Community Involvement Program is committed to promoting communication between citizens and CDPHE. The Community Involvement Plan (CIP) Revision describes the community involvement and public participation program developed for the Site. This CIP Revision, dated September 2009, was developed in coordination with the EPA and updated the previous CIP, dated September 2004. Concurrent with the five-year review, state and EPA community involvement coordinators conducted interviews and revised the plan. The updated CIP is attached as Appendix C.

The results of this fourth five-year review indicate that the remedies implemented to date to address immediate and long-term health and environmental risks are functioning as expected. A protectiveness determination of the OU 4 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including completion of the mine waste remediation and treatment of the remaining adit discharges associated with this OU. It is expected that these actions will take approximately in the next three to five years. The remedies that have been completed at the site remain protective.
Furthermore, those remedies are protective while the remedial actions at other operable units were not completed at the time of this compilation and the protectiveness of those remedies cannot be determined. Because hazardous substances, pollutants or contaminants remain at the Site, another five-year review will be required in September 2014.

2.0 SITE CHRONOLOGY

The following table provides a summary of the Site chronology:

Table 1: Chronology of Events

Event	Date
NPL listing	September 8, 1983
Time-Critical Removal Actions	March 1987 – August 1991
Remedial Investigation/Feasibility Study complete	June 8, 1987
OU1 ROD signature	September 30, 1987

Table 1 continued: Chronology of Events	
OU2 ROD signature	March 31, 1988
Transfer of lead status to CDPHE	June 1988
OU2 Remedial Actions	Start September 1991 – Complete May 2003
Phase II Remedial Investigation/Feasibility Study complete	September 1991
OU3 ROD signature	September 30, 1991
OU3 Administrative Orders on Consent	February 1993 – September 1998
OU3 Potentially Responsible Party Removals	Start June 1993 – Complete November 1996
First Five-Year Review	**March 30, 1994**
OU3 Unilateral Administrative Orders	July 1994 – September 1997
OU3 Remedial Actions complete	Start January 1995 – End September 1999
OU3 Potentially Responsible Party Remedial Action complete	Start February 1995 – End August 2000
OU3 Non-Time Critical Removal Actions complete	Start November 1996 – Complete December 1998
Second Five-Year Review	**March 26, 1999**
OU2 ROD Explanation of Significant Differences	September 1, 1999
Argo Tunnel Water Treatment Plant operational and functional	September 28, 1999
OU3 ROD Amendment	June 5, 2003
OU4 Remedial Investigation/Feasibility Study complete	September 29, 2004
OU4 ROD signature	September 29, 2004
Third Five-Year Review	**September 29, 2004**
Reorganize remaining OU2 and 3 projects under OU4	June 2006
Amendment to OU3 & OU4 ROD (Repository)	September 25, 2006
Remediation System Evaluation for Argo Tunnel WTP	September 27, 2007
Acquisition of repository property	October 30, 2008
Fourth Five-Year Review	**September 30, 2009**
OU 3 Argo Tunnel Treatment Plant O&M transferred to state	October 1, 2009

3.0 SITE BACKGROUND and REGULATORY COMPLIANCE

SITE BACKGROUND

The Site is located on the east slope of Colorado's Front Range approximately 30 miles west of Denver. The Clear Creek drainage basin encompasses roughly 400 square miles and has elevations ranging from 5,700 feet above mean sea level (ft MSL) to more than 13,000 ft MSL. The cities of Central City, Black Hawk, Idaho Springs, Silver Plume and Empire are located within the watershed near the Clear Creek mainstem and/or its major tributaries. Designated uses of Clear Creek include recreation, agriculture and drinking-water supply. Downstream, Clear Creek empties into the South Platte River just north of Denver.

The Site was added to the Superfund National Priorities List (NPL) in September 1983. Over the next several years, the Environmental Protection Agency (EPA) initiated Remedial Investigations and Feasibility Studies (RI/FS) at the Site. Several removal actions also were conducted at the Site by EPA's Emergency Response Branch.

The Site is transected by the Colorado Mineral Belt, the location of numerous ore bodies developed in the late 1800s and through the 1900s by extensive underground mine workings. Tertiary Age veins and stocks within the host rock are the sources of sulfide ores that contain deposits of several minerals including gold, silver, iron, copper, lead, nickel, zinc, cadmium, manganese and others. The area has been heavily mined, beginning with the discovery of placer gold in Idaho Springs in 1859 and followed quickly by the first lode discovery in Gregory Gulch.

Historic mining resulted in modern-era environmental problems. Placer mining required the removal of stream substrate and relocation of stream channels. Mine tunnels continue to drain acidic metals-laden water. Mine waste and mill tailings piles were left unprotected throughout the watershed. Total and dissolved iron, zinc, copper, cadmium, manganese, lead and arsenic associated with the mine discharges flow into Clear Creek and its tributaries and negatively impact the ecology and water quality of these water bodies.

Modern urbanization also has impacted Clear Creek. The towns of Silver Plume, Georgetown and Idaho Springs have encroached on the stream. Construction of U.S. 6, U.S. 40 and I-70 has caused significant channelization of Clear Creek and created runoff of vehicle waste, traction sand and chemical de-icer from the roadway. The legalization of gaming in Black Hawk and Central City has increased traffic, impacted the North Fork of Clear Creek, and has altered the landscape with the removal of steeply sloped hillsides to allow casino development.

The objectives of the planned remedial actions are to protect human health and the environment. The specific remedial action objectives for the Site are to protect humans from the potentially harmful effects of metals, especially lead and arsenic, to which they can be exposed via contact with tailings and waste rock material. A second objective is to protect humans from exposure to harmful levels of metal in contaminated private drinking water supplies. Finally, EPA and CDPHE seek to restore the water quality of Clear Creek to a condition that protects aquatic species.

EPA initially designated three Operable Units for the Site. Operable Unit 1 was designated to address treatment of acid mine drainage from five mine tunnels. Operable Unit 2 was designated to address remediation of mine tailings and waste rock in the immediate proximity of the five discharging tunnels specified in Operable Unit 1. Operable Unit 3 was designated to address control of surge events from the Argo Tunnel.

A Record of Decision (ROD) for Operable Unit 1 (OU1) was signed September 30, 1987. The ROD for Operable Unit 2 (OU2) was signed March 31, 1988. In August 1988, EPA completed the Argo Tunnel Discharge Control Feasibility Study. The purpose of the study was to evaluate alternatives for reducing the sources of water into the Argo Tunnel such as alluvial ground water or snow buildup inside mine shafts and for controlling or reducing the likelihood of a sudden surge of acid water (a blowout) from the Argo Tunnel. The ROD for Operable Unit 3 (OU3) was delayed pending additional studies, as discussed below.

In June 1988, the U.S. Bureau of Reclamation was assigned the lead for the remedial design of OU2. Remedial action was completed at two of the five tailings and waste rock piles before work on OU2 was temporarily suspended. EPA gave the lead for remedial design for the remaining OU2 properties to CDPHE on September 21, 1995.

In June 1988, EPA transferred the lead role for the Site, excluding OU2 remedial design, to CDPHE via a cooperative agreement (CA V008534-01). CDPHE initiated a comprehensive evaluation of the Site via the Phase II Remedial Investigation and Feasibility Study (RI/FS). The Phase II work expanded the original study area to encompass the entire watershed. Camp Dresser and McKee completed the Phase II RI in September 1990 and the Phase II FS in June 1991. The Record of Decision for the Phase II studies was signed September 30, 1991, and is referred to as the OU3 ROD. The OU3 ROD amended the OU1 ROD and also included a final decision for the original OU3.

In October 1991, soon after the OU 3 ROD was signed, Colorado voters approved limited-stakes gambling in the cities of Black Hawk and Central City. Land values increased rapidly and a significant increase in construction activity ensued. Several private entities stepped forward to conduct remedial actions that once had been targeted for fund-lead tasks. EPA's remedial planning activities were impacted as a result, with a shift of emphasis from fund-lead to enforcement activities.

The OU3 ROD delayed the final decision on treatment of the Gregory Incline, National and Quartz Hill tunnels pending treatability studies. This decision became the basis of a new operable unit, Operable Unit 4 (OU4), to address remaining mine adit discharges and to control erosion and metals-contaminated sediment from waste rock piles to the North Fork of Clear Creek.

The OU4 ROD focused on the North Fork of Clear Creek watershed. The OU 4 ROD was signed September 24, 2004. In June 2006, CDPHE submitted a cooperative agreement application (V-97814001) to request federal funding assistance to implement the OU4 remedial actions. With the agreement, the site was reorganized to implement the remaining OU2 and OU3 projects, specifically the Quartz Hill mine waste pile and the Golden Gilpin mine waste site, under OU4.

REGULATORY COMPLIANCE

Consistent with Section 121(c) of CERCLA, as amended, and Section 300.430(f)(4)(ii) of the NCP, CDPHE as lead, and on behalf of EPA, is performing the five-year review for the Site. A statutory five-year review is required when the selected remedial action at a Site results in any hazardous substances, pollutants or contaminants remaining at a site above levels that allow for unlimited use and unrestricted exposure. The five-year review shall be conducted every five years after initiation of such remedial action. The purpose of the five-year review is to ensure that the remedial actions conducted at the Site remain protective of public health and the environment and are functioning as designed.

3.1 Statutory Review

A statutory five-year review is required at any site where unlimited use and unrestricted exposure, based on ROD cleanup levels, have not been attained (EPA, 1991). A five-year review is required no less than every five years after initiation of the selected remedial action. EPA prepared five-year reviews for the Site in 1994 and 1999. The 2004 five-year review was prepared by CDPHE. Future five-year reviews will be prepared by EPA or upon designation, by CDPHE. Reviews entail a site visit to review the status of the implemented remedy and to determine the protectiveness of the remedy with respect to human health and the environment. This document presents the results of the 2009 review.

3.2 Applicable or Relevant and Appropriate Requirements

As part of the five-year review, Applicable or Relevant and Appropriate Requirements (ARARs) developed during previous Site evaluations were reviewed. The primary purpose of this review was to determine if any newly promulgated or modified requirements of federal or state environmental laws have significantly changed the protectiveness of the remedies implemented at the Site. The ARARs reviewed were those included in the OU2, OU3 and OU4 RODs. The OU1 ARARs were not reviewed because OU1 was superseded by OU3 and the ARARs from OU 1 were transferred to OU 3.

3.2.1 Colorado Water Quality Control Act

The surface-water remedial action objective developed during the Phase II studies is to "reduce metals loading to streams from point discharges in order to reduce in-stream metals concentrations to levels protective of aquatic life." The OU3 ROD stated:

> "The Selected Alternative may not achieve Colorado state table value standards on Clear Creek below the confluence with the West Fork of Clear Creek. EPA and [CDPHE] will monitor the effectiveness of the remedy after it is implemented to determine if state table value standards are achieved. If they are not achieved, an evaluation will be made to determine if additional cleanup is required, or, it may be determined that a site-specific state stream standard can be established which is protective of the uses of Clear Creek."

Remedial actions have occurred with the general objective of providing protection to brown trout in Clear Creek's mainstem as well as major tributaries. In addition to that goal, the agencies have continually evaluated the goal of compliance with ARARs by comparing ambient water quality to the water quality criteria outlined in regulations promulgated under the Colorado Water Quality Control Act.

Since the signing of the OU2 (March 1988), OU3 (September 1991) and OU4 (September 2004) RODs, the Colorado Water Quality Control Commission (WQCC) has adopted several changes in Regulation 38 – Classification and Numeric Standards for the South Platte River Basin, which includes the Clear Creek mainstem and Clear Creek tributaries. The historical chronology of development and changes of the stream standards of interest (trace metals) through September 2004 is outlined in the 2004 Five-Year Review.

Since the 2004 review, the WQCC has further amended Regulation 38. In February 2009, the WQCC changed the temporary modifications for Clear Creek Segment 11 (mainstem from the Argo Tunnel discharge to the Farmers Highline Canal diversion in Golden, Colorado) and the North Fork of Clear Creek Segment 13b (mainstem of the North Fork including all tributaries, lakes, reservoirs and

wetlands from the source to the confluence with Clear Creek). The amended stream standards are presented in the table below in red and compared to the OU4 ROD remediation goals (presented in black) for both high- and low-flow periods. The standards for copper are numeric and shown in blue. The stream standards presented in the table became effective on March 30, 2009.

Metal	Remediation Goals (µg/L)		
	Flow Regime	North Fork (Segment 13b)	Clear Creek below Idaho Springs (Segment 11)
Zinc (dissolved)	High-Flow	381**(1582 ch)**	200 **(325 ch)**[1]
	Low-Flow	675 **(1582 ch)**	300 **(325 ch)**[1]
Copper (dissolved)	High-Flow	7.4 **(64 ch)**	5.2 **(17 ch)**
	Low-Flow	15.1**(64 ch)**	9.2 **(17 ch)**
Cadmium (dissolved)	High-Flow	1.9 **(4.7 ch)**	1.4 (TVS)
	Low-Flow	3.5 **(4.7 ch)**	2.3 (TVS)
Manganese (dissolved)	High-Flow	1,531 **(3841)**	600 (50 WS)
	Low-Flow	2,021 **(3841)**	600 (50 WS)

[1] Value presented is a temporary modification. The numeric standard is 300µg/L.

The WQCC conducted another hearing during June 8 and 9, 2009 as part of its triennial rule-making process. At that time the Clear Creek standards were revised again. The following tables summarize the revisions resulting from this most recent rule-making hearing:

Clear Creek Stream Classifications and Standards prior to June 2009 Rule-Making Hearing

Stream Segment	Classification	Numeric Standards	Temporary Modification
2. Mainstem of Clear Creek, including all tributaries, lakes, reservoirs and wetlands from the I-70 bridge above Silver Plume to the Argo Tunnel discharge, except for specific listings in Segments 3 though 10	Aquatic Life Cold 1 Recreation 1a Water Supply Agriculture	Zinc (ac) – TVS Zinc (ch) – 200 µg/l (dis)	Cu (ch) = 7.4 µg/l (dis) Zn (ch) = 254 µg/l (dis)
3a. Mainstem of South Clear Creek including all tributaries lakes, reservoirs and wetlands from the source to the confluence with Clear Creek except for the specific listing in 3b and 19	Aquatic Life Cold 1 Recreation 1a Water Supply Agriculture	Zinc (ac) – TVS Zinc (ch) – TVS	
3b. Mainstem of Leavenworth Creek from the source to confluence with South Clear Creek	Aquatic Life Cold 2 Recreation 1a Water Supply Agriculture	Zinc (ac) – TVS Zinc (ch) – TVS	
11. Mainstem of Clear Creek from the Argo Tunnel discharge to the Farmers Highline Canal diversion in Golden, Colorado	Aquatic Life Cold 1 Recreation 1a Water Supply Agriculture	Zinc (ch) – 300µg/l (dis)	Zn (ch) = µg/l (dis)
13b. Mainstem of North Clear Creek, including all tributaries, lakes, reservoirs and wetlands from the source to the confluence with Clear Creek	Aquatic Life Cold 2 Recreation 1a Agriculture	Zn (ch) – 740 µg/l (dis)	Cd (ch) = 4.7 µg/l (dis) Mn (ch) = 3841µg/l (dis) Zn (ch) = 1582 µg/l (dis) Fe (trec) = 7941

Clear Creek Stream Classifications and Standards Promulgated during June 2009 Rule-Making Hearing

Stream Segment	Classification	Numeric Standards*	Temporary Modifications**
2a. Mainstem of Clear Creek, including all tributaries and wetlands from the I-70 bridge above Silver Plume to a point just above the confluence with West Fork Clear Creek except for specific listings in Segments 3a and 3b	Aquatic Life Cold 1 Recreation E Water Supply Agriculture	Zn (ac) $0.978e^{(0.8537\{\ln(\text{hardness})\})+1.9467}$ Zn (ch) $0.986e^{(0.8537\{\ln(\text{hardness})\})+1.8032}$	Zn (ch) = 353 µg/l (dis) Zn (ac) = 586 µg/l (dis) type i Cd (ch) = 1.54 µg/l (dis) type iii
2b. Mainstem of Clear Creek, including all tributaries and wetlands from a point just above the confluence with West Fork Clear Creek to a point just below the confluence with Mill Creek, except for specific listings in Segments 4 through 8	Aquatic Life Cold 1 Recreation E Water Supply Agriculture	Zn (ac) TVS Zn (ch) TVS	
2c. Mainstem of Clear Creek, including all tributaries and wetlands from a point just below the confluence with Mill Creek to a point just above the Argo Tunnel discharge, except for specific listings in Segments 9a, 9b, and 10	Aquatic Life Cold 1 Recreation E Water Supply Agriculture	Zn (ac) $0.978e^{(0.8537\{\ln(\text{hardness})\})+1.9467}$ Zn (ch) $0.986e^{(0.8537\{\ln(\text{hardness})\})+1.8032}$	Cu (ch)=11.4 1.54 µg/l (dis) type iii
3a. Mainstem of South Clear Creek including all tributaries and wetlands, from the source to the confluence with Clear Creek except for the specific listing in 3b and 19	Aquatic Life Cold 1 Recreation E Water Supply Agriculture	Zn (ac) $0.978e^{(0.8537\{\ln(\text{hardness})\})+1.9467}$ Zn (ch) $0.986e^{(0.8537\{\ln(\text{hardness})\})+1.8032}$	
3b. Mainstem of Leavenworth Creek from the source to the confluence with South Clear Creek	Aquatic Life Cold 2 Recreation E Water Supply Agriculture	Zn (ac) $0.978e^{(0.8537\{\ln(\text{hardness})\})+1.9467}$ Zn (ch) $0.986e^{(0.8537\{\ln(\text{hardness})\})+1.8032}$	
11. Mainstem of Clear Creek from the Argo Tunnel discharge to the Farmers Highline Canal diversion in Golden, Colorado	Aquatic Life Cold 1 Recreation E Water Supply Agriculture	Zn (ac) $0.978e^{(0.8537\{\ln(\text{hardness})\})+1.9467}$ Zn (ch) $0.986e^{(0.8537\{\ln(\text{hardness})\})+1.8032}$	Cd(ch)=1.42 54 µg/l (dis) type iii
13b. Mainstem of North Clear Creek including all tributaries and wetlands from a point just below the confluence with Chase Gulch to the confluence with Clear Creek, except for the specific listings in segment 13a	Aquatic Life Cold 2 Recreation E Agriculture	Zn (ch) – 740 µg/l (dis)	Cd (ch) = 4.7 µg/l (dis) Mn (ch) = 3841µg/l (dis) Zn (ch) = 1582 µg/l (dis) Fe (trec) = 7941

*For all new segments established during the 2009 rule-making hearing, the WQCC adopted table value standards or other basic numeric standards for all metals not specifically listed in this table. The WQCC also adopted new basic standards for arsenic and chromium III that will be applied to all segments unless otherwise noted in Regulation 38.

**The temporary modification adopted for the listed Clear Creek segments have an expiration date of July 1, 2014. After that date the standards will be re-assessed in the triennial review. Type (i) modification used where the standard is not being met because of human-induced conditions deemed correctable within a twenty (20) year period. Type (iii) modification used where there is significant uncertainty regarding the appropriate long-term underlying standard.

Response actions completed to date have resulted in significant water quality improvements in several segments within the Superfund Study Area. At the time of this review, several segments are attaining the surface water quality standards outlined in Regulation 38. However, specific metals such as zinc and copper continuously exceed promulgated water quality standards in a number of segments.

In some segments, completion of planned response actions should result in significant water quality improvements. For example, once the OU4 remedy is completed, water quality is expected to improve in segments 13b and 11. As response actions continue, the agencies will evaluate improvements in water quality to determine if existing standards are being attained. If standards are not attained, the agencies will evaluate the need for site-specific water quality criteria that remain protective of the designated uses. Where appropriate, the agencies may propose revisions to existing water quality criteria.

Although future response actions will improve water quality in some segments, other segments, including some that periodically exceed standards for one or more metals, will not be improved by the future response actions. The most notable of these segments is Segment 2a, where zinc levels frequently exceed existing standards. Because ARARs are not being met and in response to stakeholder interest, the EPA and CDPHE agreed as part of the stakeholder outreach associated with the Colorado Water Quality Control Commission 2009 South Platte Basin triennial rulemaking hearing, to conduct further study. To address this issue, the agencies plan to conduct an evaluation of aquatic conditions, including habitat, to determine the appropriate biological expected condition for this segment. In addition the agencies will analyze the feasibility of zinc-loading reductions through additional mine waste source control. The results of this investigation, conducted as part of OU4, will help determine if existing standards might be attained, or if site-specific water quality criteria are necessary for this segment.

3.2.2 Safe Drinking Water Act

A new standard for arsenic in drinking water has become effective since the last five-year review, lowering the Maximum Contaminant Level (MCL) from 50 µg/L to 10 µg/L. EPA promulgated the new standard on January 23, 2006. The new arsenic MCL of 10 µg/l became effective before it was adopted in Colorado on May 31, 2008.

The new standard may affect residences using private ground water wells as a domestic water supply. As part of the selected remedy for OU3, CDPHE conducted an evaluation of domestic water supply wells between 1994 and 1996. During operation of the Clear Creek Drinking Water Program, CDPHE offered sampling to domestic well owners within the Superfund Study Area who were not connected to a public water system.

Approximately 60 homeowners with domestic wells asked to participate in the program. CDPHE visited each residence to collect water samples (typically from the kitchen tap), and samples were shipped to the U.S. EPA Region VIII Environmental Services Division Laboratory for metals analysis. Over the two-year period, samples were analyzed using two different EPA methods with different detection limits for arsenic. Early in the program, samples were analyzed using method 200.7, which has a method detection limit of 50 micrograms per liter (µg/L). Later in the program, samples were analyzed using method 200.9, for which the method detection limit is typically 5.0 µg/L or lower. Approximately 50 percent of the samples collected during the program were analyzed using method 200.7, and levels of arsenic were below the method detection limit in all of those samples. For the remaining 50 percent of samples, arsenic analyses were conducted using method 200.9. For most of the samples analyzed using method 200.9, arsenic was not detected above the method detection

limit. Arsenic was detected in three of those samples at levels ranging from 1.1 to 2.3 µg/l, well below the recently promulgated MCL of 10 µg/L.

Under the drinking water program, where concentrations of one or more trace metal were found at levels greater than the MCL, CDPHE provided an alternate drinking water source or individual wellhead treatment system. Of the 60 private wells sampled, only four were found to have elevated concentrations of one or more metals. Of the four wells eligible for alternate supply or treatment, arsenic was not one of the contaminants of concern.

CDPHE coincidentally collected several opportunity samples during sampling for the drinking water program, some from mine waste source areas. For convenience, opportunity samples were submitted for analysis along with the drinking water program samples. Two samples were collected from ponds adjacent to the Boodle Mill in Central City. Water in the ponds was suspected to have been a combination of surface water run-off and shallow, contaminated ground water. Analytical results using method 200.9 showed that the pond water contained highly elevated levels of cadmium, lead, copper, manganese and zinc. However, the highest level of arsenic detected in samples from the Boodle Mill ponds was 4.7 µg/L, well below the MCL of 10 µg/L.

Arsenic standards were changed and there was a concern that owners of domestic wells might be affected by the change in that they would have to "upgrade" their systems to address the change in standards. However, the available drinking water program data indicates that arsenic does not appear to be a contaminant of concern for private drinking water supply wells, even when other contaminants are detected above MCLs. This conclusion is supported by concurrent data collected from mine waste source areas that shows arsenic levels to be below the drinking water MCL even when other metals are present at high levels. Therefore, no additional sampling of private domestic wells is recommended at this time.

3.2.3 To Be Considered Documents

In July 1994, EPA issued Directive #9355.4-12, Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites. In December 1997, CDPHE issued a policy document entitled Proposed Soil Remediation Objectives. The soil concentrations provided in these documents are To Be Considered (TBC) health-protective benchmarks rather than ARARs. Soil clean-up levels used at the Site were derived from site-specific risk-based calculations consistent with approaches allowed in these guidance documents. EPA and CDPHE will continue to monitor the Site, and any future changes or modifications in ARARs will be reported in the next five-year review.

4.0 REMEDIAL ACTIONS

This section discusses each of the four Site operable units with respect to the description, background and remedial action objectives for each operable unit with an emphasis on OU4, as projects related to this operable unit were initiated in 2006. The reader is referred to the 2004 Five-Year review for more detail on remedial actions previously implemented under Operable Units 1, 2 and 3. The overall remedy implemented to date for all four of the operable units is judged to be protective of human health and the environment.

4.1 Operable Unit 1

4.1.1 Description

OU1 was designated to specifically address treatment of the acid mine drainage from five tunnels:

Table 1
Operable Unit 1

Operable Unit	Source Name at Time of ROD	Location	Status
OU1	National Tunnel	Black Hawk	To Be Completed Under OU 4
OU1	Gregory Incline Tunnel	Black Hawk	To Be Completed Under OU 4
OU1	Quartz Hill Tunnel	Central City	To Be Completed Under OU 4
OU1	Argo Tunnel	Idaho Springs	Complete
OU1	Big Five Tunnel	Idaho Springs	Complete

These discharges posed a threat to the water quality of Clear Creek, drinking water systems withdrawing water from Clear Creek, existing aquatic resources in Clear Creek and humans and wildlife that may come in contact with the discharges or consume fish exposed to the metals in the surface flow of Clear Creek.

4.1.2 Background

Surface water at the Site is impacted by the direct discharge from mine drainage tunnels. These discharges are characterized by low pH values and high concentrations of metals including aluminum, arsenic, cadmium, chromium, copper, lead, manganese, nickel, silver and zinc.

4.1.3 Remedial Action Objectives

The OU1 ROD was signed in September 1987 (EPA/ROD/R08-87/016). Recognizing that the tunnels covered under OU1 were only one of several factors contributing to water-quality and aquatic-habitat degradation, EPA denoted that the OU1 ROD selected remedy was an interim remedy. This interim remedy was to comprise the construction of passive-treatment systems to treat acid mine drainage discharging from each tunnel (Table 1), contingent on the successful completion of pilot studies. If the pilot studies did not show passive treatment to be effective, the OU1 ROD allowed the flexibility to revert to active treatment. The results from pilot scale demonstration studies within the Site to evaluate the passive treatment wetlands technology to remove metals from the discharges determined that the technology was inefficient with respect to metals removal, the wetlands were unable to with stand the harsh winter conditions in the mountains during the winter months and the wetlands required several acres of land that is unavailable in the small towns were the wetlands would need to be constructed.

4.1.4 Summary of Remedial Actions

OU 1 called for treatability studies of passive systems at the mine adits. Treatability studies performed by the Colorado School of Mines at the Big Five Mine Tunnel indicated that a large area to construct wetlands would be necessary for successful metals removal to occur, rendering this option infeasible. Concurrently with these studies, the Phase II investigation was initiated to evaluate the Site comprehensively. Full-scale application of passive treatment has not been implemented at any of the

five tunnels. The OU1 ROD was amended by the OU3 ROD to consider active treatment of the discharges, an element of the OU 1 ROD.

A protectiveness determination of the OU 1 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including completion of the treatment of the Gregory Incline, Quartz Hill and National Tunnel discharges. It is expected that these actions will be completed in the next three to five years. The remedies that have been completed under this OU remain protective.

4.2 Operable Unit 2

4.2.1 Description

OU2 was designated specifically to address the remediation of waste rock in the immediate proximity of the five discharging tunnels addressed under OU1, summarized in the following table:

Table 2
Operable Unit 2

Operable Unit	Source Name at Time of ROD	Location	Status
OU2	National Waste Pile	Black Hawk	Complete
OU2	Gregory Incline Waste Pile	Black Hawk	Complete
OU2	Quartz Hill Waste Pile	Central City	To Be Completed Under OU 4
OU2	Argo Waste Pile	Idaho Springs	Complete
OU2	Big Five Waste Pile	Idaho Springs	Complete

These waste rock piles were subject to intense erosion during precipitation events. The run-off from the piles posed a threat to the water quality of Clear Creek, drinking water systems withdrawing water from Clear Creek, existing aquatic resources in Clear Creek and humans and wildlife that may come in contact with them. Additionally, the fine-grained material was easily transported from the piles into residential areas during wind events.

4.2.2 Background

Waste rock piles contribute contaminants in a variety of ways, including runoff from the piles carrying dissolved and suspended metals; the potential for collapse of unstable piles into surface waters; and human uptake of metals from inhalation of dust or ingestion of materials from the piles.

Fund-lead remedial actions at OU2 were performed under Cooperative Agreement V 998764-01.

4.2.3 Remedial Action Objectives

The OU2 ROD, dated March 31, 1988 (EPA/ROD/R08-88/019), selected remedial actions to include:

- Slope stabilization at the Big Five and Gregory Incline waste rock piles
- Monitoring of the gabion wall at the Gregory Incline and
- Run-on control at the Argo, Big Five, Gregory Incline, National and Quartz Hill waste rock piles.

Similar to the OU1 ROD, the OU2 ROD indicated the selected remedies were interim remedies, because the net beneficial impact to the Site would not be realized until completion of the other operable units.

CDPHE issued an Explanation of Significant Differences (ESD) for OU2 in September 1999. The ESD was necessary because, subsequent to the OU2 ROD, site-specific information regarding risks from lead and arsenic exposure were developed and EPA issued new Clean Water Act storm water regulations, both of which impacted the OU2 remedy. The ESD presents the changes that were made to the remedy selected for OU2. Briefly, the changes include:

- Re-grading of the Argo waste pile to remove its toe from Clear Creek
- Capping and constructing a retaining wall along a portion of the Argo waste pile toe
- Constructing run-off controls along the Argo waste pile toe
- Capping the top of the Argo waste pile
- Capping the Big Five waste pile
- Constructing a retaining wall and re-grading the Big Five waste pile

4.2.4 Summary of Remedial Actions

All of the OU2 response actions are complete except the Quartz Hill mine waste pile. These response actions included slope stabilization; capping; run-on and run-off controls; and/or mine waste removal at the Argo tailings and water rock pile, Gregory Incline tailings pile, Big Five waste rock pile and Argo waste pile. Removal actions were conducted by private parties to comprehensively remediate the Gregory Incline and National waste piles as development occurred on the properties. These actions are detailed in the Third Five-Year Review Report.

Quartz Hill Mine Waste Pile – The OU2 ROD selected in-place capping for the Quartz Hill mine waste pile to stabilize the pile and improve Clear Creek surface water quality, by preventing run-on from contacting mine waste. In February 2006, CDPHE contracted with an engineering firm, Tetra Tech RMC, to design the Quartz Hill mine waste pile remediation. The key components of the design include: 1) re-grading of the side slopes to a 2:1 grade and capping with a rock cover, 2) placement of gravel road base on the parking area surface, 3) construction of run-on and run-off controls, and 4) installation of a new high-density polyethylene (HDPE) storm drainage system and abandonment of the existing storm culvert. The remedial design was completed to the construction documents stage in September 2006. CDPHE coordinated with EPA enforcement regarding ownership and access. The joint project approach included first notifying affected private parties of the proposed design to provide them the opportunity to comment or to propose their own development plans. In 2007, the EPA filed notices of intent to file liens on the properties on which the waste pile is located. CDPHE transmitted copies of the design along with an introductory letter to land owners in December 2006.

In 2007, CDPHE and EPA also met with a prospective purchaser of the site. In spring 2008, the EPA's liens were finalized and property owners received notices. EPA and CDPHE continue to be open to discussions with landowners and prospective purchasers that would include private-party implementation of a remedy. A specific timeframe for having CDPHE and EPA implement a remedy in lieu of private party implementation has not been set. In July 2009, a new Colorado law went into effect that allows higher stakes gaming. This change may lead to renewed private-party interest in development of the Quartz Hill waste pile site. In August 2009, EPA requested the property owners implement tolling agreements to toll the running of any applicable statute of limitations. This action was taken to preserve the potential to recover funds should EPA and CDPHE implement a remedy on the property.

In June 2006, OU 2 was reorganized to include and implement the Quartz Hill mine waste pile under the OU 4 ROD.

A protectiveness determination of the OU 2 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including completion of the mine waste remediation at the Quartz Hill pile. It is expected that these actions will take approximately three to five years to complete. The remedies that have been completed under this OU remain protective.

4.2.5 Operations and Maintenance

Operations and maintenance (O&M) is required at several of the OU2 waste piles and pipelines. CDPHE performs annual O&M inspections and develops a report of its findings and corrective actions. The most recent report was completed in April 2009. All of the completed OU2 remedies were inspected. The City of Idaho Springs is performing O&M at the Big Five waste pile under a Prospective Purchaser Agreement and submits an annual report to EPA and CDPHE. The 2008 report concluded the site was in good condition and reported on minor maintenance activities completed by the city that year. CDPHE is responsible for O&M of the Argo waste pile. In 2009, CDPHE contracted for maintenance work that included removal of accumulated sediment in on-site retention basins and in front of the portal, reestablishment of drainage swales and ditches, and placement and compaction of clean fill along the top of the waste pile to improve drainage. O&M for the Gregory Incline and National waste piles was performed by their respective respondents during the first five years after completion of the response action but is no longer required as casino development has resulted in the paving over of the location where the waste piles were located. CDPHE performs periodic cleaning of the National and Gregory Incline pipelines to remove sediment buildup. CDPHE most recently arranged for the clean out of these tunnels in August 2006.

4.3 Operable Unit 3

4.3.1 Description

Operable Unit 3 encompasses the entire Clear Creek Watershed, defined as the Site study area. The Phase II investigations selected eight draining tunnels (five of which were discussed in OU1) and 21 waste piles (five of which were addressed in OU2) to evaluate for a remedial determination.

4.3.2 Background

OU3 was originally designated to address the control of surge events from the Argo Tunnel. In 1988, CDPHE assumed lead agency status and initiated a more comprehensive investigation of the watershed. This investigation became known as the Phase II RI/FS. OU3 was re-designated as the Phase II investigations.

In the fall of 1999, CDPHE submitted a grant application to EPA for additional funds to continue remedial design work for OU3 (CA No. V 008534-01). Subsequent applications have been submitted and awards received for ongoing remedial design work. A grant application also was prepared to fund remedial actions at several source areas listed in OU3 (CA No. V 998176-01).

4.3.3 Remedial Objectives

The OU3 ROD, dated September 1991 (EPA/ROD/R08-91/055), updated decisions previously prescribed in the OU1 ROD and detailed the decisions resulting from the Phase II investigations.

The OU3 ROD superseded the OU1 ROD by:

- Using an Interim Waiver of Applicable or Relevant and Appropriate Requirements (ARARs) for the discharge from the Big Five Tunnel
- Collecting the discharges from the Gregory Incline, National, and Quartz Hill tunnels and piping to North Clear Creek to eliminate overland travel and to reduce the potential for direct human contact
- Invoking an interim remedy waiver of ARARs and delaying a decision on final treatment of the Gregory Incline, National, and Quartz Hill tunnels until further investigations have been conducted

Other major components of the OU3 ROD include:

- An alternate drinking water supply for residences where required
- Passive treatment of the Burleigh discharge
- Chemical treatment of the Argo Tunnel discharge instead of constructed wetlands as previously selected in the OU1 ROD
- No action to control surge events from the Argo Tunnel
- Reduction in the heavy metals load from Woods Creek
- A ground water collection system in the Idaho Springs area to address non-point source metals loading to surface water, currently referred to as the Virginia Canyon ground water project
- Capping or physical barriers, and institutional controls for select mine waste piles (Gregory Gulch piles #1 and #2, Clay County, Boodle Mill, McClelland, North Clear Creek, Chase Gulch #1 and #2, Quartz Hill, Golden Gilpin, Black Eagle, and Little Bear)

The following table summarizes tasks completed and pending under OU 3:

Table 3
Operable Unit 3

Operable Unit	Source Name	Location	RA Status
	Mine Adit Discharges	**Location**	**Comment**
OU3	Rockford	Idaho Springs	No Action
OU3	McClelland	Dumont	No Action
OU3	Burleigh	Silver Plume	ROD amended to select No Action
OU3	Argo Bulkhead	Idaho Springs	Delayed until funding available
	Waste Piles		
OU3	Urad	Woods Creek	1993
OU3	Empire	Empire	No Action
OU3	Minnesota Mill Tailing	Empire	November 12, 1996
OU3	McClelland	Dumont	January 6, 1995
OU3	Black Eagle	Chicago Creek	October 13, 1994
OU3	Little Bear Creek	Idaho Springs	December 14, 1998
OU3	Boodle Mill	Central City	August 24, 2000
OU3	Gregory Gulch #1	Central City	September 24, 1998 March 29, 1999
OU3	Gregory Gulch #2	Central City	September 28, 1999
OU3	Chase Gulch #1	Black Hawk	January 27, 2000
OU3	Chase Gulch #2	Black Hawk	Complete September 2005
OU3	Golden Gilpin	Black Hawk	Mill sites 12 & 13 complete April 1994 Mill site 11 complete August 2008
OU3	North Clear Creek	Gilpin County	November 10, 1996
OU3	North Clear Creek Dredge	Gilpin County	Delayed until OU4 investigations complete
OU3	Clay County	Gilpin County	April 19, 1996
OU3	Drinking Water	Site wide	September 30, 2003
OU3	Repository	Site Wide	Amendment to the OU 3&4 ROD September 25, 2006. Const. began 2008.
OU3	Golden Gilpin Mill	Gilpin County	Complete September 19, 2008*
	Ground Water		
OU3	Virginia Canyon Project – Ground Water	Idaho Springs	January 15, 2005

*Remedial action has or will be conducted as part of OU4

4.3.4 Summary of Remedial Actions

Since the Third Five-Year Review, the Virginia Canyon Ground Water Project and Golden Gilpin Mill Site were completed. The Argo Tunnel Water Treatment Plant continues to operate under Long-Term Remedial Actions. The response actions completed previously are detailed in the Third Five-Year Review. The Argo Tunnel Bulkhead response actions have not been completed. The repository will be addressed in this report under OU4.

Virginia Canyon Ground Water/Big Five Project – A large-scale ground water investigation was conducted by CDPHE to identify zinc loading from Virginia Canyon to the Clear Creek mainstem (CDPHE, 2002). The study successfully delineated the source as metals-contaminated ground water. A cutoff wall was designed and constructed in Virginia Canyon to capture the ground water, which was conveyed via pipeline to the Argo Tunnel WTP for treatment. The project was completed in 2005. At that time, the Colorado Department of Transportation (CDOT) was implementing a storm sewer renewal project in Idaho Springs involving replacement of sewer pipe along Colorado Boulevard. CDPHE negotiated with CDOT to place a pipeline in the CDOT trench to convey the Big Five discharge to the Argo Tunnel WTP. A design to collect the discharge at the portal and the conveyance system was completed and implemented in 2005.

Golden Gilpin Mill Site – The Golden Gilpin Mill Site, located north of the Town of Black Hawk and adjacent to the North Fork of Clear Creek, was a source of erosion and the release of mill tailings to the stream. WRC Engineering, Inc. (WRC) and Smith Environmental were selected to perform design engineering on behalf of CDPHE and completed a design in 2005. During the design process for the Golden Gilpin Mill Site, a number of issues had to be considered to achieve an acceptable set of construction plans. The Golden Gilpin Mill Site maintains a permit with the Colorado Division of Reclamation Mining and Safety (DRMS). Due to the active mine permit, the project design was structured to allow for either complete or partial reclamation of the waste pile. The design allowed for capping and re-vegetation of the entire waste pile or alternatively, capping only the side slopes of the waste pile. Following additional agency consultation, EPA advised CDPHE to omit capping the top of the waste pile with the intent that the property owner would be responsible for that action in the future. This approach also provides the property owner with the option to use the pile for future mine-related activities under a DRMS permit.

Following remedial design, construction was not immediately implemented pending development of an enforcement approach for the remaining portions of the Superfund remedy. The Golden Gilpin Mill Site was further complicated because of ongoing discussions between the agencies and the owner of the property regarding potential purchase or lease of the Bates Hunter Mine Water Treatment Plant for OU 4 water treatment. Left Hand Excavating (LHE) under contract to CDPHE constructed the remedy during June through September 2008. Of those waste piles identified for a response action under the OU3 ROD, the Golden Gilpin Mill remedial action was the last mine waste pile to be addressed.

Argo Tunnel Water Treatment Plant – On April 7, 1998 the Argo Tunnel Water Treatment Plant (WTP) began operating full time to address metals loading from the Argo Tunnel located in the eastern part of Idaho Springs. The plant was built on land acquired by EPA in a settlement with the landowner, Mr. Jim Maxwell, as detailed in a consent decree lodged with the court on June 3, 1997 (Civil Action No. 97-WY-286). The facility was deemed operational and functional on September 30, 1999. The plant uses a neutralization and clarification process to precipitate and remove heavy metals from the acid-mine drainage. An average flow of 250 gallons per minute is treated, and approximately 900 pounds of metals are removed daily. The WTP's effluent is discharged directly to Clear Creek, and the solid metal sludge is disposed of at a municipal landfill. Certified operators run the plant under contract to CDPHE.

During 2005, the Argo Tunnel WTP was converted from a process using sodium hydroxide to a lime-based precipitation process. The conversion was implemented to reduce chemical reagent costs, to improve settling of the precipitated flocculent in the clarifiers, and to improve characteristics of the underflow sludge and filter cake. The conversion of the plant to lime resulted in a slight increase in

solids content of the filter cake. However, the basic physical precipitation process remained unchanged.

In the spring of 2007, a Remediation System Evaluation (RSE) was funded by EPA and conducted at the Argo Tunnel WTP by GeoTrans, Inc. The RSE report provided several recommendations to improve effectiveness, reduce costs and implement technical improvements. Subsequently, EPA provided funding of $1,200,000 to implement a portion of the RSE recommendations.

CDPHE proposed implementing a High Density Sludge (HDS) system rather than the RSE recommendations as described. This approach would require hiring a design engineer, conducting additional piloting and implementing capital improvements to the Argo Tunnel WTP. The nature of capital improvements is not known at this point, but would likely include an aeration system, modifications to the pH adjustment system (pre-mix recycled solids with lime) and additional or replacement pumps and tanks. CDPHE has procured a design contractor to conduct pilot testing and evaluate design options. Although this approach was not specifically recommended in the RSE report, it is consistent with the intent of the recommendations. Implementation of a true HDS system should reduce ongoing costs related to sludge disposal, chemical usage, labor and filter scaling.

The Argo Tunnel WTP has been operating continuously since April 8, 1998. Compliance monitoring data has been collected at the frequency specified in the ARAR Compliance Document (ACD), issued February 1, 1999. The facility is eligible for a reduction in monitoring per the "Interim Guidance for Performance-Based Reduction of NPDES Permit Monitoring Frequencies," EPA 833-B-96-001, April 1996. CDPHE proposed to EPA in 2009 to analyze effluent samples on a twice-per-month basis (reduced from weekly), with the exception of manganese, which will continue to be analyzed weekly. Whole Effluent Toxicity (WET) testing has been performed monthly since plant start-up, and the samples have never shown any significant toxicity at any effluent concentration. Therefore, CDPHE proposed to reduce WET testing to annual sampling. Additionally, CDPHE recommended reducing influent in-stream monitoring from quarterly to semi-annually (high flow and low flow), and to discontinue sampling for nutrient parameters. EPA concurred with these recommendations on June 29, 2009. The new compliance monitoring strategy became effective on July 1, 2009.

EPA currently funds 90 percent of the Long-Term Remedial Action costs through a cooperative agreement (V 998608-01). CDPHE will assume the entire operation and maintenance cost for the plant beginning on October 1, 2009, with the transition of the remedy status to O&M. Consistent with the assurances provided by CDPHE in the cooperative agreement, CDPHE will accept title to the Argo Tunnel WTP property interests when the Long-Term Remedial Action is completed. CDPHE is in the process of completing the steps necessary to accept the title, including having obtained approval in March 2009 from the state legislature and arranging for another state agency to hold the property interests on CDPHE's behalf, as CDPHE does not have authority to do so.

Argo Tunnel Bulkhead – The Remediation System Evaluation (RSE) for the Argo Tunnel Water Treatment Plant (2007) recommended an evaluation of blowout protection for the Argo Tunnel. The report noted that "…a large blowout could occur during any season and could have significant impacts on the ecology of the creek and on downstream public water systems that draw water from Clear Creek. Therefore, the site stakeholders should come to agreement on how to address the potential for future blowouts." The RSE recommendations are being implemented to the extent EPA funding was made available. The blowout protection evaluation should be conducted. If it is determined that blowout protection (i.e., a flow-through bulkhead) is warranted, ROD change documentation would be necessary as this feature is not currently a ROD component.

Virginia Canyon mine waste rock piles – In 2005, EPA contemplated the removal of five mine waste rock piles located at the headwaters of Virginia Canyon in Clear Creek County. This process occurred while the ground water cutoff wall was being constructed in Virginia Canyon. EPA requested CDPHE conduct an investigation (CDPHE, 2005) describing the piles and providing data on contamination levels associated with each pile. CDPHE identified six piles, the Williams and Rio Grande, Tattler, Lower Clarissa, Trio and Diamond Joe, in need of a response action because they exhibit significant erosion and because the toe of each pile is located within the drainage channel. Erosion of the piles during storm events has resulted in the transport of metals-laden sediment from the piles to the storm flow in the channel and ultimately to the Clear Creek mainstem. This condition was indicated by the volume of sediment in the channel below the piles and supported by pictures of flood events in the drainage and the volume of waste rock and sediment transported into the Idaho Springs residential area at the mouth of the drainage.

The piles would have to be removed and relocated to a landfill under a large-scale project because capping was not feasible due to the steep slopes of the piles and because the narrow Virginia Canyon drainage would not allow re-grading of the piles to a slope more amenable for capping. At that time, however, the cost of implementing this project was beyond the funding available to EPA. The project is now economically viable with the ability to relocate the mine waste to the Site-wide repository property acquired in 2008. In 2009, the EPA Region 8 Emergency Response Unit expressed interest in conducting a removal action for these piles and consolidating the mine waste at the on-site repository. The funding was ultimately directed to another priority. EPA and CDPHE project managers should continue to coordinate with EPA Region 8 Emergency Response Program concerning a potential removal action for the Virginia Canyon mine waste rock piles remediation which would enhance the protectiveness of the remedy. Removal of the piles would enhance the OU3 remedy in Virginia Canyon, eliminate the discharge of metals-contaminated ground water to Clear Creek; and benefit the residents of Idaho Springs during storm events. The need to conduct this removal is also supported by the volume of sediment that must be removed regularly by Clear Creek County from the basin associated with the Virginia Canyon ground water cut-off wall.

A protectiveness determination of the OU 3 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including treatment of the National Tunnel, Gregory Incline and Quartz Hill discharges. These three discharges were transferred over to the OU 4 ROD and will be addressed under this OU. It is expected that these actions will be completed in the next three to five years. The remedies that have been completed under OU 3 remain protective. In addition, tasks such as the construction of the flow-through bulkhead and removal of the waste rock piles in the headwaters of Virginia Canyon, if funded, would further enhance the remedy.

4.3.5 Operation and Maintenance

Operations and maintenance (O&M) is required at several of the waste piles. As described previously, CDPHE performs O&M inspections and develops an annual report of its findings and corrective actions. The most recent report was completed in April 2009. All of the completed OU3 remedies were inspected.

The O&M for the OU3 waste piles is the responsibility of private parties, US Forest Service, local cities, counties or CDPHE. Specific maintenance issues and follow-up activities are detailed in the April 2009 report. No significant maintenance issues were observed that would compromise the protectiveness of the remedy. Since the third Five-Year Review, CDPHE has worked with Clear Creek County to repair erosion damage and to improve drainage at the McClelland waste pile.

CDPHE also performed maintenance work with Central City at the Boodle Mill. CDPHE currently is working with the private owner of the Clay County waste pile to implement minor maintenance.

CDPHE assumed full responsibility for the operation and maintenance of the Argo Treatment plant on October 1, 2009.

4.4 Operable Unit 4

4.4.1 Description

The need for OU4 was identified in the OU3 ROD and was developed specifically for the North Fork of the Clear Creek sub-watershed. The OU4 remedial actions address contaminated surface water, ground water and sediment. The cleanup strategies address threats through the capping or removal of waste piles and treatment of point and non-point sources of surface water contamination.

4.4.2 Background

Fund-lead remedial design and remedial actions at OU4 are being performed under Cooperative Agreements V 978122-01 and V 978140-01, respectively. Initial federal assistance was received for remedial design in April 2005 and for remedial action in October 2006.

4.4.3 Remedial Objectives

OU 4 efforts focus on the North Fork of Clear Creek. The OU 4 ROD was prepared as a collaborative effort between EPA and CDPHE and was signed in September 2004. A ROD amendment to add an on-site repository was completed in September 2006.

The proposed remedial actions for OU 4 outlined in the ROD include:

- Treatment of Gregory Incline discharge and Gregory Gulch ground water at the Bates Hunter Mine water treatment plant,
- Treatment of the National Tunnel discharge at a passive treatment system downstream of Black Hawk along Highway 119,
- Tributary sediment control involving waste pile removal/capping, sediment detention structures on Russell and Nevada Gulches, and other sediment-reduction measures in Russell, Gregory and Nevada Gulches,
- Construction of an on-site repository, and
- Improvements to the North Fork of Clear Creek.

With the June 2006 administrative restructuring of the site, OU4 also includes the remaining OU2 and OU3 waste rock pile remedial actions.

4.4.4 Summary of Remedial Actions

Sediment Control Measures and Mine Waste Remediation, Phase I: Design and construction of the tributary sediment control measures and mine waste remediation has three phases of design and construction. CDPHE hired Tetra Tech, Inc. in April 2006 to provide engineering and design services. The first phase was bid and constructed in 2007 and included two sediment dams in Nevada Gulch and Russell Gulch and erosion control at mine waste piles in Russell, Willis, South Willis and Gregory Gulches. These projects are shown in Table 4. Construction of Phase I of the sediment and

mine waste pile erosion control work was performed in August through December 2007 by Earth Tech under contract to CDPHE. The Phase I administrative closeout of the project occurred in spring 2008. The final cost for the phase one work was $1,171,173.

Table 4
Operable Unit 4
Phase I Sediment Control Measures and Mine Waste Remediation

Project	Location	Remedy and Status
Nevada Gulch Sediment Retention Basin	Nevada Gulch Drainage	Sediment retention – Complete
Russell Gulch Sediment Retention Basin	Russell Gulch Drainage	Sediment retention – Complete
Anchor Waste Rock Pile	Willis Gulch	Erosion control – Complete
Hampton Waste Rock Pile	Willis Gulch	Erosion control – Compete
Powers Waste Rock Pile	Willis Gulch	Erosion control – Complete
Silver Dollar Waste Rock Pile	Willis Gulch	Erosion control – Complete
Willis Gulch Check Dam	Willis Gulch	Water management – Complete Failed with first severe storm event
Russell Gulch Check Dam	Willis Gulch	Water management – Complete

Fifteen environmental covenants, as required per C.R.S. 25-15-318 through 327, for Phase I projects were granted by the landowners and filed with Gilpin County. Additional covenants will be sought for Phase II and Phase III, once Phase III is completed.

Sediment Control Measures and Mine Waste Remediation, Phase II – Tetra Tech's design contract was revised in March 2008 to include design of the Church Placer grading and reclamation for use as a mine waste repository. The second phase construction documents were completed and advertised for bid in May 2008. Bids were received in June 2008 and McCollum's Excavating, a local Black Hawk company, was awarded the contract for the Phase II work. Phase II involved significant regrading and preparation of the Church Placer property for future use as a mine waste repository and also includes capping and erosion control at the Pittsburgh and nearby waste piles (shown in Table 5). The contract value for the Phase II work was $1,249,922. An amendment to the contract was processed and approved to allow for the transportation and placement of a more fortified soil/rock cover at the Church Placer and Pittsburgh waste rock pile projects. This increased the total project cost to more than $1,877,589. The construction began in August 2008, with major activities being completed in January 2009 and re-vegetation being largely completed in May 2009. Remaining re-vegetation will be conducted during fall 2009. CDPHE utilized approximately 35,000 cubic yards of rock and soils generated from a CDOT curve-straightening project to cap the Pittsburgh mine waste pile and tailings impoundment and at the repository as soil cover material. This approach resulted in cost savings for CDPHE, EPA and CDOT and promoted "green remediation" through materials reuse.

Table 5
Operable Unit 4
Phase II Sediment Control Measures and Mine Waste Remediation

	Location	Remedy and Status
American Flag Waste Rock Pile	Nevada Gulch	Erosion control – Complete
Nevada Gulch Check Dams	Nevada Gulch	Water management – Complete
Alva Adams Waste Rock Pile	Russell Gulch	Erosion control – Complete
Baltimore Waste Rock Pile	Russell Gulch	Erosion control – Complete
Mattie May Waste Rock Pile	Russell Gulch	Erosion control -Complete
Russell Gulch Drop Structures	Russell Gulch	Water management – Complete
Pittsburgh Waste Rock and Tailings Piles	Russell Gulch	Erosion control – Complete (A severe storm event scoured a channel adjacent to the west end of the remedy. The erosion problem will be addressed under Phase III.)
Church Placer & Site-wide Repository	South Willis Gulch	Under construction
South Willis Gulch Check Dams	South Willis Gulch	Water management – Complete

Sediment Control Measures and Mine Waste Remediation, Phase III – The Phase III Sediment Control Measures and Mine Waste Remediation construction activities began July 6, 2009, with McCollum's Excavating conducting the work as the low bidder. The contract value for the Phase III work is $1,138,227. Both the Phase II and Phase III successful bids were lower than the engineer's estimate, reflecting the competitive nature of the construction industry at this time. This project, as shown in Table 6, involves the excavation, transportation and consolidation of select waste rock piles from Nevada Gulch, Russell Gulch and South Willis Gulch to the repository and reclamation where the piles have been removed. A soil cover will be constructed over the repository. It also includes erosion-control measures at some additional piles in South Willis Gulch. The Phase III construction is anticipated to be completed in November 2009. CDPHE has relocated the Kokomo waste rock pile, located on the Church Placer property, to the repository with funding provided by DRMS. Reseeding of the Kokomo area will be conducted this fall.

Under an interagency agreement with CDPHE, the DRMS hired Berry Excavating to close four mine adits that are located at mine waste piles where CDPHE is or has implemented erosion-protection measures. The State Historical Preservation Office provided coordination and concurrence. These closures were completed in summer 2009.

Table 6
Operable Unit 4
Phase III Sediment Control Measures and Mine Waste Remediation

Project	Location	2009 Remedy and Status
Church Placer & Site-wide Repository	South Willis Gulch	Under Construction
Kokomo Waste Rock Pile – DRMS	South Willis Gulch	To be relocated to Site-wide Repository
Old Jordan Waste Rock Pile	South Willis Gulch	Relocation to Site-wide Repository
Hazeltine Waste Rock Pile	South Willis Gulch	Erosion control – Complete
Iroquois Waste Rock Pile	Russell Gulch	Relocation to Site-wide Repository
Section 19 Waste Rock Pile	Russell Gulch	Relocation to Site-wide Repository
Argo Waste Rock Pile	Russell Gulch	Relocation to Site-wide Repository
Aurora Waste Rock Pile	Russell Gulch	Relocation to Site-wide Repository
Centennial East Waste Rock Pile	Russell Gulch	Erosion control – Complete
Centennial Waste Rock Pile	Russell Gulch	Erosion control – Complete
Niagara Waste Rock Pile	Russell Gulch	Relocation to Site-wide Repository
Nevada Gulch Tailings Piles	Nevada Gulch	Relocation to Site-wide Repository

On-Site Repository – An amendment to the OU4 ROD was completed to include a Site-wide repository. After several years of negotiating with landowners, CDPHE was able to purchase 28.5 acres of the Church Placer claim located in Gilpin County and within the Site on October 30, 2008.

A Site characterization assessment, prepared by Golder Associates (2001), was performed under OU4 RI/FS that identified the Church Placer as the most favorable location of three sites evaluated. Recent activities have been conducted under the OU4 remedial design and remedial action grants. CDPHE has been investigating the possibility of siting a mine-waste repository within the watershed since late 2000. The repository would be used for mine wastes such as waste rock and tailings, sediments from sedimentation dams, and potentially for water-treatment sludges. CDPHE presented the proposed repository concept to the Clear Creek and Gilpin County Commissioners and other interested parties in 2001. The Church Placer was identified as the preferred location for such repository. In 2006, CDPHE and EPA prepared and completed a Proposed Plan and Record of Decision (ROD). Overall public comments were supportive of the repository, with primary concerns relating to potential truck traffic.

CDPHE had an appraisal of the Church Placer property prepared in 2002. Negotiations between the agencies and owners of the Church Placer between 2002 and into 2007 were unsuccessful. An adjacent landowner purchased Church Placer in 2007 and indicated willingness to sell the mining-impacted portion of the property needed for the repository. Tetra Tech's design contract for the tributary sediment-control activities was amended in 2007 to include performing a comprehensive geotechnical investigation at the Church Placer, and amended again in 2008 to include the grading and design of the property layout as part of the Phase II work to be constructed in 2008. EPA performed a land survey of the Church Placer in 2007 that, due to complications associated with complex mining claims and the need for detailed title review, was completed in 2008. The state negotiated with the new landowner and closed on the 28.5-acre property on October 30, 2008. In

coordination with Gilpin County, the state placed a deed restriction on the property that prohibits any future residential development.

The Church Placer claim was the site of historic mining activities dating to 1908 and later was utilized by Solution Gold, LLC as a heap-leach facility for reprocessing mine waste rock and recovering gold. The company went into bankruptcy and abandoned operations by 1995. At that time the Division of Minerals and Geology (DMG) attempted to close the heap-leach pads using an inadequate bond. Construction to reclaim the 28.5 acres and to establish a Site-wide repository began in 2008. The repository will be used to consolidate mine waste under Phase III work planned for 2009. The repository also will be used for the storage of sediments from sediment-retention dams constructed as Phase I sediment-control measures and waste rock remediation.

CDPHE is working with its design engineer and EPA to develop re-vegetation success criteria for the Church Placer repository property. The re-vegetation success criteria will be used in the Operational and Functional determination for this remedial action and portions of the Waste Rock Remediation and Sediment Control project.

Gregory Incline, Gregory Gulch and National Tunnel conveyance projects – The OU4 ROD called for passive treatment of the National Tunnel discharge and active treatment of the Gregory Incline and Gulch at the Bates Hunter Mine Water Treatment Plant. CDPHE contracted with Industrial Facilities Engineering, Inc., (IFE), to design the collection and conveyance systems for mine discharge drainages associated with the Gregory Gulch, the Gregory Incline and the National Tunnel. A schematic design was submitted to CDPHE and EPA in July 2008. Based on the schematic design, CDPHE will pursue a pipeline that transports the National Tunnel water downstream in the Highway 119 right of way, likely within Highway 119 itself.

In addition, IFE's services included evaluating the Bates Hunter Mine water treatment plant, identified in the OU4 ROD as the treatment location for the Gregory Gulch and Gregory Incline mine waters. In August 2004, CDPHE signed a letter of intent with the owner of the Bates Hunter facility to enter into a cooperative situation in which the Bates Hunter Plant would be operated for the mutual benefit of the owner and the agencies. The owner desires to reserve the ability to use the plant to dewater the Bates Hunter mine.

The recent assessments of the Bates Hunter facility indicate it does not have the capacity to treat both the private owner's mine dewatering needs and the Gregory Incline discharge and the Gregory Gulch surface and ground water. Substantial expansion would be required to treat all the water including upgrades to clarification, sludge storage, sludge pressing and automation would be needed to increase the facility capacity. IFE also produced a cost analysis of upgrading the Bates Hunter plant versus building a new plant. EPA and CDPHE met in summer 2008 to discuss the findings of these reports. It was agreed that the agencies consider construction of a new active water treatment plant at the site where the National Tunnel passive system was to be located. CDPHE will prepare a Proposed Plan to be issued for public comment.

In spring 2008, CDPHE and EPA decided to obtain additional information on the relationship between the mine pools, ground water and surface water. In the last quarter of 2008, a contract amendment was authorized for IFE to provide additional sampling, including radioisotope analysis, and continuous flow monitoring of the incline and the Bates Hunter mine pool water level. Dewatering of the Bates Hunter mine ceased in late July 2008, and monitoring from the second half of 2008 showed that as the water level rose in the Bates Hunter, flow from the Gregory Incline increased from approximately 65 gpm to 100 gpm, demonstrating a relationship between the Gregory Incline

flow and the water level in the upstream Bates Hunter vein system. In August 2008, IFE conducted a subsurface investigation including drilling and installation of monitoring wells and tracer studies of the mine pools.

National Tunnel Passive Treatment – CDPHE and the Colorado School of Mines (CSM) have an interagency agreement under which CSM has been evaluating the effectiveness of various passive treatment systems at the National Tunnel discharge as part of remedial design activities. The treatability studies are being performed under the bridge where Miners Mesa Road and Highway 119 intersect, and include evaluation of multiple passive treatment substrates, including manure and organic substrate, ethanol and chitin (crab shell waste) systems. CSM issued the "Sulfate Reducing Bioreactor Pilot Study" work product on August 11, 2008 and provided preliminary design criteria for a full-scale treatment system.

North Clear Creek Improvements – The State Highway (SH) 119 corridor between US 6 and Black Hawk parallels the mainstem of North Clear Creek, which is greatly impacted by historic mining activities. The Colorado Department of Transportation (CDOT) is planning to implement transportation improvements along SH 119. The overlapping boundary of the two projects provides a unique opportunity for CDPHE and CDOT to work together to realize cost savings and create a better end product.

Recognizing the opportunity to collaborate on the projects occurring in the North Clear Creek watershed, CDPHE, CDOT and EPA entered into a memorandum of understanding, dated January 11, 2008, to coordinate efforts. This memorandum was followed by an interagency agreement between CDPHE and CDOT, effective August 6, 2009. There is a significant potential that CDPHE/EPA and CDOT will be able to team multiple aspects of projects that could result in North Clear Creek habitat and channel stability improvements. CDOT has hired HNTB for design work for SH 119 for the first mile located just downstream of Black Hawk (the Main Street South Project). The team is looking at the CDOT right-of-way along SH 119 as the preferred location to site the National Tunnel/Gregory Incline pipeline and the new treatment plant.

North Clear Creek constructed wetlands – Construction of the Black Hawk Central City Sanitation District (BHCCSD) mitigation wetland was completed in 2007 as a teamed project with the Sanitation District and CDPHE/EPA splitting the cost. This project supports the North Fork of Clear Creek Improvements called for in the OU4 ROD. The project provides flow-controlled wetland cells that polish North Clear Creek water. There are three wetland cells located north of North/East of Clear Creek and two wetland cells located South/West of North Clear Creek. There was rapid and significant growth of the wetland plants. Minor repairs including adjustment of rock in the North Clear Creek channel were conducted in October 2007, March 2008 and September 2008 to assure good mixing of North Clear Creek water with the BHCCSD effluent prior to the North/East cells intake. A CSM graduate student monitored the wetland cells over the 2008 summer. The results indicate the cells remove 10 percent to 15 percent of the metals from the water. In consultation with EPA, CDPHE entered into an interagency agreement with CSM in March to continue monitoring the wetlands through 2009.

4.4.5 Site Visits

Numerous site visits were completed by CDPHE and EPA staff project managers throughout the duration of the first two phases of the Sediment Control Measures and Waste Rock Remediation project, August 2007 through January 2009. These visits were conducted as a part of the five-year review as well as operation and maintenance inspections.

4.4.6 OU 4 Remedial Actions

The construction of Phase I and Phase II Mine Waste Remediation and Sediment Control projects is a significant step forward for remedial actions under OU4. Phase III is currently being implemented.

The remaining components of OU4, including addressing the Gregory Incline, National Tunnel and Quartz Hill discharges and metals-contaminated ground water in Gregory Gulch, should be implemented.

A remedial action at the Quartz Hill pile, now a component of OU4, has been delayed due to the agencies' desire to coordinate the cleanup of the property with anticipated gaming development. EPA and CDPHE are prepared to continue discussions with landowners and prospective purchasers that would include private party implementation of a remedy.

CDPHE will prepare a Proposed Plan to be issued for public comment recommending that the National Tunnel, Gregory Incline and Gregory Gulch mine water be treated at an active treatment plant. CDPHE will produce a ROD amendment upon approval of utilizing this technology.

5.0 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The 2004 five-year review for the Central City/Clear Creek Superfund Site provided the following recommendations:

Table 7. Actions Taken Since the Last Five-Year Review in 2004

Issues from Previous Review	Recommendations/Follow-up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
Develop a database to record parties responsible for O&M and to track/confirm that required O&M is being performed	CDPHE currently inspects all of the project locations within the Central City/Clear Creek Superfund Site where response actions have been completed.	CDPHE	2004 Five-year review	Following those inspections, CDPHE produces an annual O&M report for the Site. The report identifies the locations where response actions have been completed and where waste has been left in place.	January 2007
Evaluate the effectiveness of institutional controls where waste has been left in place and develop a database to consolidate the information	CDPHE currently conducts annual Operation and Maintenance inspections on all remedial actions implemented within the Site.	CDPHE	2004 Five-year review	The annual O&M report contains a section that identifies and evaluates the institutional control in place and lists all of the locations within the Site where wastes were left in place following completion of the response action and the institutional control for each location.	April 2009
Outstanding OU3 remedial actions specified under the OU3 ROD have not been completed	Complete OU3remedial actions.	CDPHE	2004 Five-year review	All OU3 remedial actions specified under the OU3 ROD have been completed.	January 2005
Initiate remedial actions per the OU4 ROD	Implement components of mine waste remediation and sediment control portion of the OU4 ROD. Conduct treatment studies for mine discharges.	CDPHE	2004 Five-year review	Phase I and II of the mine waste remediation and sediment control element of the OU 4 ROD have been completed. Phase III is under construction.	August 2006
Make a final decision on the Big Five adit discharge	Prepare a design for collection and conveyance of discharge to Argo WTP.	CDPHE	2004 Five-year review	The Big Five discharge was collected and conveyed to the Argo Tunnel W TP.	January 2005

Table 7 (continued) Actions Taken Since the Last Five- year Review in 2004

Issues from Previous Review	Recommendations/Follow-up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
Numerous sources of surface water sampling data need to be consolidated under one database.	Consolidate surface water data into a manageable and centralized database.	CDPHE	2004 Five-year review	A common surface-water database for hardness and trace-metals has been developed for use by CDPHE in setting/evaluating stream standards as well as in assessing remedial-action effectiveness. All parties involved with the collection of surface water data have been contacted and the information has been consolidated. Future updates to this common database are recommended.	February 2007
A site-wide repository has been contemplated at the Site since 1997. A study was conducted by Golder and Associates in 2001, under contract to CDPHE, to recommend a location for the repository. Three locations were evaluated and one recommended.	Prepare an ESD to the OU3 ROD to include a Site-wide repository and purchase land and initiate design for the repository.	CDPHE	2001	An amendment to the OU3 and OU4 ROD for the Site-wide repository was completed and signed by Mr. Dodson on September 25, 2006. The repository was designed and construction began in 2008.	August 2008

Clean-up Actions by Other Parties – In addition, the Division of Reclamation, Mining and Safety (DRMS) will be closing the Franklin Mine, located in the headwaters of Gilson Gulch, which is situated at the east end of Idaho Springs in Clear Creek County. The Clear Creek Watershed Foundation (CCWF), an independent organization located in Clear Creek County, will be initiating work in the lower reach of Gilson Gulch beginning in 2009. The efforts by both of these groups will mitigate storm event releases of metals-contaminated material to Clear Creek.

The CCWF also has obtained funding for the implementation of several projects in Trail Creek, located west of Idaho Springs in Clear Creek County. The Freeland-Lamartine Mining District is at the headwaters of Trail Creek and represents a source of metals-contaminated sediment to Clear Creek during run-off events.

The above-mentioned projects will not only enhance agency remedies completed along Clear Creek, but will provide additional protectiveness to the remedies and to Clear Creek.

A protectiveness determination of the OU 4 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including treatment of the National Tunnel, Gregory Incline and Quartz Hill discharges and completion of Phase III of the sediment control measures and mine waste remediation project.

6.0 FIVE-YEAR REVIEW PROCESS

This five-year review was completed between March and September 2009. Components of the five-year review included:

- Community involvement
- Document review
- Data review
- Site inspection

- Local interviews
- Five-year review report development and review

6.1 Community Involvement

Members of the community were notified that the fourth five-year review was occurring via a public notice published in the *Clear Creek Courant* and the *Central City Register-Call* newspapers during May 2009. Notification also occurred via the July 2009 *Update Fact Sheet*, mailed to residents in Clear Creek and Gilpin counties. The Central City/Clear Creek Community Involvement Plan was updated in conjunction with this five-year review, and is included as Appendix C of this report. Once finalized, the community will be notified that the five-year review has been completed, and the results of the review will be provided to all site repositories.

6.2 Document Review

Several relevant documents were examined in support of this five-year review. A list of documents referenced is presented in Section 13. Applicable or Relevant and Appropriate Requirements also were reviewed, as discussed in Section 3.2.

6.3 Data Review

Surface water sampling has been conducted at the Central City/Clear Creek Superfund Site since the early 1980s. In general, most contaminants were detected at their highest concentrations early in the history of the Site. This finding is evident from looking at two key metals, copper and zinc.

UCCWA has been conducting surface water sampling, including along the lower Clear Creek mainstem (stream segment 11), since February 1994. Several metals are monitored along with nutrients and flow. Copper and zinc concentrations in Clear Creek in this reach below the Argo Tunnel WTP effluent discharge to just upstream from Golden were compared to their stream standards. During the first five years of monitoring (1995-1999), copper exceeded the temporary-mod standard of 17 µg/L 78 percent of the time. During the next five years (2000-2004), the copper standard was exceeded 42 percent of the time. Currently, there is no stream standard applicable to copper. However, for comparison with previous conditions and associated standards, the average copper concentration for the 2004-2008 period (46 sample analyses for monitoring site CC-40) was 6.15 µg/L, with a 85^{th}-percentile value for this same period's data set of 15.7 µg/L (the underlying standard using the hardness concentration average for this subperiod). This underlying TVS was exceeded in only three of 46 samples during this most recent period at this site. Comparative values at a downstream monitoring site CC-60 near Golden are: 5.20 µg/L average concentration, 13.4 85^{th} percentile, and only two of 39 sample values exceeding this underlying standard.

Similarly, the exceedance rate for zinc decreased from 68 percent to 26 percent between these two periods (1995-99 vs. 2000-04), based on a temporary-mod standard of 300 µg/L that was historically applicable. Currently, using the period of record average hardness concentration (84.5 mg/L), the stream standards applicable to zinc for monitoring site CC-40 in stream-segment 11 are a recalculated chronic standard of 143 µg/L and a recalculated acute standard of 165 µg/L. For some comparison with previous conditions and associated standards, the average zinc concentration for the 2004-2008 period (46 sample analyses for monitoring site CC-40 near Kermitts) was 160 µg/L. These recalculated standards were exceeded in 20 of 46 samples during this most recent period, or about 43 percent of the time at this site. Comparative values at a downstream monitoring site CC-60 near

Golden are: 136 average concentration for zinc, and 11 of 39 samples exceeding these applicable recalculated standards for chronic and acute conditions.

Continued monitoring and evaluation is planned by the CDPHE and supported by the USEPA to evaluate the protectiveness of the remedy.

6.4 Site Inspection

Because remedial and operation and maintenance activities continue at the Site, various CDPHE and EPA project managers make routine visits to specific portions of the Site. For this five-year review, a Site-wide visit was conducted on August 3, 2009. The purpose of the site visit was to assess the protectiveness of the remedies that have been completed and to evaluate the integrity and success of previously constructed remedy components including:

- waste pile slope stabilization and capping
- revegetation efforts
- discharge or run-on conveyance structures

A more detailed description of Site observations is provided in the discussion of each Operable Unit.

6.5 Local Interviews

Between May 1 and June 30, 2009, CDPHE and EPA community involvement coordinators conducted interviews of various parties in person and by telephone. Interviewees included citizens residing within the Site, public officials and members of UCCWA and the Clear Creek Watershed Foundation. The results of the interviews are presented in the 2009 update of the Clear Creek/Central City Community Involvement Plan (Appendix C).

7.0 TECHNICAL ASSESSMENT

The following conclusions have been determination for the remedies at the Clear Creek/Central City Superfund Site:

7.1 Operable Unit 1

Question A: Is the remedy functioning as intended by the decision documents?

No. The OU3 ROD superseded the OU1 ROD, therefore no remedies were implemented under the heading of OU1.

Question B: Are the assumptions made at the time of the remedy selection still valid?

No. The OU3 ROD superseded the OU1 ROD, therefore no remedies were implemented under the heading of OU1.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No. The OU3 ROD superseded the OU1 ROD, therefore no remedies were implemented under the heading of OU1.

7.2 Operable Unit 2

Question A: Is the remedy functioning as intended by the decision documents?

No. Following the signing of the OU2 ROD, a Baseline Risk Assessment was completed for the Site and human health action levels were established for lead and arsenic in soil. The established action levels were 500 parts per million (ppm) for lead and 130 ppm for arsenic. Since the Big Five and Argo mine waste piles exhibited soil concentrations of lead and arsenic greater than the risk-based action levels, an Explanation of Significant Differences was issued to incorporate capping into the remedy at these two piles. However, due to concerns of the local State Historic Preservation Office and the property owner, the Argo waste pile was not capped. Access to the pile is controlled, and therefore human exposure is limited.

Question B: Are the assumptions made at the time of the remedy selection still valid?

Yes.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No. No new ecological risks or changes in land use were discovered during the five-year review.

7.3 Operable Unit 3

Question A: Is the remedy functioning as intended by the decision documents?

Yes. The Argo Tunnel WTP continues to achieve a 99.9 percent reduction in metals loading from the tunnel into Clear Creek. The Virginia Canyon Ground Water Project was completed, treating this non-point source load at the Argo Tunnel WTP and eliminating between 200 and 500 pounds of zinc per day to the mainstem. The Big Five discharge also was collected and conveyed to the Argo Tunnel WTP, reducing another 50 pounds per day of metals contamination to the mainstem. OU3 waste piles that have been regraded and/or capped are stable and show no evidence of erosion into adjacent streams. Human exposure to site hazards is being minimized by removing direct contact with tunnel discharges. Residences previously identified as being exposed to unacceptable metal concentrations in their drinking water are being supplied safe water.

Question B: Are the assumptions made at the time of the remedy selection still valid?

Yes. A baseline risk assessment was performed prior to the signing of the OU3 ROD. No new toxicological information was discovered during the five-year review that would indicate the risk assessment is no longer appropriate.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No. Although surface water quality standards and the MCL for arsenic have changed, those changes do not call into question the protectiveness of the OU 3 remedy. No new risks were discovered during

the five-year review. However, as described in the 2008 O&M Inspection Report, the Chase Gulch #2 Mine Waste Pile and Clay County Mill Site property owners have made some land use modifications (i.e., road building, construction fill placement). CDPHE will continue to monitor these and other changes for potential impacts to the remedies.

Removal of the six waster rock piles in Virginia Canyon was considered by EPA in 2005. A report was submitted to EPA in 2005 detailing the piles and provided recommendations for the removal. However, the cost of the project was prohibitive at that time. Further consideration has been presented by EPA's Removal Program to implement the project once funding becomes available. This project would enhance the remedy in Virginia Canyon but not affect the current protectiveness of the remedy.

7.4 Operable Unit 4

Question A: Is the remedy functioning as intended by the decision documents?

No. The overall OU4 remedy as completed to date is protective; however, the water treatment needs to be completed.

The OU4 tasks yet to be completed, as prescribed in the OU4 ROD, are described in Section 9.0.

A significant precipitation event during the weekend of July 25-26, 2009 caused erosion damage to portions of the OU4 North Clear Creek Sediment Control Measures and Mine Waste Remediation project. This damage should be repaired during Phase III of this project, currently being implemented.

Question B: Are the assumptions made at the time of the remedy selection still valid?

Yes. A baseline risk assessment was performed prior to the signing of the OU4 ROD. No new toxicological information was discovered during the five-year review that would indicate the risk assessment is no longer appropriate. Although water quality standards for Clear Creek and the MCL for arsenic have changed the remedy selection is still valid and protective.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No. No new ecological risks or changes in land use were discovered during the five-year review. Casino development has not impacted the remedy. In fact, casino development has improved the environment through the removal of waste rock piles and tailings impoundments once considered for remedial action by the agencies resulting in a cost savings.

7.5 Technical Assessment Summary

According to the data reviewed, the site inspection and the interviews, the remedies that have been completed are functioning as intended by the decision documents. There have been no changes in the physical conditions of the Site that would affect the protectiveness of the remedy. There have been no changes in the ARARs that impact the remedy selected and implemented at the Site. There is no information that calls into question the protectiveness of the remedies constructed to date.

Following completion of all of the prescribed OU4 remedial actions, the concentrations of metals in Clear Creek below Idaho Springs (Segment 11) are expected to be significantly reduced. At that time, compliance with the remedial action objectives can be assessed. CDPHE and EPA may want to

participate in a use attainability analysis to determine whether numeric remediation goals are appropriate and whether additional remediation efforts are warranted.

8.0 ISSUES

Table 8 Issues

Issue	Currently Affects Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
The Gregory Incline, National Tunnel and Quartz Hill discharges remain the major sources of metals loading to the North Fork of Clear Creek. These three discharges have been identified for treatment per the OU4 ROD.	**Y**	**Y**
The Quartz Hill tailings pile has been identified for capping or other response action under OU4. This task will need to be completed to finalize OU4 tasks at the Site.	**Y**	**Y**
The surge event protection evaluation as recommended by the RSE should be conducted. If it is determined that surge protection is warranted a ROD change documentation under OU4 would be necessary as this feature is not currently a ROD component	**Y**	**Y**
North Fork of Clear Creek improvements CDOT to widen SH 119, remediate waste piles, reconstruct portions of the channel and stabilize the channel	**Y**	**Y**

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

With EPA and CDPHE oversight, the corresponding recommendations and follow-up actions are as follows:

Recommendations and Follow-Up Actions

Issue	Recommendation and Follow-up Action	Party Responsible	Milestone Date	Affects Protectiveness (Y/N)	
				Current	Future
National Tunnel, Gregory Incline & Quartz Hill discharge	Design and build WTP to treat discharges	EPA and CDPHE	9/2012	Y	Y
Quartz Hill tailings pile	Execute plan with casino developer(s) to address pile or agencies implement a remedy to cap pile	EPA and CDPHE	9/2012	Y	Y
Argo Tunnel flow-through bulkhead	Conduct investigations within the Argo Tunnel to identify location for construction of the bulkhead. Evaluate feasibility, design and construct bulkhead.	EPA and CDPHE	9/2012	Y	Y
North Fork of Clear Creek Improvements	Continue to work with and monitor CDOT's progress on their SH 119/North Fork improvement project.	EPA and CDPHE	9/2012	Y	Y

10.0 PROTECTIVENESS STATEMENT

OU 1: A protectiveness determination of the OU 1 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including completion of the treatment of the Gregory Incline, Quartz Hill and National Tunnel discharges. It is expected that these actions will be completed in the next three to five years. The remedies that have been completed under this OU remain protective.

OU 2: A protectiveness determination of the OU 2 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including completion of the mine waste remediation at the Quartz Hill pile. It is expected that these actions will take approximately three to five years to complete. The remedies that have been completed under this OU remain protective.

OU 3: A protectiveness determination of the OU 3 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including treatment of the National Tunnel, Gregory Incline and Quartz Hill discharges. These three discharges were transferred over to the OU 4 ROD and will be addressed under this OU. It is expected that these actions will be completed in the next three to five years. The remedies that have been completed under OU 3 remain protective. In addition, tasks such as the construction of the flow-through bulkhead and removal of the waste rock piles in the headwaters of Virginia Canyon, if funded, would further enhance the remedy.

OU 4: A protectiveness determination of the OU 4 remedy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions including treatment of the National Tunnel, Gregory Incline and Quartz Hill discharges and completion of Phase III of the sediment control measures and mine waste remediation project.

11.0 NEXT REVIEW

The next five-year review for the Central City/Clear Creek Superfund Site is required by September 2014, five years from the date of this review. The agencies may complete the next five-year review early in order to inform the 2013 Colorado Water Quality Control Commission Triennial Review.

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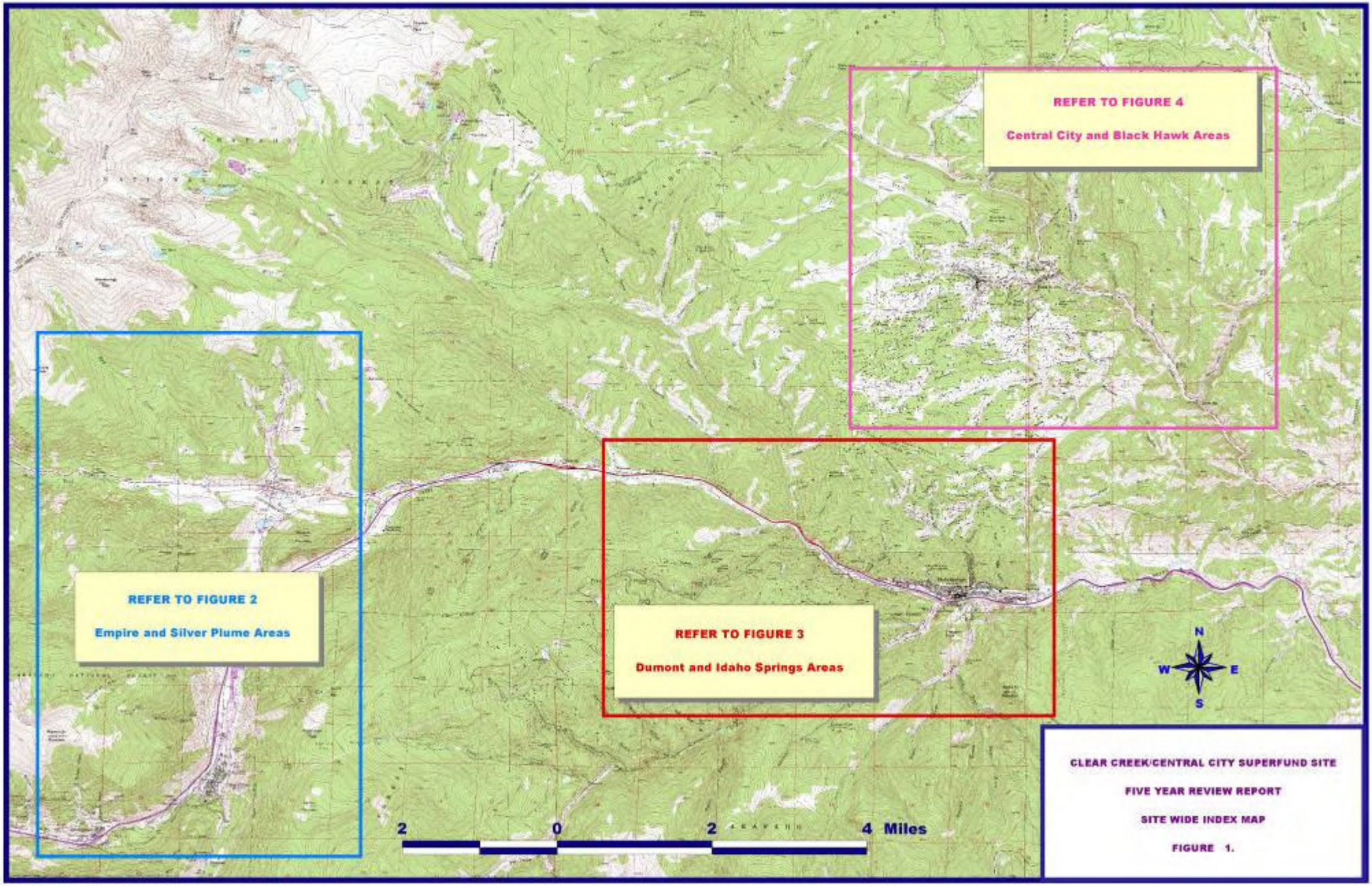
APPENDIX A: SITE MAPS


REFER TO FIGURE 4
Central City and Black Hawk Areas
REFER TO FIGURE 2
Empire and Silver Plume Areas
REFER TO FIGURE 3
Dumont and Idaho Springs Areas
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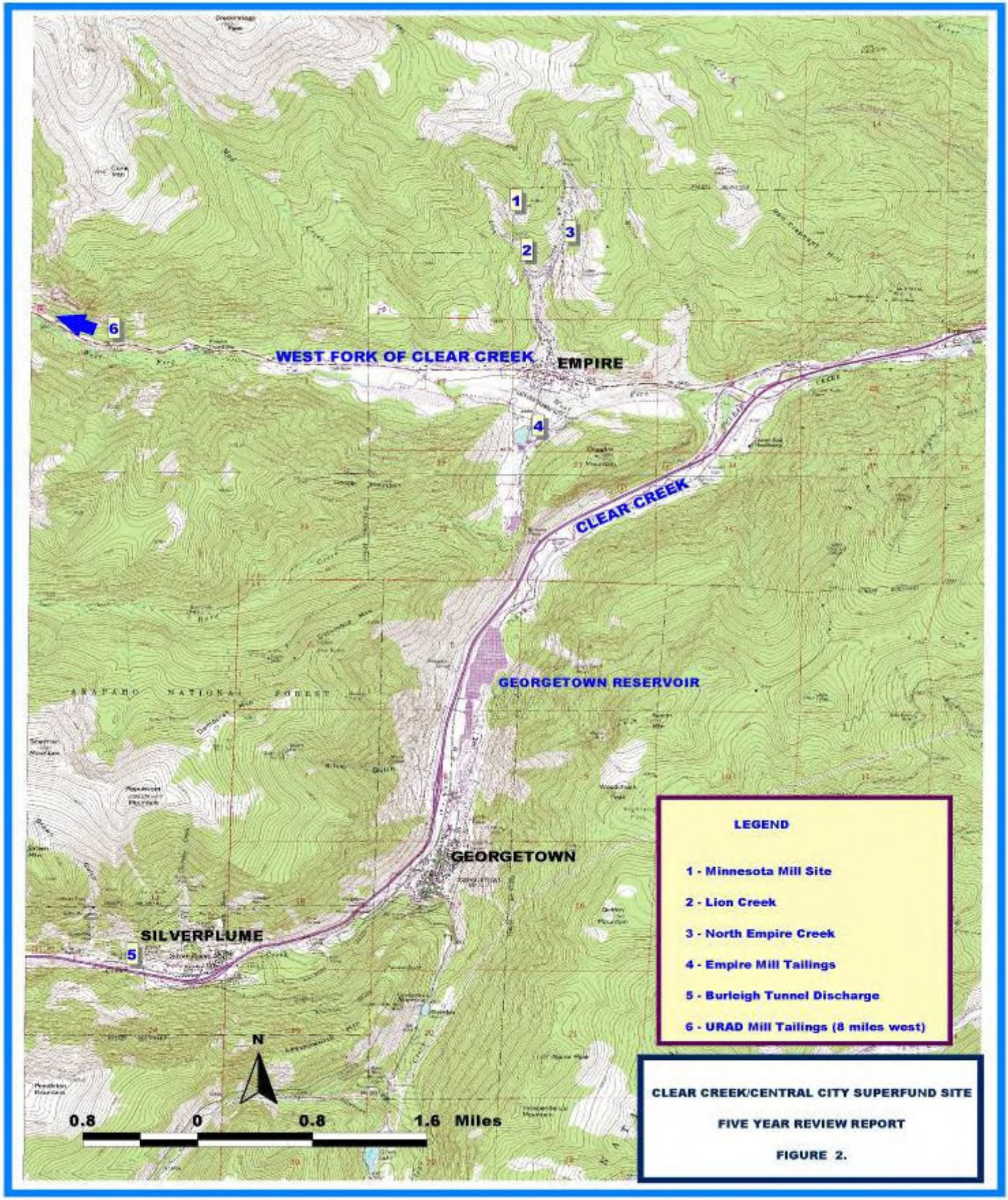
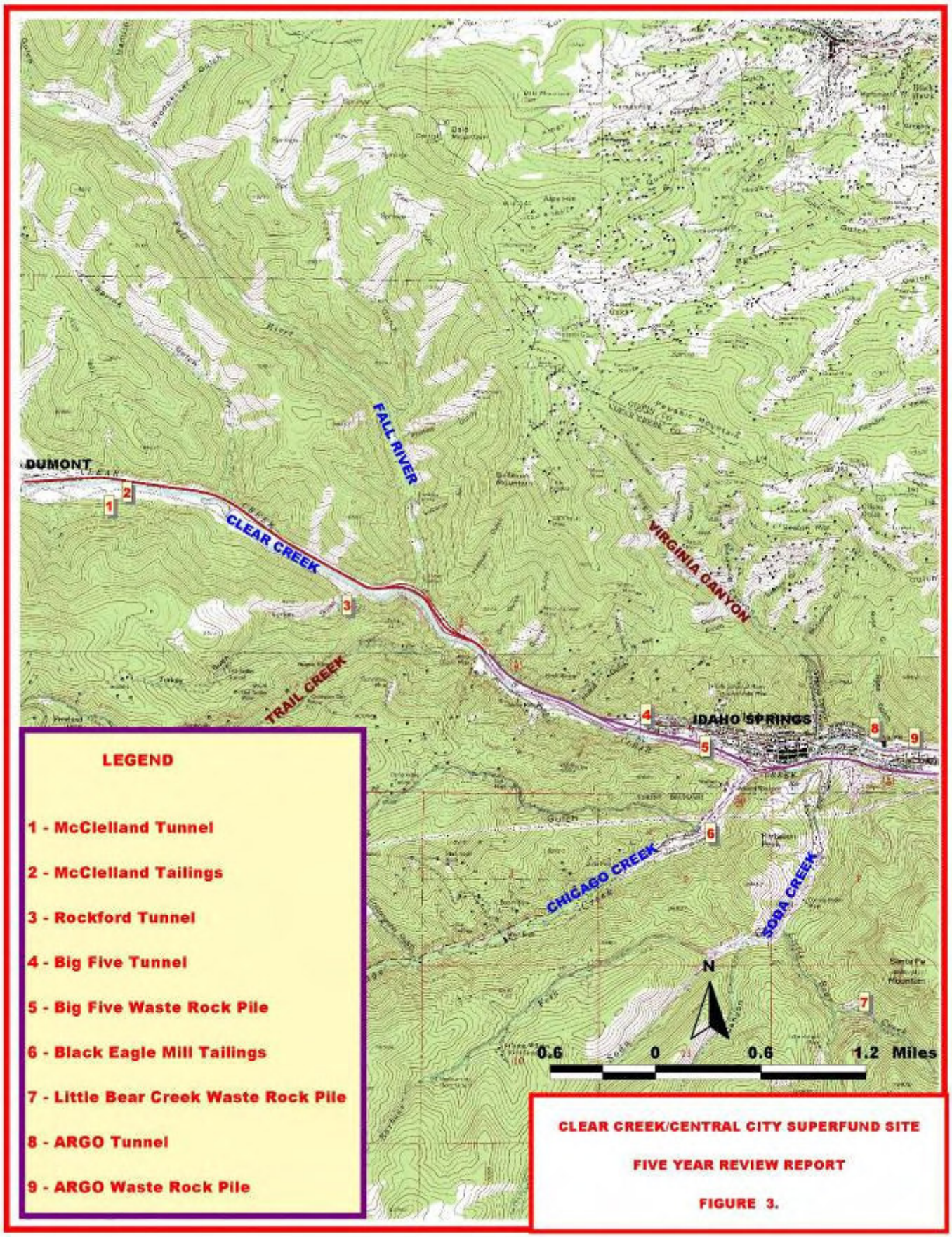
CLEAR CREEK/CENTRAL CITY SUPERFUND SITE
FIVE YEAR REVIEW REPORT
SITE WIDE INDEX MAP
FIGURE 1.



CLEAR CREEK/CENTRAL CITY SUPERFUND SITE

FIVE YEAR REVIEW REPORT

FIGURE 2.



LEGEND

1 - McClelland Tunnel

2 - McClelland Tailings

3 - Rockford Tunnel

4 - Big Five Tunnel

5 - Big Five Waste Rock Pile

6 - Black Eagle Mill Tailings

7 - Little Bear Creek Waste Rock Pile

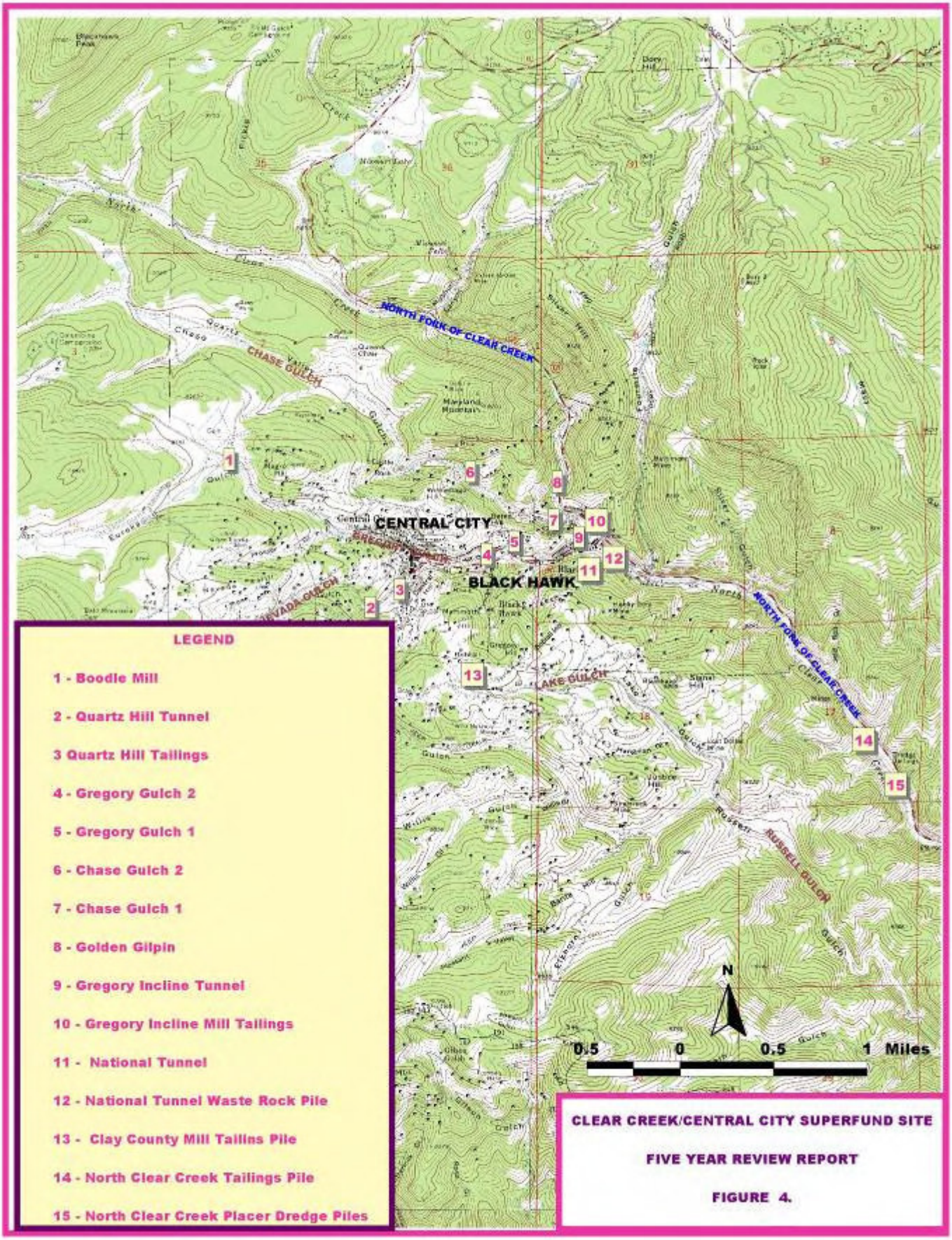
8 - ARGO Tunnel

9 - ARGO Waste Rock Pile

CLEAR CREEK/CENTRAL CITY SUPERFUND SITE

FIVE YEAR REVIEW REPORT

FIGURE 3.



LEGEND

1 - Boodle Mill

2 - Quartz Hill Tunnel

3 Quartz Hill Tailings

4 - Gregory Gulch 2

5 - Gregory Gulch 1

6 - Chase Gulch 2

7 - Chase Gulch 1

8 - Golden Gilpin

9 - Gregory Incline Tunnel

10 - Gregory Incline Mill Tailings

11 - National Tunnel

12 - National Tunnel Waste Rock Pile

13 - Clay County Mill Tailins Pile

14 - North Clear Creek Tailings Pile

15 - North Clear Creek Placer Dredge Piles

CLEAR CREEK/CENTRAL CITY SUPERFUND SITE

FIVE YEAR REVIEW REPORT

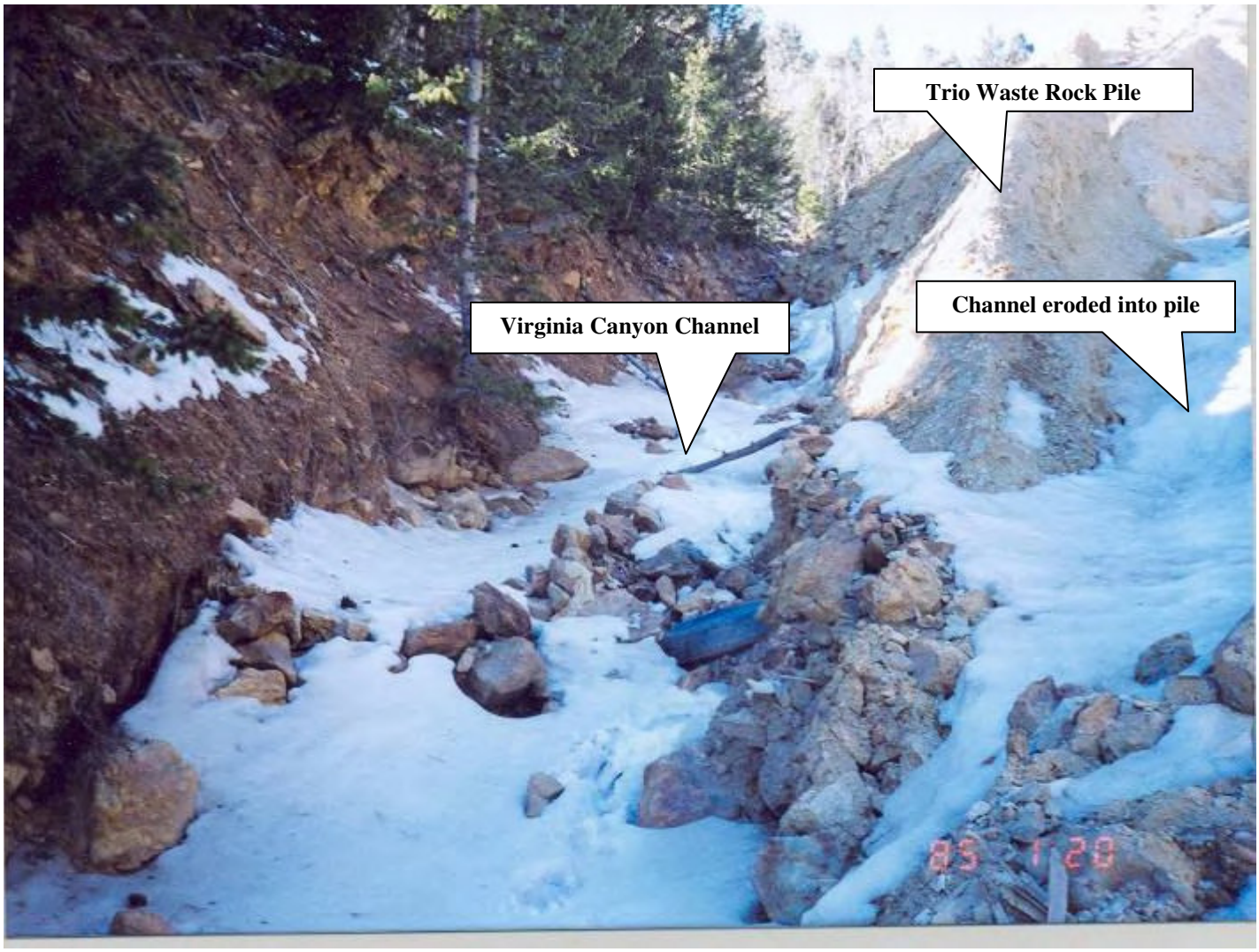
FIGURE 4.

APPENDIX B: SITE PHOTOGRAPHS

Argo Tunnel Water Treatment Plant in Idaho Springs.

Un-remediated Quartz Hill Tailings Pile in Central City

Williams/Rio Grande Waste Rock Pile in Virginia Canyon, Clear Creek County



Trio Waste Rock Pile Virginia Canyon, Clear Creek County

Lower Clarissa Waste Rock Pile Virginia Canyon, Clear Creek County

Diamond Joe Waste Rock Pile Virginia Canyon, Clear Creek County

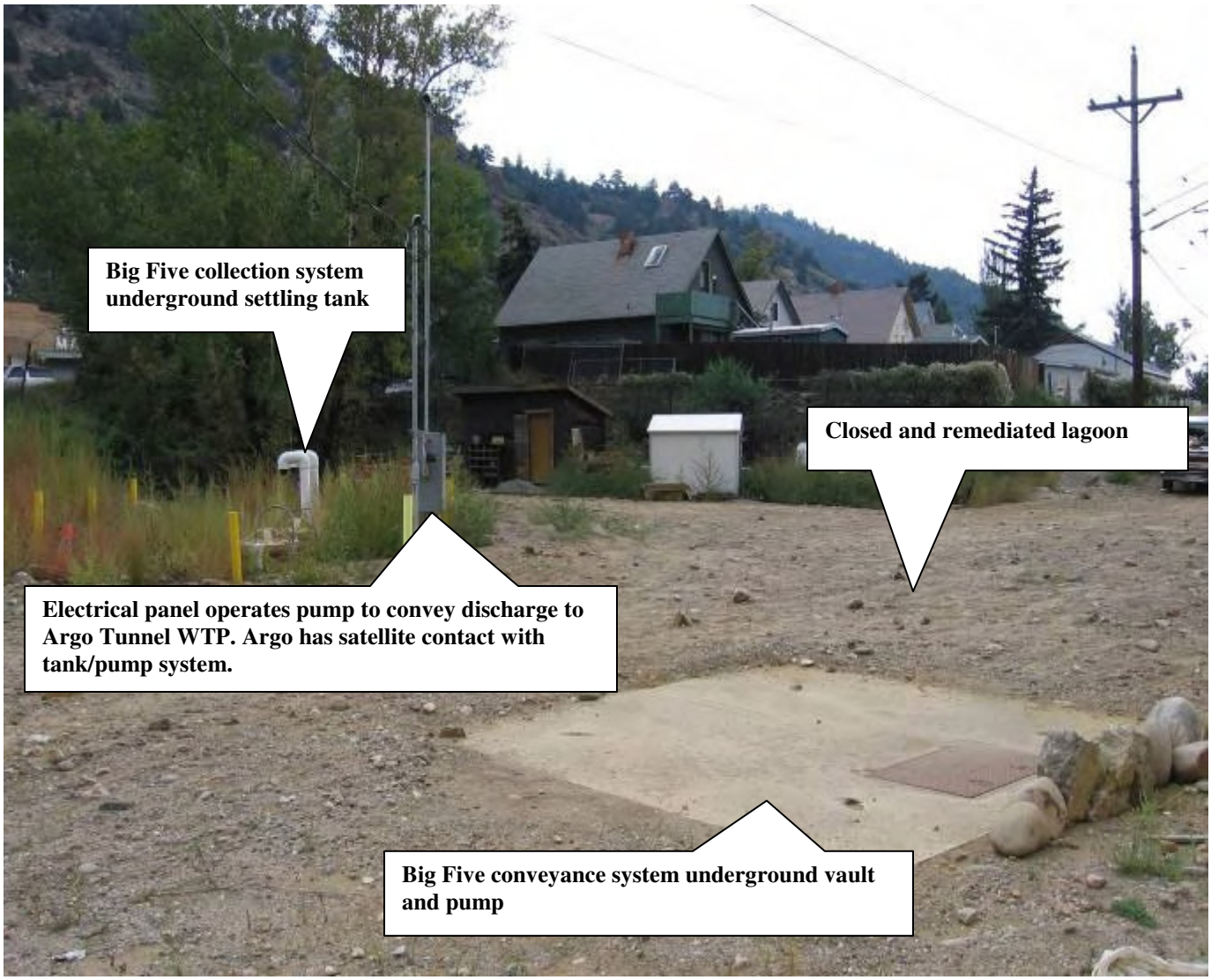
2008 OU4 Phase II site-wide repository under construction.

2008 OU4 Phase II re-graded Pittsburg tailings impoundment and Russell Gulch drop structures in the center of the photograph.

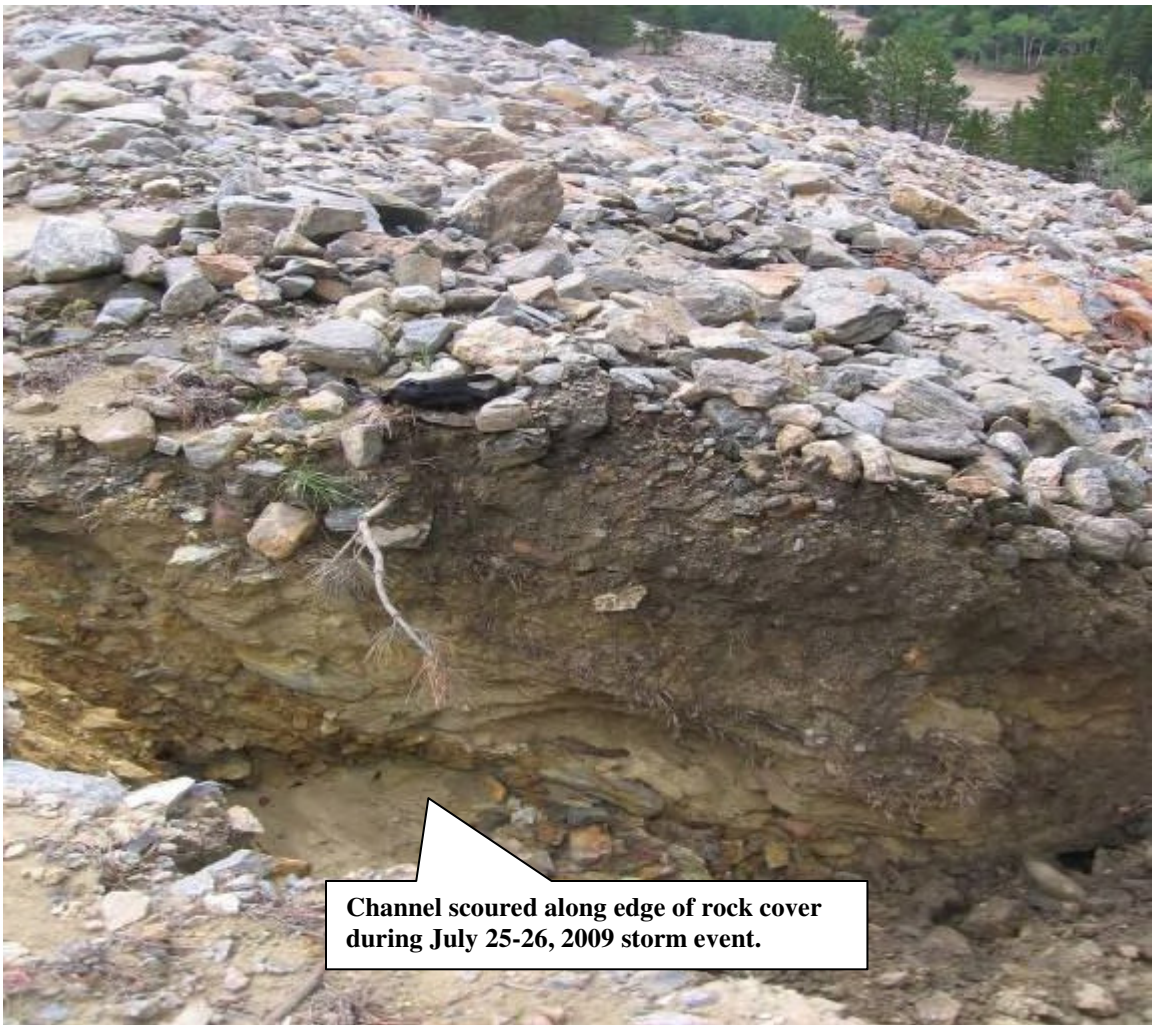
2007 OU4 Phase I Nevada Gulch Sediment Retention Basin.

2007 OU4 Phase I Russell Gulch Sediment Retention Basin.

Big Five Tunnel, West End of Idaho Springs -2004 pre-remediation.



Big Five Tunnel after remediation and construction of the Big Five discharge collection and conveyance system.



View to south along the Pittsburgh Waste Rock Pile showing scour.

View to east along the Pittsburgh Waste Rock Pile where scouring exposed geofabric underlying the rock cover.

View to west at the Willis Gulch check dam constructed during the Phase I OU 4 activities. The July 25-26, 2009 storm event resulted in the failure of the face of the dam. Dark gray rocks in the lower left hand corner of the picture were transported from the face of the dam during the storm event. The channel scour is approximately two feet deep, whereas the channel was level across the channel width after construction of the dam.

View to west at the Willis Gulch check dam. The July 25-26, 2009 storm event resulted in the failure of the face of the dam and the filling of the upstream face of the dam with sediment. The center of the picture shows the scouring to the face of the dam during the storm event flow in Willis Gulch. At this point any water will flow directly over the dam without slowing down and sediment will not be retained behind the dam.