

SUMMITVILLE MINE SUPERFUND SITE

2010 5-YEAR REVIEW REPORT SUMMITVILLE MINE SUPERFUND SITE RIO GRANDE COUNTY, COLORADO

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9/30/10

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LIST OF ACRONYMS

AMD	Acid Mine Drainage
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	U.S. Agency for Toxic Substances and Disease Registry
BOR	Bureau of Reclamation
CCR	Code of Colorado Regulations
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CSU	Colorado State University
EPA	Environmental Protection Agency
ESD	Explanation of Significant Differences
FS	Feasibility Study
GCL	Geosynthetic Clay Liner
g/m ²	grams per square meter
gpm	gallons per minute
HDPE	High Density Polyethylene
HLP	Heap Leach Pad
IMS	Intermountain Mine Services
mgd	million gallons per day
mg/L	milligrams per liter
MLRD	Mined Land Reclamation Division
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NWD	North Waste Dump
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PA/SI	Preliminary Assessment and Site Inspection
PF	Pumphouse Fault
PRP	Potentially Responsible Party
PW	Pumping Well
RAO	Remedial Action Objective
RI	Remedial Investigation
RMC	Rocky Mountain Consultants
ROD	Record of Decision
RTG	Resource Technologies Group
SAP	Successive Alkalinity-Producing
SCMCI	Summitville Consolidated Mining Company, Inc.
SDI	Summitville Dam Impoundment
SEO	Colorado State Engineer's Office
TAG	Technical Assistance Grant
TSS	Total Suspended Solids

UAA	Use Attainability Analyses
USFS	United States Forest Service
USGS	United States Geological Survey
WFD	Wightman Fork Diversion
WTP	Water Treatment Plant
WQCD	Water Quality Control Division

EXECUTIVE SUMMARY

This document presents a five-year statutory review of the remedies and ongoing work at the Summitville Mine Superfund Site. This is the third five-year review completed for the Site. The scope of this review includes the following emergency response actions and operable units (OUs):

- Plugging of the Reynolds and Chandler Adits (Emergency Response)
- OU0: Water Treatment
- OU1: Heap Leach Pad Detoxification/Closure
- OU2: Mine Waste Excavation and Mine Pit Closure
- OU3: South Mountain Groundwater
- OU4: Site-Wide Reclamation
- OU5: Final Site-Wide Remedy

Interim Records of Decisions (RODs) were published for OU0, OU1, OU2 and OU4 in January 1995. An interim ROD was not drafted for OU3, South Mountain Groundwater; this environmental medium was included in the subsequent scope of work for OU5. The ROD for OU5, Final Site-Wide Remedy, was issued in September 2001.

The Site does not pose a risk to human health. Threats to the environment have been reduced but the Final Site-Wide Remedy is currently not protective of the environment. All imminent threats at the site have been addressed. The remedy is expected to continue to be protective of human health. Protection of the environment will continue to improve as the remaining elements of the Final Site-Wide Remedy are completed. However, protectiveness cannot be determined for the Final Site-Wide Remedy until further information is obtained. This information will be obtained through the Site-Wide monitoring program as the remaining elements of the Final Site-Wide Remedy are completed. Assuming these elements are completed and fully operational within the next five years, a protectiveness determination may be made in the next (fourth) five-year review.

The following issues are identified in this five-year review:

1. Site-Wide Reclamation (OU4) assumptions have not been fully realized. The sizing of the Site water storage and treatment facilities in the FS and ROD was based on the premise that the OU4 reclamation effort would necessitate only water generated from 68 acres of the Site requiring treatment. Over the past five years, water originating from an additional 174 acres to 292 acres was directed to the SDI for storage and treatment. This additional volume of water has required adjustments to water treatment capacity, water storage capacity, and delayed the implementation of mine pool management.
2. The existing WTP has had insufficient capacity to treat the volume of water generated by the spring snow melt. The existing water storage capacity has historically been insufficient to store the volume of water generated at the Site by the spring snow melt. Consequently, the lack of treatment and storage capacity has delayed the implementation of mine pool management. Copper loads

originating from the mine pool (through non-point source discharges) and Site water turned out during the spring snow melt results in copper concentrations in excess of stream standards in the Alamosa River.

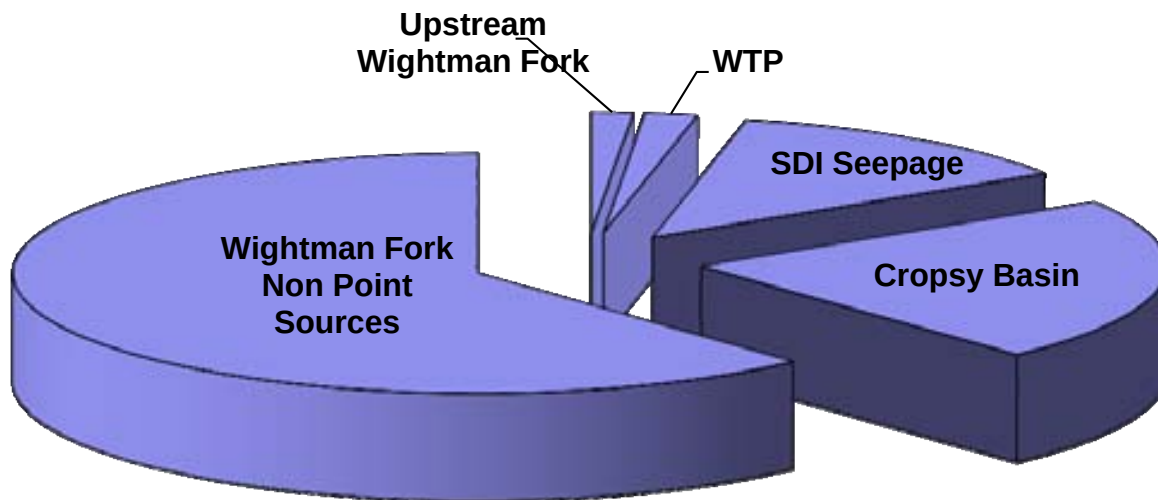
3. Non-point seepage through the SDI embankment and surface flow in the Cropsy basin contributes to copper concentrations in excess of water quality standards in the downstream Alamosa River. On-site seepage upstream of the A3-Ditch Turnout inhibits the use of this structure to manage Site water.
4. Mine pool management has not been implemented.

Based on this five-year review, the following recommendations and follow-up actions should be considered to enhance the short- and long-term protectiveness enacted at the Site:

1. Revise the site water balance following commissioning of the new WTP and the completion of the SDI spillway raise (December 2012).
2. With respect to OU5 elements currently under construction or planned for construction:
 - a.** Evaluate the performance of the new water treatment plan (commission date of spring 2012).
 - b.** Evaluate the impact of the increased storage capacity through raising of the SDI spillway weir (construction completed in fall 2010) on water management.
 - c.** Incorporation of the Reynolds Adit Improvement Project (construction completed in FY 2011) in the Mine Pool Management Plan.
3. With respect to planned elements to address non-point AMD both off and on the Site:
 - a.** Complete the design and construction of the capture and pump back system to address SDI embankment seepage.
 - b.** CDPHE will develop alternatives to minimize contact of Ditch R water with AMD producing rocks in the Campbell Quarry.
 - c.** Construct system to divert seepage around the A3-1 Ditch Turnout so CDPHE can utilize this turnout structure, as appropriate.
4. Initiate mine pool management and develop options for controlling non-point source discharges to upper Wightman Fork as other elements of the OU5 Remedy are completed and the Site water balance revised.

Until all remaining components of the final remedy (CDPHE, 2001) are implemented, the ability of the site-wide remedy to achieve Remedial Action Objectives cannot be determined. Although the few remaining point sources at the Site contribute to copper loads, plans are in place to address these items. As illustrated in Figure ES-1, non-point sources contribute more than 60 percent of the copper loading from the Site to Wightman Fork. These continuing non-point source loads tied to the mine pool will likely result in copper standards not being met in the Alamosa River during low flow conditions. Non-point source seepage is also impacting revegetation efforts on Site and increasing O&M costs.

Figure ES-1: Copper Loading Sources in Wightman Fork, 2005 - 2009



Note: Based on 5-year average total copper load of 25.8 lbs/day at WF5.5

FIVE YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site name (from WasteLAN): Summitville Mine		
EPA ID (from WasteLAN): COD 983778432		
Region: 8	State: CO	City/County: Rio Grande
SITE STATUS		
NPL Status: ☒ Final, ☐ Deleted, ☐ Other (specify) proposed		
Remediation Status (choose all that apply): ☒ Under Construction, ☒ Operating, ☒ Complete		
Multiple OUs? ☒ Yes, ☐ No	Construction Complete date:	
Has site been put into reuse: No Please refer to text description for each OU.		
REVIEW STATUS		
Reviewing Agency: ☐ EPA, ☒ State, ☐ Tribe, ☐ Other		
Author Name: Austin Buckingham		
Author Title: Remedial Project Manager	Author Affiliation: CDPHE	
Review period: March 2010 through September 2010		
Date(s) of site inspection: Seasonally continuous the months of March through October, 2005 through 2010		
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), ☐ Other (specify)		
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 WasteLAN): 09/27/2005		
Due Date (five years after triggering action date): 09/27/2010		

Protectiveness Statement: The Site does not pose a risk to human health. Threats to the environment have been reduced but the Final Site-Wide Remedy is currently not protective of the environment. All imminent threats at the site have been addressed. The remedy is expected to continue to be protective of human health. Protection of the environment will continue to improve as the remaining elements of the Final Site Wide Remedy (ROD, 2001) are completed. To be protective in the long term the following actions must be completed:

1. Completion of the SDI seepage capture system and refinement of water management practices in the Cropsy basin.
2. Commissioning of the new WTP and completion of the SDI spillway raise.
3. Completion of the seepage diversion downstream of the A3-Ditch Turnout.
4. Revision of the Site water balance.
5. Implementation of a Mine Pool Management Program.

It is expected that these actions will take approximately five years to implement. The results will be reported on the next five-year review.

1.0 INTRODUCTION

This document presents a five-year statutory review of the remedies and ongoing work at the site. The five-year review is required under the Comprehensive Environmental Response, Compensation Liability Act (CERCLA) and the National Contingency Plan (NCP). CERCLA §121 states:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

The U.S. Environmental Protection Agency (EPA), in the National Contingency Plan for Oil and Hazardous Substances (NCP), requires in 40 CFR § 300.430(f)(4)(ii) that:

If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after initiation of the selected remedial action.

This five-year review was performed by Tetra Tech, Inc. for the Colorado Department of Public Health and Environment (CDPHE). Golder Associates, Inc. also provided data and information that assisted in the preparation of this document.

This is the third five-year review completed for the Summitville Mine Superfund Site (Site) (Figure 1-1). In keeping with the requirements of CERCLA 121 (c) and the NCP, the signature date of the prior five-year review sets the schedule for the subsequent five-year review. The previous (second) Summitville Mine Superfund Site Five-Year Review was completed in September 2005, thereby triggering the schedule for this third review.

The scope of this review includes the following emergency response actions and operable units (OUs):

- Plugging of the Reynolds and Chandler Adits (Emergency Response)
- OU0: Water Treatment
- OU1: Heap Leach Pad Detoxification/Closure
- OU2: Mine Waste Excavation and Mine Pit Closure
- OU4: Site-Wide Reclamation
- OU5: Final Site-Wide Remedy

Interim Records of Decisions (RODs) were published for OU0, OU1, OU2 and OU4 in January 1995. An interim ROD was not drafted for OU3, South Mountain Groundwater; this media was

included in the subsequent scope of work for OU5. The ROD for OU5, Final Site-Wide Remedy, was issued in September 2001.

2.0 *SITE CHRONOLOGY*

The Summitville Mine Superfund Site is located at an elevation of 11,500 feet in the San Juan Mountains of south central Colorado (Figure 1-1). The site is a former open-pit gold mine that operated between 1984 and 1992. During that period, the operator mined low-grade ore from two adjacent pits, crushed the ore, placed it on a heap leach pad, and then extracted gold and other precious metals from the crushed ore using a cyanide solution. In December 1992, the mine operator declared bankruptcy and the State of Colorado requested and received emergency assistance from the federal government. Summitville was nominated to the National Priorities List (NPL) in 1994. To date, the costs of remedial actions implemented at the site by the federal government and the State of Colorado are in excess of \$200 million. Work at the site continues. A chronology of the CERCLA related actions at the site is provided in Table 2-1 and discussed below. Site features are shown in Figure 2-1.

Table 2-1
Chronology of Significant Events at the
Summitville Mine Superfund Site

Date	Event
December 15, 1992	Mine owner abandons the site
1992-1994	EPA and CDPHE perform emergency response at site
1994-1995	Plugging of Reynolds and Chandler Adits
1994-1995	Heap Leach Pad (HLP) Detoxification
December, 1994	Interim Records of Decisions (IRODs) issued for: OU0: Water Treatment OU1: HLP Closure OU2: Cropsy Waste Pile, Beaver Mud Dump, Summitville Dam Impoundment (SDI) and Mine Pits OU3: South Mountain Groundwater (later incorporated into OU5) OU4: Reclamation
1993-1996	Excavation of mine rock from Cropsy Waste Pile and Beaver Mud Dump and sediment from Cleveland Cliff's Tailings Pond completed, with internment of material in mine pits (OU2). Improvements made to Cleveland Cliff's Tailings Pond embankment, resulting in creation of the SDI.
1995	Centralization of water treatment operations at the water treatment plant complete
1996	Routing of site surface waters to SDI
1996-2010	Ongoing water treatment with continual safety improvements and process modifications.
1994-1998	Cropsy Valley restoration and revegetation.
1998	HLP Cap complete (OU1) and regrading of North Waste Dump complete
1998-2001	OU5 Site-Wide Remedial Investigation and Feasibility Study
September 2001	OU5 Record of Decision issued
2002	Site reclamation (OU4) complete
2004	New water treatment plant design
2003-2004	Upgrade of site ditches, construction of highwall ditch and retention pond, construction of groundwater interceptor drains complete.
2005	CDPHE assumes lead role for Water Treatment Plant and site operation and maintenance.
2007	Rule change before the Colorado Water Quality Control Commission for aluminum standards in the Alamosa River.
2008-2009	Upgrade of the Wightman Fork Diversion
2008-2010	Installation of microhydroelectric power plant
2009-2010	Completion of the SDI emergency spillway channel; addition to spillway increasing SDI storage capacity
2008-2012	Revision of new water treatment plant design and construction of new plant.
2010-2011	Design and construction of Reynolds Adit Improvements

On December 3, 1992, SCMCI announced its pending bankruptcy and informed the State of Colorado that it would not continue financial support for site operations beyond December 15, 1992. On December 4, the State of Colorado requested emergency response assistance from the federal government. EPA performed a Preliminary Assessment and Site Inspection (PA/SI) on

December 9, and on December 16, 1992 EPA Region 8 assumed control of the site as part of an Emergency Response Removal Action. A Hazard Ranking System package was completed for the site on January 27, 1993, and on May 10, 1993 the site was proposed for inclusion on the CERCLA National Priorities List (NPL). The Summitville Mine was added to the NPL on May 31, 1994. The site EPA Identification Number is COD 983778432.

When EPA assumed control of the site in December 1992, the overtopping of HLP Dike No. 1 posed an imminent threat to human health and the environment. Overtopping of the dike would have resulted in an uncontrolled release of a metals-rich, cyanide solution to the Alamosa River watershed. After addressing this imminent threat, EPA determined that the existing site water storage and treatment capacity were not sufficient to treat the volume of water in the HLP or, in the long term, manage the quantity of water generated from the various AMD sources at the site. This shortfall in combined storage/treatment capacity was particularly critical during the spring snow melt period.

EPA released a proposed plan in August 1994 describing a series of emergency and interim remedial actions for the site. Preliminary remedial action objectives (RAOs) for these early actions were:

- Reduce or eliminate deleterious water quality flow from the site into Wightman Fork.
- Reduce or eliminate the need for continued expenditures in water treatment.
- Reduce or eliminate the acid mine/acid rock drainage from manmade sources.
- Reduce or eliminate any human health or adverse environmental effects from mining operations downstream from the site, to include the Alamosa River.
- Encourage early actions and acceleration of the Superfund process.

The status of these early actions is summarized in Section 2.1.

2.1 *Early Actions*

The Reynolds Adit was identified as the largest individual source of copper loading to surface water at the site, with peak flows of 600 to 900 gpm and an estimated annual copper load of over 143,000 pounds (71½ tons). EPA plugged the Reynolds Adit in 1994-1995 under an emergency action to prevent the uncontrolled releases of AMD. The interconnected Chandler Adit was also plugged as formation of the mine pool behind the Reynolds Adit plug would lead to uncontrolled releases of AMD via the Chandler Adit portal.

EPA initially established five operable units (OUs) at the site and commissioned remedial investigations and focused feasibility studies on each. Work on OU3, South Mountain Groundwater, was tabled and this media was incorporated into the site-wide remedy (Section 2.2). The four remaining operable units addressed through early actions were:

- OU0: Water Treatment
- OU1: Heap Leach Pad Detoxification/Closure
- OU2: Mine Waste Excavation and Mine Pit Closure
- OU4: Site-Wide Reclamation

Interim RODs were issued for these four operable units in January 1995. The status of these operable units is summarized below. A detailed technical assessment of the work performed under these interim remedial actions is presented in Section 7.

Water Treatment (OU0): Consolidation of water treatment into a single facility constructed from donated and surplus equipment was completed in the mid-1990s. Water treatment continues to date in the existing water treatment plant (WTP) with ongoing efforts to improve safety and efficiency. Water discharged from the WTP to Wightman Fork is required to meet effluent standards for copper, iron, manganese and pH based on a seven-day consecutive average. A new water treatment plant is under construction and scheduled to be fully commissioned in 2012. The future of the existing WTP has not been decided.

Heap Leach Pad Detoxification/Closure (OU1): Detoxification of cyanide in the HLP was accomplished through a rinsing program in 1994 through 1995. Following completion of the rinsing program the HLP was graded and capped during the 1997 through 1998 construction season and vegetated. However, between the completion of the rinsing program and the completion of the cap, the HLP refilled with rainwater and snowmelt. Comparison of pre-rinsing water quality data to 2009 data indicates a 99 percent reduction in the aqueous-phase cyanide concentration in the HLP.

Excavation of Cropsy Waste Pile, Beaver Mud Dump, and Cleveland Cliffs Tailing Pond/ Mine Pit Closure (OU2): Mine rock in the Cropsy Waste Pile, Beaver Mud Dump and the Cleveland Cliffs Tailing Pond was excavated and placed in the mine pits through the mid-1990's. Prior to the placement of mine rock, the base of the pits were lined with cement kiln dust. Once filled, the south mine pit was capped with a geosynthetic clay liner (GCL) and a repository for WTP sludge was established on the southeast portion of the pit. The GCL cap was omitted from the north mine pit as the United States Bureau of Reclamation (BOR) determined that low permeability material placed in this pit rendered the GCL unnecessary.

The removal of mine rock from the Cropsy Creek valley and the Beaver Mud Dump has minimized the potential for AMD generation in these areas. However, this mine rock is not removed from contact with the environment as the groundwater/mine pool level inundates the deeper north mine pit for the majority of the year and, occasionally, seasonally inundates the lower portion of the south mine pit.

In addition to removing solids from the Cleveland Cliffs Tailing Pond, EPA and BOR performed work on the dam embankment and the adjacent Wightman Fork bypass. Work on the dam embankment included the installation of outlet works, construction of a spillway apron and the upper portion of the spillway channel, buttressing of the downstream face and armoring of the upstream face. The capacity of the Wightman Fork bypass was increased to handle the 10-year event. Once completed in 1996, the 90 million gallon SDI became the contaminated water storage reservoir for the site.

Site-Wide Reclamation (OU4): Reclamation of the site was implemented in multiple phases over several years. Major earthwork was completed in 2001. Select water management

components of the Final Site-Wide Remedy (Section 2.3.2) were incorporated into OU4. Researchers from Colorado State University biennially survey and report on the vegetative cover at the site. The results of the most-recent survey (2009) are provided in Appendix B.

2.2 *Final Site-Wide Remedy*

In 1996, EPA began transferring the lead for certain work at the site to CDPHE. These lead activities included the Remedial Investigation (RI), Feasibility Study (FS) and Remedial Design/Remedial Action for the Final Site-Wide Remedy (OU5). The OU5 RI and FS were performed in 1998 through 2001, culminating in the publication of the OU5 Record of Decision (ROD) in September 2001. The OU5 ROD addressed the threats to the environment that remained at the site after completion of emergency and interim remedial actions (Section 2.3.1). The goal of the final remedy was to capture the remaining mobile source material (i.e., metals-bearing acid mine drainage), contain them in an onsite impoundment, and to neutralize the pH and remove metals using lime-based water treatment technology.

In addition to maintaining the interim remedial actions for OU1, OU2 and OU4, the Final Site-Wide Remedy published in the September 2001 ROD contained the following twelve major components:

1. Evaluate on-site contaminated water impoundment upstream of the Wightman Fork-Cropsy Creek confluence.
2. Construction of a new water treatment plant.
3. Possible breach and removal of the existing Summitville Dam Impoundment.
4. Construction of a sludge disposal repository.
5. Upgrade of Wightman Fork Diversion.
6. Upgrade of select site ditches.
7. Construction of groundwater interceptor drains.
8. Construction of a Highwall ditch.
9. Rehabilitation of Reynolds Adit.
10. Management of mine pool water.
11. Continued site maintenance, and groundwater/surface water and geotechnical monitoring on site.
12. Surface water, sediment, and aquatic life monitoring in Alamosa River and Terrace Reservoir.

The location of the new water treatment plant was modified in a 2003 Explanation of Significant Differences (ESD). The status of the remedial design and remedial action on the various OU5 components is described in Section 4.

2.3 *PRP Settlements*

The United States government filed a proof of claim in the SCMCI Chapter 7 bankruptcy case. However, there were not sufficient assets to fund a distribution to general unsecured creditors and, therefore, no payment was made on this claim. The bankruptcy case was closed on November 6, 2000. Government claims were also filed against the parent company of SCMCI,

Galactic Resources, Ltd, in a bankruptcy proceeding in Canada, and a small distribution was received.

In 1996 and 1998, EPA entered into administrative settlements with companies involved at various times in mining operations or exploration activities at the Summitville Mine Site prior to SCMCI's heap leach gold mining operations.

In May 1996, the United States Department of Justice and the State of Colorado Department of Law initiated a civil action against potentially responsible parties. In June 2001, the United States government and the State reached a settlement with Robert Friedland, the former chairman of the board and chief executive officer of Galactic Resources, Ltd. Under the terms of the settlement, Mr. Friedland made a lump sum payment of approximately \$20 million shortly after the settlement was approved by the U.S. District Court.

Settlements were also reached with other viable potentially responsible parties including current and former operators and owners of the site.

A December 2009 reorganization plan filed by Asarco's parent company, Americas Mining Corporation, provided more than \$1.7 billion in funds for environmental remediation of more than 50 sites in 19 states currently and formerly owned or operated by Asarco. The settlement includes the funding of environmental custodial trusts and remediation at a series of Colorado sites, including the Summitville Mine Superfund Site.

3.0 SITE BACKGROUND

The Summitville Mine Superfund Site is located in the southeastern portion of the San Juan Mountains in the southwest corner of Rio Grande County, approximately 60 miles west of Alamosa, Colorado (Figure 1-1).

3.1 Physical Characteristics

The site is at elevations between approximately 11,000 to 12,000 feet in the San Juan Mountain Range of the Rocky Mountains, approximately two miles east of the Continental Divide. The Summitville Mine is defined as the permitted 1,231-acre mine site that covers most of Section 30 and the northern one-third of Section 31, Township 37 North, Range 4 East, of the 6th New Mexico Principal Meridian.

The site lies within the 1.86 million acre Rio Grande National Forest. The closest paved road to the site is U.S. Highway 160, approximately 18 miles distant via United States Forest Service (USFS) gravel roads. The community of Jasper is located on the Alamosa River approximately 8½ miles downstream of the Site (Figure 3-1). Although Jasper has about 150 private property owners, there are only a few year-round residents. The closest major population center is the town of South Fork (2008 population of 653), located approximately 25 highway miles to the north and in a drainage not impacted by site activities.

The USFS does not maintain the Rio Grande National Forest gravel road system in the site vicinity during the winter due to the over 300 inches of annual snowfall. CDPHE's contractors generally plow the USFS roads in late February to initiate water treatment activities. Water historically is discharged from the site's water treatment plant beginning April 1st. Site activities continue through the summer and early fall terminating not later than October 31st, with the contractors generally leaving the area by mid-November.

3.2 Land and Resource Use

The Rio Grande National Forest lands surrounding the site have primarily been used for recreation, hunting, and livestock grazing. The ghost town of Summitville abuts the northern boundary and its abandoned buildings provide a tourism attraction. To the south lies the *Wightman Fork to Lookout* roadless area.

More recently, mining was the primary use of resources in the Summitville Mining District. Remediation has been the primary activity in the area since 1992 and seasonal (April through October) water treatment will continue at the site for an indefinite period. The Superfund site is not staffed in the winter months. Due to its remoteness, the location is likely not routinely visited in the winter months except by snowmobile operators and, potentially, by cross country skiers or snowshoers.

National Wetlands Inventory mapping indicates that the broad Wightman Fork valley north and northwest of the North Waste Dump (Figure 2-1) is comprised of freshwater emergent and freshwater forested/shrub wetlands. The south bank of the Wightman Fork downstream of the

SDI and around the confluence with Cropsy Creek is mapped as freshwater forested/shrub wetland.

USFS mapping indicates that the majority of the area is non-suitable habitat for lynx. The small, scattered forested areas throughout the site (Figure 2-1) are potentially suitable, but not prime, lynx habitat.

As discussed in the second five-year review (CDPHE, 2005), the OU5 ROD was issued shortly after the State of Colorado enacted a law which stipulated that property owners must provide an environmental covenant for an environmental remediation project that results in residual contamination at levels that do not allow unrestricted use, when the remedy utilizes an engineered feature or structure that requires monitoring, maintenance, or operation or one that will not function as intended if the engineered feature is disturbed. The OU5 ROD was in preparation at the time that the State of Colorado enacted this legislation and, therefore, the provisions of the Colorado Hazardous Waste Act (25-15-321 C.R.S.) were not incorporated into the OU5 ROD. Because remedial action at the site will not allow unrestricted use of the property at the completion of the remedial action, and since the remedial action will require continued operation of engineering features (e.g., water storage and treatment, mine pool management, and groundwater interceptor drains) to maintain the protectiveness of the remedial action, the environmental covenant law was triggered at the site. Consequently, the State of Colorado negotiated an environmental covenant with the Aztec Group (owners of mining claims at the site) in April 2002, which runs with the land in perpetuity.

3.3 History of Contamination

The region surrounding the mining site experienced active volcanism as recently as 20 to 25 million years ago. The Summitville Mining District, which includes the site, lies within a collapsed caldera that dates from these times. Several other collapsed calderas and related areas of volcanically altered rocks, including mineralized zones, are present within the Alamosa River watershed. These altered and mineralized rocks are the source for numerous, naturally occurring, acidic springs and seeps throughout the watershed. The naturally acidic and metals-bearing waters produced in the watershed adversely affected water quality and aquatic habitat in the Alamosa River prior to mining. Drainage from other legacy mine sites within the Alamosa River watershed also contributes to degraded water quality and aquatic life habitat in the watershed. These natural and human caused conditions were described in the Use Attainability Analyses report (Tetra Tech, 2005) which supported the increase in aluminum standards in the Alamosa River basin. In 1998, the recognized conditions in the upper Alamosa River watershed resulted in the adoption of ambient pH standards as low as 3.52 for the Alamosa River upstream of the confluence with Wightman Fork. These conditions will continue to have adverse impacts on the watershed after the sources at the site have been addressed.

Mining has occurred in the Summitville Mining District since the 1870's. Until the most recent phase of mining, miners historically employed underground methods for the recovery of gold, silver, and, to a lesser extent, copper. This historic mining activity resulted in a network of underground workings that are connected, either directly through raises, winzes, crosscuts, etc.,

or indirectly via fractures, faults, etc. The Reynolds Adit, which is the lowermost adit connecting the upper South Mountain underground workings, was driven during the late 1890's to early 1900's. The purpose of the Reynolds Adit was to serve as an ore-haulage adit for the upper workings and to dewater South Mountain, thereby facilitating mining. The most recent phase of mining began in 1984, when large-scale, open-pit operations began at the site. The open-pit mining operations used cyanide heap leaching to extract precious metals from approximately 10 million tons of low-grade ore after it was excavated, crushed and placed on a heap leach pad.

Features and structures from the period of open-pit mining dominate the site landscape (Figure 2-1). The Highwall is a steep face of South Mountain that was created by open-pit mining. The mining exposed acid-generating rocks that are a source of continuing acid mine drainage. The former north and south open-pit mines were located at the base of the Highwall. Both pits have been backfilled and reclaimed. The Heap Leach Pad was constructed in the Cropsy Creek Valley, east of the former mine pits. The Heap Leach Pad has been capped and vegetated. The Summitville Dam Impoundment is used to store AMD impacted waters for treatment. Other notable site features include the North Waste Dump, WTP, and the Reynolds and Chandler Adits.

Surface water (both treated and untreated) from the site drains to Wightman Fork and then flows approximately five miles downstream to the confluence of the Alamosa River. The Alamosa River flows past the small town of Jasper, approximately four miles below the confluence with Wightman Fork, and into Terrace Reservoir (Figure 3-1). Terrace Reservoir was constructed in 1911 as an irrigation reservoir, and that remains its primary function today. Water released from Terrace Reservoir is diverted via a series of manmade canals and ditches to a large area in the west-central portion of the San Luis Valley of Colorado where it is used for agricultural irrigation, livestock watering and wildlife habitat. Crops grown using Alamosa River water include alfalfa, barley, wheat and potatoes. Below Terrace Reservoir, the Alamosa River flows through Capulin and terminates at its final point of diversion prior to reaching the Rio Grande.

Diversions from the Alamosa River also feed wetlands that are habitat for aquatic life and migratory waterfowl, including portions of the Monte Vista National Wildlife Refuge. The Monte Vista National Wildlife Refuge is located on the western edge of the Central Flyway and is a major stopover for migrating greater sandhill cranes moving between their wintering area around Bosque del Apache National Wildlife Refuge in New Mexico and breeding grounds in the northern United States and southern Canada. Up to 20,000 cranes pass through the San Luis Valley in the spring and again in the fall, along with mallards, pintail and teal ducks, Canada geese and American avocets, killdeer, white-faced ibis, egrets and herons.

Releases of AMD and seepage from the HLP (cyanide and metals-bearing) from the Summitville Mine beginning in the 1980s impacted the downstream Alamosa River resources described in the prior paragraphs. After the mine operator declared bankruptcy, EPA took control of the site in late 1992 and began to address the existing and threatened releases from the site (Section 2.1).

3.4 Initial Response

As discussed in Section 2.1, upon taking control of the site in December 1992 EPA implemented emergency water treatment actions to address the imminent threat posed by the potential overtopping of the HLP. Overtopping of the HLP would have released cyanide solutions to Wightman Fork and the Alamosa River. Subsequent emergency actions included the plugging of the Reynolds and Chandler Adits, which addressed the major point source of AMD at the site. Following these emergency actions, EPA initiated a series of interim remedial actions (OU0, OU1, OU2 and OU4). Work on these interim remedial actions was initiated and, in the case of OUs 1 and 2, completed prior to the issuance of the OU5 ROD. The EPA began transferring the lead on OUs 4 and 5 to the State of Colorado in the late 1990s. Cleanup actions to date have been funded by the Superfund trust fund, the State of Colorado, and settlement funds.

3.5 Basis for Taking Action

Following the implementation of the emergency and interim remedial actions described in Section 2.1, the U.S. Agency for Toxic Substances and Disease Registry issued a Public Health Assessment (ATSDR, 1997) that classified the site as posing no apparent public health hazard. However, releases from the site still posed a threat to the environment. Consequently, the objective of the Final Site-Wide Remedy (OU5) was to address the threats to the environment that remained at the site following the completion of the emergency and interim remedial actions.

With the consolidation of the majority of impacted site drainages flowing to the SDI by 1996, limited point source discharges of AMD remained at the completion of the OU5 RI. These included the Pumphouse Fault (PF-0) and the gravel drain at the base of the SDI embankment (SDI-Toe Channel). Releases of untreated water from the SDI provided a large source of copper and other metals to the watershed during high flow conditions. Under low flow conditions, non-point sources provided a substantial portion of the copper loading to Wightman Fork.

The OU5 Record of Decision focused on threats to the environment and, specifically, to the threats posed to aquatic life by the remaining contaminated media and structures at the site. Elevated concentrations of copper were the primary aquatic risk driver to the Alamosa River ecosystem. The site was the predominant source of copper loading to the Alamosa River. Although the copper concentrations in the Alamosa River were well below their peak levels, they routinely exceeded chronic and acute water quality standards during the period covered by the OU5 Remedial Investigation.

4.0 REMEDIAL ACTIONS

This section presents a summary of the emergency and interim remedial actions and the final remedial action implemented at the Superfund site..

4.1 Remedy Selection

The conditions confronting the federal and state agencies at the Summitville Mine in the early 1990s are discussed in Section 4.1.1. These conditions set the stage for the development and implementation of the emergency and interim remedial actions throughout the remainder of the 1990s. The development and implementation of the Final Site-Wide Remedy (OU5) is discussed in Section 4.1.2.

4.1.1 Emergency and Interim Remedial Actions

The imminent threat facing EPA in December 1992, when they assumed control of the site, was the potential overtopping of the HLP's downstream dike (Dike No. 1). Overtopping of the dike would have resulted in an uncontrolled release of a metals-rich, cyanide solution to the Alamosa River watershed. After addressing this threatened release, EPA determined that the existing site water storage and treatment capacity were not sufficient to detoxify the volume of water in the HLP as part of its final closure. Additionally, the EPA determined that the combined water storage and treatment capacity present would not be sufficient to handle the long-term volume of AMD generated at the site, particularly during the spring snow melt periods. Thus, plans were developed to plug the Reynolds Adit, to upgrade the water treatment facilities, and to upgrade the existing impoundment and dam.

Large accumulations of waste rock, ore stockpiles, and tailing were present at several locations throughout the site. The open-pit mines, which exposed acid generating rock to the atmosphere, also served as focused groundwater recharge basins that funneled snowmelt, precipitation and AMD to the mine workings and adjacent highly fractured and faulted mineralized bedrock.

EPA identified several distinct areas discharging large amounts of AMD, or having the potential to generate volumes of AMD, as the primary areas to focus on during the emergency and interim remedial actions. The copper load¹ from these areas was estimated to total 321,000 pounds in 1991 (EPA, 1995c):

- Reynolds Adit - 143,000 pounds (44.5 percent)
- Cropsy Waste Pile - 33,400 pounds (10.4 percent)
- Heap Leach Pad or "overflow potential" - 84,000 pounds (26.2 percent)
- French Drain Sump² - 14,600 pounds (4.5 percent)
- Cleveland Cliffs Tailing Impoundment and Beaver Mud Dump - 17,000 pounds (5.3 percent)

¹ Copper was determined to be the primary metallic risk driver for ecological (aquatic life) risk.

² The French drain sump was located downgradient of the HLP and at the terminus of the system of underdrains installed by SCMCI and intended to capture cyanide-bearing waters seeping from the HLP.

Combined, the remaining sources at the site were estimated to contribute less than ten percent (<29,000 pounds) of the site's 1991 copper load.

The proposed plan for four interim actions at the site was released to the public in August 1994. Preliminary remedial objectives for the interim actions were established in the 1994 proposed plan. These preliminary remedial objectives were developed in consideration of the then current regulatory guidelines and compliance with applicable or relevant and appropriate requirements (ARARs). The preliminary remedial objectives for the site were:

- Reduce or eliminate deleterious quality water flow from the site into Wightman Fork.
- Reduce or eliminate the need for continued expenditures in water treatment.
- Reduce or eliminate the acid mine/acid rock drainage from the manmade sources.
- Reduce or eliminate any human health or adverse environmental effects from mining operations downstream from the site, to include the Alamosa River.
- Encourage early actions and acceleration of the Superfund process.

EPA targeted five “*primary areas of concern at the site*” for emergency response actions or interim remedial actions. Emergency response actions included plugging of the Reynolds and Chandler Adits. The other areas of concern were addressed through interim Record of Decisions as described below:

- Water Treatment, (OU0, EPA, 1995a).
- Heap Leach Pad Detoxification/Closure, designated (OU1, EPA, 1995b).
- Excavation of mine wastes from the Cropsy Waste Pile, Beaver Mud Dump and the Cleveland Cliffs Tailing Pond, placement of this material in the mine pits, and mine pit closure, designated (OU2, EPA, 1995c).
- South Mountain groundwater, (OU3).
- Site-wide reclamation activities, (OU4, EPA, 1995d).

The scopes of the emergency response/interim remedial actions implemented by EPA at the site are discussed in the following subsections.

4.1.1.1 *Adit Plugging*

Both the Reynolds and the Chandler Adits were plugged. The purpose in plugging the Reynolds Adit was to minimize discharge from the largest point source of AMD at the site. Flows of the order of 600 to 900 gpm were measured from the Reynolds Adit during the spring snowmelt period. The estimated annual copper loading from the Reynolds Adit in 1991 was 143,000 pounds (71½ tons) or 44.5 percent of the copper loading from the site. Although a portion (average of 120 gpm) of the portal flows was treated in the Portal Interim Treatment System much of the Reynolds Adit flow reported, untreated, to surface water. These untreated portal flows impacted the surface water media in Wightman Fork and the Alamosa River.

SCMCI's preliminary plan for plugging the adit system called for three bulkheads: one at approximately 1,240 to 1,280 feet inside the portal and a second at approximately 600 to 660 feet

inside the portal, with a third to be placed in the collapsed Dexter Cross-cut, which joins the Reynolds from the northwest, approximately 120 feet from the portal (SCMCI, 1992). Due to the bankruptcy the mining company did not install the plugs.

In February 1993, EPA issued a Request for Proposal to plug the adit. The selected contractor, Intermountain Mine Services (IMS), proposed to install two bulkheads in the adit: one at 1,265 feet and a second at 625 feet from the portal. The EPA also requested that IMS clear the Dexter Cross-cut and then, based on the geology encountered, if necessary, design a third bulkhead. Because plugging of the Reynolds Adit would lead to the development of a “mine pool,” the Chandler Adit would also be plugged under the program to prevent rising water levels in the mine pool from discharging from the inundated underground mine workings.

The construction of the bulkheads in the Reynolds and Chandler Adits is described in Section 4.2.1.1. The ongoing O&M and monitoring requirements specific to the emergency action construction elements are discussed in Section 4.3.1.1.

4.1.1.2 Water Treatment (OU0)

Water treatment was initiated at the site on an emergency basis after SCMCI declared bankruptcy and abandoned the site in early December 1992. On December 18, 1992, EPA issued an Action Memorandum, documenting the need for water treatment as a time critical removal action. Treatment of water occurred at different locations around the site for the first few years that EPA was at the Summitville location. This included the Cyanide Destruction Plant, the Metals Removal Plant, the Crospy WTP and the Portable Interim Treatment System.

EPA commissioned a Water Treatment Focused Feasibility Study and, of the five alternatives that survived the screening process, Alternative #4 (continued treatment with AMD conversion and containment) was selected as the water treatment interim remedial action. The major components of the selected interim alternative included:

- Continued treatment of the Crospy Waste Pile drainage and the French drain waters in the Crospy Water Treatment Plant.
- Continued reduction of cyanide in the water from the HLP in the Cyanide Destruction Plant and Metals Removal Plant until the water quality met remedial action objectives.
- Completion of HLP remediation, followed by the conversion of the Cyanide Destruction Plant to treat AMD. The Metals Removal Plant would be closed and would remain on site as a contingency facility.
- Containment of AMD in the area of the SDI/Beaver Mud Dump during peak surface water flows that exceed Cyanide Destruction Plant capacity (500 gallons per minute). The contained water would be treated before being released into Wightman Fork

The Water Treatment Interim ROD was issued January 1995.

4.1.1.3 *Heap Leach Pad Detoxification/Closure (OU1)*

Treatment of the cyanide solution in the HLP was initiated at the Summitville Mine on an emergency basis after SCMCI declared bankruptcy and abandoned the site in early December 1992.

EPA commissioned a Heap Leach Pad Focused Feasibility Study and, of the six alternatives that survived the screening process, Alternative 5-3 (Injection-Extraction Wells, Pump and Treat, Biotreatment, Recontour, Capping and Bioreactor) was selected as the HLP interim remedial action. The major components of the selected interim alternative included:

- Development and implementation of HLP solution collection system consisting of injection/extraction wells installed in the HLP.
- Pumping and treating of the contaminated leachate.
- Short term biotreatment of waters, in-situ biotreatment of ore and leachate using cyanide-destroying bacteria.
- Grading, recontouring, capping and vegetating the HLP to reduce the volume of water to be treated.
- Installation of a lined surge pond and a bioreactor using sulfate-reducing bacteria to treat acid waters generated after the HLP is remediated.
- Periodic monitoring of groundwater for cyanide and/or metal concentrations.

The Heap Leach Pad Interim ROD was issued January 1995.

4.1.1.4 *Excavation of Cropsy Waste Pile, Beaver Mud Dump, and Cleveland Cliffs Tailing Pond/Mine Pit Closure (OU2)*

Large volumes of mine rock were present in the Cropsy Waste Pile and the Beaver Mud Dump in 1992. Smaller accumulations of mine rock and ore were present at other locations. The Cleveland Cliffs Tailing Pond (aka the SDI) was partially filled with mill tailing and its embankment lacked modern hydraulic structures.

EPA commissioned the Cropsy Waste Pile Focused Feasibility Study and, of the five alternatives that survived the screening process, Alternative 3 (Removal to the mine pits) was selected as the interim remedial action. The major components of the selected interim alternative included:

- Excavation of the Cropsy Waste Pile to an elevation of 11,620 feet.
- Excavation of the Beaver Mud Dump and the SDI.
- Lining of the bottom of the mine pits with a layer of pH neutralizing material.
- Placement and capping of excavated material in the mine pits.

The interim ROD was issued January 1995.

4.1.1.5 South Mountain Groundwater (OU3)

This non-time critical removal action consisted of characterizing the hydrogeology of South Mountain groundwater. Operable Unit 3 was incorporated into the site-wide Remedial Investigation/Feasibility Study (Section 4.1.2) in the late 1990s, and groundwater is addressed as part of OU5.

4.1.1.6 Site-Wide Reclamation (OU4)

EPA commissioned a Reclamation Focused Feasibility Study and, of the three alternatives that survived the screening process, Alternative 2 (Onsite Topsoil with Amendments) was selected as the reclamation interim remedial action. The major components of the selected interim alternative included:

- Reclamation of approximately 200 acres of disturbed land.
- Rough grading of all areas to be reclaimed to a 33 percent or less grade.
- Using onsite topsoil that was previously stockpiled and stored.
- Adding an optimum amount of amendments needed to produce a topsoil capable of promoting and sustaining plant growth.
- Reconfiguring the areas for slope stabilization, soil erosion and moisture retention.
- Seeding with a seed mixture designed for the diversity of habitat found at the site.
- Providing adequate weather protection for the severe site conditions.

The Reclamation Interim ROD was issued January 1995. At the time of the OU4 Interim ROD issuance, the soil amendment and seed/plant selection had not been finalized. Analysis of soil samples, greenhouse studies, and onsite field trials would continue before the final selections were made.

4.1.2 Final Site-Wide Record of Decision (OU5)

Work on the Final Site-Wide Remedy (OU5) began in 1998 under the direction of CDPHE. A site-wide Remedial Investigation (RI) and Feasibility Study (FS) were performed, with reports being issued in 2001 (RMC, 2001a; RMC, 2001b). The OU5 ROD was issued in September 2001 (CDPHE, 2001), and addressed the threats to the environment that remained at the site after completion of emergency and interim remedial actions. The major components of the Final Site-Wide Remedy include the following:

- Onsite contaminated water impoundment upstream of the Wightman Fork-Cropsy Creek confluence.
- Construction of a new water treatment plant downstream of the contaminated water impoundment.
- Possible breach and removal of the existing Summitville Dam Impoundment.
- Construction of a sludge disposal repository.
- Upgrade of Wightman Fork Diversion.
- Upgrade of select site ditches.
- Construction of groundwater interceptor drains.

- Construction of a Highwall ditch.
- Rehabilitation of Reynolds Adit.
- Management of mine pool water.
- Continued site maintenance, and groundwater/surface water and geotechnical monitoring on site.
- Surface water, sediment, and aquatic life monitoring in the Alamosa River and Terrace Reservoir.

Determination of impoundment size, and exact location and capacity of the water treatment plant were deferred to the Remedial Design phase. Institutional controls, other than continued restricted access to the site and compliance with the environmental covenant provisions, were not components of the remedy³.

The remedial action objectives (RAOs) of the Final Site-Wide Remedy (OU5) address migration, exposure pathways and potential receptors of contamination from the site. The RAOs for the final remedy of the site are presented below.

1. Control and treat surface water, groundwater and leachate, as necessary, to meet state and federal ARARs.
2. Re-establish State aquatic use classifications and attainment of water quality numeric criteria in Segment 3c for the Alamosa River and downstream.
3. Ensure geotechnical stability of constructed earthen structures and slopes.
4. Mitigate erosion and transport of sediment into Wightman Fork and Cropsy Creek.
5. Control airborne contaminants from the site.

The Human Health risk assessments for the site and downstream study areas found there to be no adverse health risk to humans. However, sufficient acute and chronic risks were found to limit aquatic life in the Alamosa River downstream of Wightman Fork.

4.1.3 Remediation Levels

Reactive transport modeling was used to assess improvements in water quality of Wightman Fork, the Alamosa River and Terrace Reservoir as part of the evaluation of the remedial alternatives for the site (HydroQual 2001). A final step of the modeling was to estimate remediation levels at the site boundary (WF5.5) that would be necessary to meet water quality standards in Segment 3c of the Alamosa River. Segment 3c was established as the offsite point of compliance for the selected remedy.

Surface water modeling was based on the EPA WASP4 transport codes with the metal-speciation submodel, META4, to describe and control metal transformations and subsequent transport and fate. The calibrated model was used to estimate the maximum concentrations of metals (remediation levels) that could be discharged from the site while still meeting water quality

³ As discussed in Section 3.2, subsequent to the issuance of the OU5 ROD an environmental covenant was executed between the State of Colorado and the Aztec Group in April 2002.

standards within Segment 3c of the Alamosa River. The estimated remediation levels for the selected remedy are presented in Table 4-1. The remediation levels are viewed as “goals” for the selected remedy due to the variability of acidity provided by the Alamosa River upstream of Wightman Fork and uncertainties of the model.

Copper’s form (particulate versus dissolved) is extremely sensitive to pH. Figure 4-1 illustrates the distribution of dissolved and particulate copper as a function of pH in the upper portion of Alamosa River Segment 3c (Figure 3-1). The copper standard in Segment 3c is for dissolved copper. During low-flow periods, the pH of water in the Alamosa River upstream of Wightman Fork is strongly acidic (pH 4 to 5); whereas, that of Wightman Fork is only slightly acidic (pH 6 to 7). Consequently, particulate copper entering the Alamosa River from Wightman Fork converts from the particulate to the dissolved form due to the more acidic conditions present in the Alamosa River. When higher pHs are present in the Alamosa River, much greater concentrations of copper can be released from the site (Figure 4-1) because the copper remains in the particulate form, which is non-toxic to aquatic life, upon entering the Alamosa River.

4.1.4 *Changes to ARARs*

Federal and state requirements that were considered applicable or relevant and appropriate requirements (ARARs) for the Final OU5 Site-Wide Remedy were identified in the ROD (CDPHE, 2001). As part of this third five-year review, the original ARARs were reviewed, focusing on those requirements that could potentially affect the protectiveness of the remedy.

With respect to chemical specific ARARS, the Colorado Water Quality Control Commission took action in 2007 on Regulation No. 36, *Classification and Numeric Standards for Rio Grande Basin* (5 CCR 1002-36), to revise upward the aluminum standards in the Alamosa River. This revision was based on a petition by CDPHE and supported by a 2005 Use Attainability Analyses (UAA) report (Tetra Tech, 2005). As will be discussed in Section 7.1, the increase in the aluminum standard allowed a change in the design of the new water treatment plant from a two-stage to a single-stage process. As specified in 5 CCR 1002-36.27(M), the aluminum standards will be revised during the next triennial review based on additional data collected after the publication of the 2005 UAA report.

With respect to action specific ARARs, the Colorado State Engineer’s Office has revised both the dam hazard classification system and the manner in which storm hydraulics are evaluated. As a result, the SDI dam embankment is now considered a large dam and classified as a significant hazard dam. This reclassification resulted in additional hydraulic modeling and design considerations during the recent Wightman Fork Diversion and Summitville Dam Impoundment Improvements project. The Colorado Division of Water Resources, Office of the State Engineer has accepted the design for the spillway (weir) raise and the completion of the channel; construction on both structures will be completed in 2010.

None of the location specific ARARs identified in the OU5 ROD were judged to relate to the protectiveness of the remedy. Consequently, revisions to the group of ARARs were not assessed.

4.2 *Remedy Implementation*

The implementation of the emergency and interim remedial actions is discussed in Section 4.2.1. The implementation of the Final Site-Wide Remedy is discussed in Section 4.2.2.

4.2.1 *Emergency and Interim Remedial Actions*

The emergency response and interim remedial actions implemented by EPA at the site are in various stages of completion as discussed in the following subsections. The performance and effectiveness of these actions is assessed in Section 7.

4.2.1.1 *Adit Plugging*

IMS initiated work on the Reynolds Adit plugging project in November 1993. The following provides a brief chronology of events of IMS's work in the Reynolds Adit:

- Mid- November 1993 through mid-December 1993: Rehabilitation of the adit.
- Mid-December 1993 through mid-January 1994: Installation of a 7 to 8 foot thick bulkhead at the 1,265 foot location and installation of the Reynolds Adit pipeline to the 620 foot plug location. A manual valve was installed on the pipeline a few feet downstream of the bulkhead.
- Mid-January 1994: The Dexter Cross-cut was rehabilitated for a length of 350 feet where it was found to terminate. Work on the Dexter Cross-cut was suspended and the bulkhead was not designed or installed.
- Mid- to late-January 1994: Work at the Reynolds Adit 620 foot location bulkhead was initiated and then stopped as EPA determined that test data from the 1,265 bulkhead exceeded expectations, thereby rendering the second bulkhead redundant.

IMS returned to the site in November 1994 to complete the Reynolds Adit pipeline to the portal. IMS also installed an electronically controlled valve on the pipeline a few feet downstream of the manual valve. The controls for the electronic valve are located at the portal. With the installation of the electronic valve, the manual valve at the bulkhead was permanently left in the open position. IMS installed a second manual valve on the pipeline at the portal and located a manual pressure gauge on the pipeline just above the portal valve. The mine pool elevation could be measured via this gauge by closing the manual valve at the portal and remotely opening the electronic valve at the bulkhead, thereby pressurizing the pipeline. As part of the OU5 RI, a pressure transducer was installed on the Reynolds Adit pipeline at the bulkhead just above the electronic valve to provide continuous mine pool elevation data; the data logger connected to the pressure transducer is located at the portal. A saddle-type flow meter was also installed on the Reynolds Adit pipeline during the OU5 RI.

IMS also installed a plug in the Chandler Adit as part of this emergency action in anticipation of the mine pool level rising in response to the plugging of the Reynolds Adit. The following provides a brief chronology of events of IMS' work in the Chandler Adit:

- February 1994: Approximate 8-foot thick plug installed at a distance of 330 feet from the portal
- May 1994: Chandler Adit plug fails, resulting in AMD discharge from the portal
- January through February 1995: Chandler Adit plug rehabilitated by filling cavity above original plug and extending the original plug an additional 10 feet (18 feet total).

As part of the OU5 RI, a manual gage and a pressure transducer were installed on the small pipe at the bulkhead; the data logger connected to the pressure transducer was located at the portal.

4.2.1.2 Water Treatment (OU0)

Consolidation of water treatment into a single facility, the existing WTP shown on Figure 2-1, was completed in 1995. With the construction of the WTP, water treatment operations at other site locations was discontinued. AMD water generated at the site is directed to the SDI, which was completed in 1996, where it is stored for treatment in the WTP.

The existing WTP uses lime-based pH adjustment technology to precipitate metals as hydroxides. The WTP typically operates from April 1st through October 31st. A raft-mounted pump delivers SDI water to the WTP through a pipeline that “Ts” at the plant and feeds two parallel treatment trains. Within each treatment train, lime and recirculated filtrate are added to the influent in the initial reactor tank to elevate the pH and promote the formation of metals-bearing particulates. Polymer is added in a second tank to enhance the formation and settling of particulates. Water exiting the second tanks from the separate treatment trains is combined in a single thickener. From the thickener, clarified water is discharged directly to Wightman Fork. The solids that settle to the bottom of the thickener are dewatered in a manual filter press; the sludge is trucked to a repository established on the south mine pit (Figure 2-1) and the filtrate is circulated to the head of the treatment trains as described above.

4.2.1.3 Heap Leach Pad Detoxification/Closure (OU1)

Following the completion of the rinsing program in 1995, the agencies determined that the detoxification of cyanide in the Heap Leach Pad was complete. This determination rendered the follow-up in-situ biotreatment called for in the interim ROD unnecessary. The HLP was subsequently graded, capped and vegetated over the course of two construction seasons, beginning in 1997 and ending late in 1998. Between the cessation of the rinsing program in 1995 and the completion of the capping in 1998, the HLP refilled with over 90 million gallons of snowmelt and rainwater.

Following completion of the capping program, two large-diameter pumping wells (PW-1 and PW-2) and several small diameter piezometers (OC-series wells) remain within the footprint of the HLP. During the HLP closure, the French drain sump was removed and the outfalls of the various HLP underdrains that reported to the sump were consolidated to the French drain pipeline that discharges directly to the SDI. Three inclinometers were installed at the crest of the downstream dike, Dike No. 1, as part of the OU5 RI.

4.2.1.4 Excavation of Cropsy Waste Pile, Beaver Mud Dump, and Cleveland Cliffs Tailing Pond/Mine Pit Closure (OU2)

The mine waste materials in the Cropsy Waste Pile, Beaver Mud Dump, and the former Cleveland Cliffs Tailing Pond were excavated and placed in the mine pits. Prior to placement of mine wastes in the pits, the base of both the north and south mine pits were lined with cement kiln dust to neutralize AMD generated within the pits. Additional materials, including demolition debris were also placed in the pits. Once filled, the south mine pit was capped with a geosynthetic clay liner (GCL) and a repository for WTP sludge was established on the southeast portion of the pit (Figure 2-1). The GCL cap was omitted from the north mine pit as BOR determined that low permeability material placed in this pit rendered the GCL unnecessary.

In addition to removing solids from the Cleveland Cliffs Tailing Pond, EPA and BOR performed work on the dam embankment and the adjacent Wightman Fork bypass. Work on the dam embankment included the installation of outlet works, construction of a spillway apron and the upper portion of the spillway channel, installation of a gravel drain, buttressing of the downstream face and armoring of the upstream face. The capacity of the Wightman Fork bypass was increased to handle the 10-year event. Once completed in 1996, the 90 million gallon SDI became the contaminated water storage reservoir for the site.

4.2.1.5 South Mountain Groundwater (OU3)

Operable Unit 3 was incorporated into the site-wide Remedial Investigation/ Feasibility Study and is addressed as part of OU5 (Section 4.2.2).

4.2.1.6 Site-Wide Reclamation (OU4)

Site-wide reclamation was implemented in multiple phases over several years, with major earthwork completed by 2001. As called for in the OU4 interim ROD, the reclamation activities work included the excavation, grading, soil amendment, topsoil placement, and re-seeding of mine-disturbed land. This included the excavation and moving of 1.3 million cubic yards of mine wastes, ditch/stream channel excavation, and the addition of approximately 140,000 cubic yards of “subsoil” amended with agricultural lime (150 tons/acre) and compost (40 dry tons/acre). Existing topsoil piles conserved during general excavation were amended with agricultural lime (30 tons/acre) and placed on the amended subsoil. Numerous mine buildings and other structures were demolished.

The Campbell Quarry was developed on site to provide approximately 100,000 cubic yards of riprap for channel lining (54-inch minus), riprap bedding (20,000 cubic yards), and base course (40,000 tons) for the USFS roads to site.

Revegetated areas are periodically evaluated by the Colorado State University (CSU) Department of Forest, Rangeland and Watershed Stewardship. CSU’s most recent reclamation monitoring report, which is based on field data collected in 2009, is provided in Appendix B.

Because funding remained in the OU4 budget in the early 2000s, select elements related to water management from the OU5 ROD were included in the OU4 work. These included:

- Upgrade of select site ditches.
- Construction of groundwater interceptor drains.
- Construction of a Highwall ditch.

The upgrade of the site ditches included the installation of six turnout structures which enabled CDPHE the option of sending surface water from select onsite areas to the SDI for treatment or, under certain water quality/quantity conditions, off site without treatment. The locations of the turnouts were selected based on revegetation success/observed water quality improvements or projected water quality improvements. This additional OU4 work was completed during the 2003-2004 construction seasons.

4.2.2 Final Site-Wide Record of Decision (OU5)

Final remedial actions identified in the OU5 ROD addressed threats to the environment that remained at the site after completion of emergency and interim remedial actions described in Section 4.2.1. The goal of the final remedy follows this three-step process:

Step 1: Capture the mobile source material, (i.e., acid mine drainage);

Step 2: Contain AMD in an onsite impoundment; and

Step 3: Treat AMD (remove metals and raise the pH).

The final remedy is intended to continue the benefits achieved through the emergency actions and interim remedial actions and to further reduce and control threats to the environment. The final remedy will maintain interim remedial actions for OU1, OU2 and OU4. The major components of the Final Site-Wide Remedy as described in Section 2.2.

4.3 Remedy Operation and Maintenance

The operation and maintenance (O&M) of the emergency and interim remedial actions is discussed in Section 4.3.1. The status of the Final Site-Wide Remedy is discussed in Section 4.3.2. The costs for operating the site are presented in Section 4.3.3.

4.3.1 Emergency and Interim Remedial Actions

The emergency response and interim remedial actions implemented by EPA at the site are in various stages of completion. The O&M and status of these early actions is discussed in the following subsections.

4.3.1.1 Adit Plugging

No rehabilitation work (e.g., replacement of timber sets) has been performed in either the Reynolds or Chandler Adits since the early 2000s. In July 2010, CDPHE selected an engineering firm to perform the design and construction of the adit improvements called for in

the OU5 ROD. The final design for the Reynolds Adit will be completed over the winter 2010-2011 and the construction completed in FY 2011

The existing Reynolds Adit condition is physically inspected on an annual basis by a qualified engineer. The inspection is performed under a confined space permit; the adit is ventilated for 24 hours prior to entry. The inspection includes a visual observation of the following:

- Rock conditions.
- Supports (timbers).
- Walkway and drainage ditch.
- Location and relative magnitude of groundwater inflow.
- General condition of the bulkhead.
- General condition of the piping and associated valves.

Until relatively recently, the valves were operated to ensure their operational capabilities. Deterioration of the valves has raised concerns about their integrity. Consequently, the valves were not operated in 2009. The annual inspections document a continuing deterioration of timber supports which present significant safety concerns in some areas. Additionally, ground loss is increasing, continually decreasing access through the adit.

The Chandler Adit was historically provided a similar inspection. However, since the collapse of the Chandler Adit at its portal sometime in late 2006 to early 2007, it has not been entered or inspected. When last accessed in July 2006, cracked and displaced timbers were observed near the Chandler Adit portal. Overall, access and drainage in the adit were better than those observed in the Reynolds Adit. The Chandler Adit bulkhead was heavily stained and covered by precipitates. The small diameter pipe that penetrates the bulkhead contains a sampling port, a manual pressure gage, and a pressure transducer; all were in working order in July 2006.

The annual adit inspection reports for years 2005 through 2009 are provided in Appendix C.

In addition to the annual inspections, the following environmental data associated with the adits and mine pool are collected:

- Daily mine pool elevation via a pressure transducer installed on the Reynolds Adit pipeline near the bulkhead⁴.
- Monthly water quality samples from the Reynolds Adit portal invert (location AD-0), representing water entering the adit between the bulkhead and the portal.
- Monthly water quality samples from a small continuous leak in the Reynolds Adit pipeline (location AD-0P), representing mine pool water.
- Seasonal discharges from the Chandler Adit (location CA-0) and Ida Adit (location IDA-0).
- Daily groundwater elevations from bedrock monitoring wells connected to the mine pool/mine pits (i.e., ABCMW-1 and ECCMW-2).

⁴ Mine pool pressure readings were also historically made at the Chandler Adit bulkhead until the collapse at the portal damaged the equipment.

Data collected from these monitoring locations are presented and evaluated in Section 7.

4.3.1.2 *Water Treatment (OU0)*

The existing WTP shown on Figure 2-1, was completed in 1995. With the construction of the WTP the water treatment operations at other site locations was discontinued. Beginning in 1996, AMD and AMD influenced water generated at site was directed to the SDI, where it is stored for treatment in the WTP.

The existing WTP uses lime-based pH adjustment technology to precipitate metals as hydroxides. The WTP typically operates from April 1st through October 31st. A raft-mounted pump delivers SDI water to the WTP through a pipeline that "Tees" at the plant and feeds two parallel treatment trains. Within each treatment train, lime and recirculated filtrate are added to the influent in the initial reactor tank to elevate the pH and promote the formation of metals-bearing particulates. Polymer is added in a second tank to enhance the formation and settling of particulates. Water exiting the second tanks from the separate treatment trains is combined in a single thickener. From the thickener, clarified water is discharged directly to Wightman Fork. The solids that settle to the bottom of the thickener are dewatered in a manual filter press; the sludge is trucked to a repository established on the south mine pit (Figure 2-1) and the filtrate is circulated to the head of the treatment trains as described above.

The targeted water treatment capacity of the plant was approximately 1,000 gpm (1.44 million gallons per day or mgd) when it was constructed in the mid-1990s. Improvements made to the original design by Golder Associates beginning in 2005 have resulted in a significant increase in treatment capacity. Treatment rates of 1,400 gpm (2.02 mgd) are now possible, while maintaining effluent discharge guidelines.

Start up of water treatment operations each spring is labor intensive due to the over 300 inches of snow that annually accumulate at the site. Spring time access requires plowing approximately 18 miles of USFS roads to reach the location. After plowing, portions of the site must be cleared to facilitate delivery of water from the SDI, enable treatment operations, allow sludge disposal and the associated environmental monitoring. Because the existing 60-foot diameter thickener is not covered, accumulated ice and snow must be manually removed from its base prior to start up. The thick ice on the SDI must also be physically punctured by a track-hoe to allow placement of the raft-supported pump. Pipelines must be cleared of ice. Because the start-up process begins in April, work is hindered by spring storms and high winds, which requires ongoing snow removal.

For the five-year period 2005 through 2009, the WTP averaged over 300 million gallons of water treated annually. The amount of water treated each year is a function of snow pack and the duration of the spring snow melt. The average water treatment rate has increased from 960 gpm in 2005 to 1,413 gpm in 2009. The combined mass of copper, zinc, aluminum, iron and manganese removed averaged 300 tons during this five-year period, with removal efficiencies in excess of 99.5 percent for copper, iron and zinc. Slightly lower efficiencies, but still in excess of 90 percent, are obtained for the removal of aluminum and manganese.

Monitoring of process data and performance of sampling at various locations within the WTP is required to ensure optimum treatment process performance. Table 4-2, taken from Golder's 2005 Data Acquisition Plan, summarizes the location, frequency, and analyses of the treatment plant O&M monitoring and sampling. The sampling and measurement frequencies presented in Table 4-1 may be changed based on observations of trends. In addition to process monitoring data, the following environmental data associated with the WTP operations are collected:

- Weekly 12-hour composite sample of influent (SDI) water.
- Weekly 24-hour composite sample of effluent.

Data collected from the WTP monitoring program are presented and evaluated in Section 7.

Additional water treatment technologies were evaluated and, in some cases, field tested at the Superfund site during the OU5 RI and FS. Active treatment technologies assessed included: ceramic microfiltration; liquid emulsion membrane; and solvent extraction-electrowinning. Passive water treatment technologies pilot tested included: successive alkalinity-producing (SAP); Aquifix; and zeolites. Based on the results of these tests and the performance of the existing system, continued treatment using lime-based pH adjustment technology was selected as the basis for the new water treatment plant. Golder provided a preliminary design for the new two-stage water treatment plant in the early 2000s. Following adoption of higher aluminum standards for the Alamosa River by the Water Quality Control Commission in 2007, Golder modified its WTP design to single stage. CDPHE is currently constructing the new single-stage WTP, which is anticipated to be completed in September 2011 and to be fully commissioned in 2012.

4.3.1.3 *Heap Leach Pad Detoxification/Closure (OU1)*

Between the cessation of the rinsing program in 1995 and the completion of the capping in 1998, the HLP refilled with over 90 million gallons of snowmelt and rainwater. As part of the OU5 RI, approximately 13.3 million gallons of water were pumped from the HLP and piped to the SDI in 2000, which resulted in a lowering of the HLP water level by approximately 10 feet; however, an estimated 80 million gallons of water containing an estimated 1,000 pounds each of cyanide and copper remain in the HLP. The pH of the HLP water remains slightly alkaline suggesting that the neutralizing material added as part of the heap leaching process has not been consumed.

HLP Dike No. 1 is inspected on an annual basis. The geotechnical inspection includes the following:

- Visual inspection of the downstream face of the embankment.
- Readings of the three inclinometers installed at the crest of the embankment.

Annual inspection reports for years 2005 through 2009 are provided in Appendix D.

In addition to annual geotechnical inspections, the following environmental data associated with the HLP are collected:

- Daily water elevations via a pressure transducer installed in piezometer OC-27.
- Monthly water quality samples from the French drain pipeline (location FD-1), representing groundwater from below the HLP and from the face of HLP Dike No. 1.
- One-time sampling of wells in 2009 that are completed in the HLP and downgradient of the HLP.
- One-time sampling of seeps and springs in 2009 downgradient of the HLP.

Data collected from these monitoring locations are presented and evaluated in Section 7.

4.3.1.4 *Excavation of Cropsy Waste Pile, Beaver Mud Dump, and Cleveland Cliffs Tailing Pond/Mine Pit Closure (OU2)*

Mine waste materials from the Cropsy Waste Pile, Beaver Mud Dump, and the former Cleveland Cliffs Tailing Pond are located in the mine pits. The south mine pit is capped with a GCL. The GCL cap was omitted from the north mine pit. As previously discussed, the material placed in the mine pits is not completely isolated from the environment. Material in the lower portion of the north mine pit is typically submerged for much of the year by the mine pool. The material placed in the south mine pit is only inundated in years with very high snowpack (and resultant higher than normal mine pool/groundwater elevations) as the base of this pit is approximately 100 feet higher than that of the north mine pit. The following environmental data associated with the mine pits are collected:

- Daily groundwater elevations from bedrock monitoring wells connected to the mine pool/mine pits (i.e., ABCMW-1 and ECCMW-2).
- Daily groundwater elevations from a monitoring well completed in the north mine pit (location RMCMW-8).
- One-time sampling of wells in 2009 that are completed in and adjacent to the mine pits.

Data collected from these monitoring locations are presented and evaluated in Section 7.

The 90 million gallon SDI, formerly known as the Cleveland Cliffs Tailings Pond before it was upgraded (Section 4.2.1.4), was constructed under OU2 activities. The following environmental data associated with the SDI are collected:

- Daily pool elevations.
- Weekly SDI water quality sample (see WTP 12-hour composite influent sample in Section 4.3.1.2).
- Monthly sample of seepage from the base of the embankment (location SDI Toe Channel)

Data collected from these monitoring locations are presented and evaluated in Section 7.

As constructed, water could not be released from the SDI over the emergency spillway because less than 50 percent of the spillway channel was completed. Therefore, the Colorado State

Engineer's Office (SEO) restricted the use of the spillway for emergency purposes only. Consequently, when rising water levels historically required releases from the SDI, water had to be released via the outlet works. These outlet works tap deeper portions of the SDI pool and, because the SDI is typically stratified during the spring runoff (poorer water quality with depth), water released from the SDI, via outlet works, historically resulted in the poorest water quality in Wightman Fork and the Alamosa River. Tetra Tech initiated work in 2008 to complete lower portion of the spillway channel; this work should be completed in 2010. As part of this project, the elevation of the spillway weir will also be raised, increasing the SDI capacity by over 10 percent to approximately 100 million gallons. If water "spills" from the SDI in the future, the quality should be better than that historically released through the outlet works⁵.

4.3.1.5 South Mountain Groundwater (OU3)

As discussed in Sections 4.3.1.3 and 4.3.1.4 several of the monitoring wells at the site are equipped with data loggers that provide daily measurements of water levels in the bedrock and mine rock. Additionally, pressure measurements made on the Reynolds Adit pipeline provide a continuous record of the mine pool level. In 2009, water levels measurements were obtained from most site monitoring wells, and water quality samples were obtained from select wells around the site. The data collected from these monitoring locations are presented and evaluated in Section 7 as part of the OU5 monitoring discussion.

4.3.1.6 Site-Wide Reclamation (OU4)

Status of the revegetation performed under OU4 is evaluated twice within each five year review period by Colorado State University (CSU), Department of Forest, Rangeland and Watershed Stewardship. CSU's most recent reclamation monitoring report, which is based on field data collected in 2009, is provided in Appendix B.

Ditch turnouts are equipped with pressure transducers to monitor the volume of water conveyed in the ditch systems. As the turnouts are operated to divert water off site, the volume of water sent off site or flowing to the SDI can be estimated. As previously described, water is released from the ditch turnouts to maintain an SDI pool level below the spillway crest. The quality of water released via the turnouts is discussed in Section 7.4.1.2.

Water management improvements (e.g., site ditches, groundwater interceptor drains, pipelines, etc.) require ongoing maintenance. With respect to ditches, the section and pools upstream of the diversion structures need to be periodically cleaned out to maintain smooth approaches to optimize the flow of water through the structures and associated pipelines. Likewise, rocks and other obstructions at the downstream end of the pipes need to be periodically cleared to allow water to flow freely through the pipes. The groundwater interceptor drains have proven problematic due to plugging with iron precipitates. The drains require frequent cleaning and, sometimes, excavation to restore flow. Over the past several years additional cleanout structures have been added to the interceptor drains to facilitate removal of iron precipitates. These

⁵ It is anticipated that future water management practices will be similar to recent practices. Specifically, water will be diverted away from the SDI via ditch turnout structures to maintain the SDI pool below the spillway weir crest.

precipitates are particularly problematic in areas where revegetation has not been successfully established, such as in the Chandler Bowl.

4.3.2 *Final Site-Wide Record of Decision (OU5)*

Status of the major components of the Final Site-Wide Remedy described in the 2001 ROD are summarized below.

Evaluate on-site contaminated water impoundment upstream of the Wightman Fork-Cropsy Creek confluence: As described in Section 4.3.1.4, the completion of the SDI spillway is currently in progress. When the weir is raised, the storage capacity of the SDI will be increased by over 10 percent, from 90 million gallons to approximately 100 million gallons.

Construction of a new water treatment plant downstream of the contaminated water impoundment (modified in the ESD 2003 to upstream of the impoundment): Construction of the new water treatment plant adjacent to the existing plant is currently underway. The 1,600 gpm plant is scheduled to be commissioned in 2012.

Possible breach and removal of the existing Summitville Dam Impoundment: With the modification to the existing SDI, construction of a new impoundment (with the breach/removal of the existing structure) is not considered necessary at the present time.

Construction of a sludge disposal repository: The historic repository located on the south mine pit remains in use. No action has been taken on siting or designing a new repository.

Upgrade of Wightman Fork Diversion: Work on Wightman Fork from the site entrance to the plunge pool downstream of the SDI was completed in 2009. The capacity of this stretch of Wightman Fork was increased from the approximate 10-year event to a 100-year event.

Upgrade of select site ditches: Performed under OU4 (see Section 4.3.1.6) in 2003. The P and L2 Ditches and the Site entrance road culverts were upgraded to convey the 100-year snowmelt or 500-year, 24-hour storm event. Water management diversion structures were constructed at: (1) the L2/P Ditch diversion, (2) the Q Ditch diversion, (3) the P Ditch diversion, (4) the A1-2 Ditch diversion, (5) the A2-3 Ditch diversion, and (6) the T Ditch diversion (Figure 4-2). At some of the diversion structures, additional upgrades to the ditch design were necessary to ensure appropriate approach and exit velocities.

Construction of groundwater interceptor drains: Performed under OU4 (see Section 4.3.1.6).

A series of collection drains and groundwater interceptors were installed at various locations around the Site in 2003. These drains typically consist of 3-foot wide trenches up to six feet deep. A 6-inch perforated drain pipe was installed on top of 6 inches of gravel. The trench was backfilled with a mixture of gravel and wood chips. Sediment traps were constructed at the surface of the drains, and cleanouts were installed at regular intervals on the pipe. Drains were installed at the following locations:

- Missionary Seeps drain

- East Chandler drains
- HLP Dike No. 1 drains
- North Waste Dump drains

The locations of these drains are provided on the schematic shown in Figure 4-2. All drains ultimately discharge to the SDI.

The operation of the groundwater interceptor drains has been mixed. In the Missionary Seeps and the area below the Chandler Adit portal (the Chandler Bowl), persistent acidic and high metals groundwater seepage has inhibited the development of vegetative cover, leading to high sediment production from this area. The volume of sediment produced – in conjunction with ferricrete deposits that form at the surface due to the high iron concentrations in the seepage – continually plugs the East Chandler drain system both at the surface and within the pipes themselves. Iron precipitates forming in the drain pipes throughout the site are a persistent problem. As a result, the groundwater interceptor drains have required a larger maintenance effort than anticipated. Some drains require cleaning as frequently as twice per year. The CDPHE has added additional cleanouts to facilitate maintenance of these systems.

Construction of a Highwall ditch: Performed under OU4 (see Section 4.3.1.6) in 2003. A ditch system was constructed along the base of the highwall to collect sediment and AMD produced from this large feature and route it to a sedimentation pond, which was also constructed in 2003. Under routine conditions, water in the sedimentation pond discharges to the SDI through the highwall pipeline. However, flows into the sedimentation pond in excess of the 10-year, 24-hour storm are routed out of the pond via a spillway, into the H-Ditch system and ultimately to the L-Ditch system where flows can be routed offsite or to the SDI at the L-Ditch turnout structure (Figure 4-2).

Rehabilitation of Reynolds Adit: Construction of the Reynolds Adit began in 1897. As documented in the Annual Inspection Reports (Appendix C) the condition of the Reynolds Adit continues to deteriorate. Selection of an engineering team to provide the final design for the adit occurred in summer 2010, with construction to be completed in FY 2011.

Management of mine pool water: Mine pool management is dependent upon the completion of the new WTP, the increased storage capacity of the SDI and the rehabilitation of the Reynolds Adit. The OU5 ROD calls for the physical management of the mine pool by controlled releases to maintain a level below the Chandler Adit.

Continued site maintenance, and groundwater/surface water and geotechnical monitoring on site: Ongoing. The annual onsite environmental data acquisition program is summarized in Table 4-3. Monitoring wells and seeps were sampled once (2009) during the previous five-year review period (2005 through 2009). The sample locations and analyte lists for this one-time sampling event are provided in Tables 4-4 through 4-6. The onsite monitoring locations are illustrated in Figure 4-2. The site sub-basins and ditch system, which provides the basis for the on-site surface water monitoring program is illustrated in Figure 4-3. Groundwater monitoring wells and seep concentration data are provided in Appendix E.

Surface water, sediment, and aquatic life monitoring in the Alamosa River and Terrace Reservoir: Ongoing. The routine offsite monitoring program consists of twice yearly surface water sampling (high- and low-flow) in lower Wightman Fork and the Alamosa River and the sampling of zooplankton and fish in Terrace Reservoir. Stream sediments, macrovertebrates and aquatic life habitat were sampled once (2009) during the five-year review period (2005 through 2009). The analyte lists for the offsite monitoring program are summarized in Tables 4-7 through 4-8. The offsite monitoring locations are illustrated in Figure 4-4. Data are summarized in Appendix F.

Data collected under the OU5 monitoring program are presented and evaluated in Section 7.

4.3.3 Operation and Maintenance Costs

O&M costs are dominated by the costs associated with water treatment. Golder Associates has operated the site for CDPHE during the entire five-year review period (2005 through 2009). CDPHE provided an estimate of costs to operate the WTP for years 2005 through 2009 in the previous five-year review document (CDPHE, 2005). The estimated costs are compared to actual costs in Table 4-9.

Table 4-9: Estimated and Actual Costs, WTP O&M Project, 2005-2009 (in Million \$)

	2005	2006	2007	2008	2009
Estimated Costs	\$1.634	\$1.635	\$1.712	\$1.832	\$2.136
Actual Costs	\$1.771	\$1.982	\$2.205	\$1.655	\$1.980
Difference	+8.4%	+21.2%	+28.8%	-9.7%	-7.3%

The cost overages were associated with non-routine repairs (e.g., pump replacements, damage resulting from lightning strikes), WTP infrastructure improvements, and modifications required to bring the WTP into compliance with current OSHA standards.

Tetra Tech has performed the site-wide monitoring program for CDPHE during the entire five-year review period (2005 through 2009). The actual costs associated with Tetra Tech's monitoring program are summarized in Table 4-10.

Table 4-10: Actual Costs, Site-Wide Monitoring Project, 2005-2009

2005	2006	2007	2008	2009
\$189,830	\$205,025	\$248,009	\$286,956	\$296,641

The actual costs have equated estimated costs.

5.0 *PROGRESS SINCE THE LAST REVIEW*

A chronology of significant events that have occurred at the Summitville Mine Superfund Site is presented in Table 2-1. This section focuses on the events that have transpired at the site in the past five years.

Table 5-1 summarizes the responses to the technical assessment questions from the second five-year review report (CDPHE, 2005).

**Table 5-1: Response to Technical Assessment Questions A, B and C
September 2005 Five-Year (Second) Review**

Questions	A	B	C	Comment
OU0 - WTP	Y	Y	Y	Defer protectiveness because more information is needed to make a determination
OU1 - HLP Closure	Y	Y	N	Remedy is protective
OU2 - Cropsy, Mine Pits and SDI	Y	Y	N	Remedy is protective
OU3 - Groundwater				Incorporated in to OU5
OU4 - Reclamation	Y/N	Y/N	N	Defer protectiveness because more information is needed to make a determination
OU5 - Final Remedy	Y/N	N	N	Defer protectiveness because more information is needed to make a determination

The protectiveness statements in the second five-year review report (CDPHE, 2005) are summarized in the following subsections for each operable unit.

5.1 *Status of Issues Identified in Last Review*

CDPHE identified several issues in the second “five-year review” report (CDPHE, 2005) that had arisen since the publication of the ROD and/or the construction of select components of the Final Site-Wide Remedy. The status of these issues is summarized in Table 5-2.

Table 5-2
Status of Issues Identified in September 2005 Five-Year (Second) Review

OU	Issue	Status
00	Existing WTP facilities originally constructed as temporary structures. Upgrades are required to meet OSHA standards, upgrade the infrastructure and improve process as noted in a July 2005 Golder Associates memorandum to CDPHE.	These items were addressed over the past five years which resulted in the WTP O&M cost overages noted in Section 4.3.3. However, these improvements also resulted in the significant treatment capacity increase described in Section 4.3.1.2. Although the original issue is considered complete, similar issues will continue to arise with the aging plant until the new WTP is commissioned in 2012.
00	Existing WTP design capacity on 1,000 gpm is inadequate.	As noted above, improvements over the past five years to the existing plant infrastructure and process has resulted in an increase of the plant capacity from 1,000 to 1,400 gpm. An additional turnout (A3-1) was added to the North Waste Dump ditch system in 2008, although the ability to turnout water from this structure has not been exercised to date. This issue is ongoing. The construction of the new WTP with a capacity of 1,600 gpm and the raise of the SDI spillway which will increase its capacity by approximately 10 million gallons are intended to alleviate the site water balance issue.
05	Groundwater underflow to Wightman Fork adjacent to the North Waste Dump is a large non-point source of metals loading at the site.	This will be addressed in the next five-year review.
05	Seepage from the SDI provides a large non-point metals load to Wightman Fork.	Ongoing. This seepage was originally intended to be captured and pumped back to the SDI as part of the 2008-2010 Wightman Fork Diversion/SDI Spillway Improvement project. However, design investigations discovered that bedrock conditions were not as assumed based on BOR documents, and that the cost to design and construct the system would exceed the budgeted amount. Additional funding is being sought to address this source of non-point metals loading.
04	Copper loading from the Cropsy Creek basin within the site.	Ongoing. In summer 2010, surface water from the upper Cropsy Creek basin was diverted back into the Cropsy Creek Diversion which will reduce flow of water through the site. Additionally, discussion is underway to reclaim the Campbell Quarry where pyrite-bearing quartz latite veins are exposed and potentially degrade Ditch R waters that flow through the quarry prior to entering Cropsy Creek.

Table 5-2
Status of Issues Identified in September 2005 Five-Year (Second) Review
(Continued)

OU	Issue	Status
04	Site-wide remediation assumptions have not been fully realized, resulting in more water requiring treatment than envisioned in the ROD.	Ongoing. The construction of the new WTP and the increased storage capacity in the SDI may negate some of this extra water requiring treatment.
05	Mine pool management.	This will be addressed in the next five-year review.
01	Heap Leach Pad reservoir. The HLP holds approximately 80 million gallons of water which contains approximately 1,000 pounds each of dissolved cyanide and copper.	Ongoing. Annual monitoring of the inclinometers on the downstream HLP embankment (Dike No. 1) and observations of the downstream face the Dike No. 1 embankment indicates the continued stability of the structure. Water quality samples collected in 2009 from wells and seeps downgradient of the HLP did not detect anomalous levels of cyanide related compounds. Within the HLP, the water level and pH have remained relatively constant over the past five-years.
00	Water source for the existing and future water treatment plants.	Ongoing.

5.2 Status of Recommendations and Follow-up Actions from Last Review

CDPHE proposed a series of recommendations in the second five-year review report (CDPHE, 2005). The status of these recommendations is summarized in Table 5-3.

Table 5-3
Actions Taken Since the Last Five-Year Review

Issue	Recommendations/ Follow-up Actions	Follow-up Actions (Status/Due Date)	Status of Follow-up Actions	Responsible Party
Implement the remaining OU5 remedial components as soon as funding permits.	Construction of a large capacity water treatment plant, continue to evaluate the SDI capacity	Funding for WTP construction obtained through American Recovery and Reinvestment Act (ARRA).	Addressed in next Five-Year Review. New WTP under construction; anticipated commissioning date in spring 2012. Design to raise SDI spillway is complete and has been approved by the State Engineer; anticipated construction in 2010.	EPA and Colorado Department of Public Health and Environment (CDPHE) for construction.
Investigate remedy options for controlling non-point source discharges	Continue to monitor performance	Diversions completed in 2005 and 2008.	Addressed in next Five-Year Review.	CDPHE
Revise the site hydraulic model and water balance.	Conduct for Wightman Fork Diversion and SDI spillway channel		Complete. Initiated in 2006, completed in 2007.	CDPHE
Reynolds Adit rehab or long-term stabilization.	Conduct annual safety inspections and a detailed inspection prior to 2010 5-year review	Conceptual level design and costing document completed in January 2009.	Addressed in next Five-Year Review. Final design/construction administration engineering contractor selected in 2010 with construction in FY 2011.	CDPHE
Explore permanent, passive or semi-passive remedies to control contaminant sources.			Considered and not implemented. Viewed as technically impracticable given current state of mine pool mitigation technology.	EPA and CDPHE

Issue	Recommendations/ Follow-up Actions	Follow-up Actions (Status/Due Date)	Status of Follow-up Actions	Responsible Party
Monitor all on-site and offsite remedial elements and affected media.	Ongoing	Annual reports	Addressed in next Five-Year Review. Ongoing	CDPHE
Status of groundwater system and seep releases.	Conduct on-site groundwater seep sampling.	Prior to 2010 5-year review.	Completed – sampled in 2009	CDPHE
Status of water-quality, sediment and aquatic life sampling	Conduct offsite sediment and aquatic life sampling in the Alamosa River	Review	Completed – sampled in 2009	CDPHE
Restocking of fish in Terrace Reservoir.	Requires concurrence with the Division of Wildlife	Planned for 2008	Completed.	CDPHE
Prepare a Use Attainability Analysis (UAA) for the Water Quality Control Commission (WQCC) to change the Alamosa River underlying aluminum standard	Prepare UAA	Completed in 2007	Complete. Water Quality Control Commission revised aluminum water quality standards for Alamosa River Segment 3b-d in 2008	CDPHE

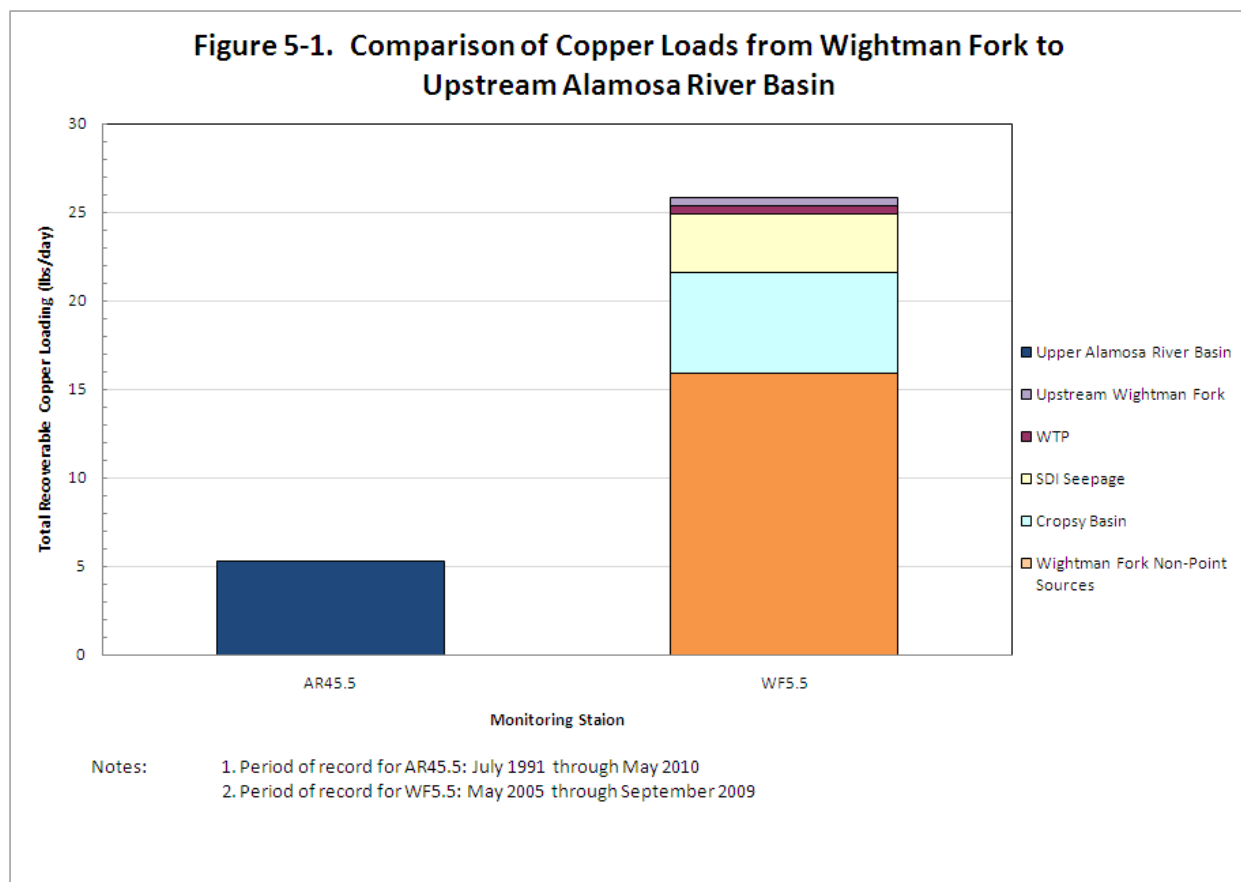
5.3 Results of Implemented Actions

A detailed evaluation of each operable unit performance and effectiveness is presented in Section 7. The following discussion focuses on conditions in the downstream Alamosa River over the past five years.

Water quality in Wightman Fork at the downstream boundary (WF5.5) and in the Alamosa River has remained relatively stable over the past five years. While almost all samples meet remediation goals at WF5.5 under high flow conditions, copper and aluminum⁶ concentrations continue to exceed their goals under low flow conditions primarily due to non-point source loading (although some unremediated point sources also contribute to this non-achievement). Further downstream in the Alamosa River (Figure 4-4), copper concentrations exceeded chronic and/or acute water quality standards through the upper portion of Stream Segment 3d (Stations AR41.2 and AR37.5) routinely under high flow conditions and, to a lesser extent, under low flow conditions (Appendix F). However, in the lower portion of Stream Segments 3d (Station

⁶ The aluminum remediation goal was established prior to the adoption of higher aluminum standards in Alamosa River by the Water Quality Control Commission (Section 7.1.3).

AR34.5) copper concentrations have been below applicable standards in all of the sampling events performed over the last five years (Section 7.5.2.2.2). The Site continues to be the major contributor of copper to the Alamosa River basin (Figure 5-1).



Water quality in Terrace Reservoir has remained relatively consistent over the last five years, with average dissolved copper concentrations in the reservoir ranging from 2 to 4 µg/L (Table 7-20). Gill netting performed in Terrace Reservoir in 2009 yielded stocked trout of different sizes, indicating the year-to-year survival of fish in the reservoir.

6.0 FIVE-YEAR REVIEW PROCESS

This section provides a summary of the activities performed leading to the preparation of the five-year review.

6.1 Administrative Components

The third five-year review team was lead by Austin Buckingham, Summitville Project Manager for CDPHE. Prior to initiation of work on the document, a meeting was held at EPA Region 8 headquarters in Denver, Colorado that was attended by: Ms. Buckingham; Mario Robles, EPA Project Manager; Pat Smith, EPA Five-Year Review Coordinator; and Tetra Tech staff. Ms. Smith provided an overview of the five-year review process and facilitated the meeting during which the project schedule was established and roles and responsibilities were assigned.

Tetra Tech consolidated the information that was utilized in this five-year review and authored the majority of the document. Marilyn Null of CDPHE updated the Community Involvement Plan, which is included in Appendix A. Ms. Buckingham and Mr. Robles provided review of draft versions of this document.

6.2 Community Involvement Activities

The CDPHE community involvement program is committed to promoting communication between citizens and CDPHE. The updated Community Involvement Plan (Appendix A) describes the current community involvement and public participation approach developed for the Summitville Mine Superfund Site, Rio Grande County, Colorado.

Community interest in the Summitville Mine Superfund Site has waned over the past several years. To that end, regularly scheduled activities for community involvement which had been the norm were scaled back in 2009. Based on the community interviews conducted in 2010, it was found that community members viewed updates via email or direct mailings as the preferred means of communication.

Documents related to the decisions, designs, site history are available to the local community at the following two repositories:

Department of Agriculture
Conejos County Natural Resources Conservation Service Center
15 Spruce
La Jara, CO 81140

Del Norte Public Library
790 Grand Avenue
Del Norte, CO 81132

Documents are also available to the public online through the state of Colorado Summitville web page: www.cdphe.state.co.us/hm/summitville.htm. Access to the Summitville Master Database

with mapping capabilities is available through an interactive website at www.cdphe.state.co.us/hm/summitville/maps.htm. CDPHE has created electronically based documents and data to provide ease of access to information.

CDPHE placed an ad in the local newspaper, the Valley Courier, on May 19, 2010 to notify the public that the third five-year review was in progress. The notice invited members of the public to submit questions or comments regarding the site to either CDPHE or EPA; addresses and phone numbers for both agencies were provided in the advertisement.

6.3 Data and Document Review

Data review is an ongoing and annual process, which is documented in annual reports. The WTP operator, Golder Associates, produces an annual report for the water treatment plant and general site operations, inclusive of onsite monitoring data. Tetra Tech conducts project monitoring for both onsite and offsite environmental media, and produces an annual report. These reports, in addition to specific inspection memoranda, assess the contaminant load generated from the site sources, conformance with effluent discharge criteria, compliance with the remedial action objectives and remedial action levels at the downstream site boundary, the Alamosa River stream standards and compliance with those objectives and standards.

6.4 Site Inspections

Site inspections are conducted on an on-going basis. Site visits are generally conducted by Agency personnel at least two times each month during the field season. Weekly conference calls are held with site contractors and personnel. These conference calls are documented in weekly minutes. Monthly water treatment plant reports are generated which document the site operations, monitoring and maintenance. Annual reports are produced documenting the year's activities and in the case of the Annual Monitoring Reports produced by Tetra Tech for CDPHE, data trends for on and offsite data are continually updated and added to the previous years, so that multiple year data trends can be evaluated.

6.5 Interviews

CDPHE conducted telephone interviews with 21 Summitville stakeholders during the weeks of May 17 and 24, and June 7, 2010. Interviewees included:

- City manager.
- County commissioners (Alamosa County, Rio Grande County, Conejos County, Saguache County).
- Former and current presidents of Rio Grande Water Conservation District.
- Water commissioner.
- Public health nurse.
- Natural Resource Damage project participants.
- Interested citizens in the area.
- Staff for Sen. Michael Bennet, Sen. Mark Udall, Rep. John Salazar.

6.5.1 Awareness and Involvement

Awareness of the Summitville cleanup is mixed, ranging from very aware and involved from the beginning to not really aware or only involved in the Natural Resource Damage projects. Those involved early in the process said interest has waned over the years, especially in light of the project “...essentially being in O&M.” Some interviewees were originally involved with the Technical Assistance Grant (TAG) group, but the TAG hasn’t met for several years and has been disbanded. Some community members participated in site tours and early meetings. Many interviewed are very interested in the status of the water treatment plant and indicated they would particularly like an update on that project. One interviewee voiced concern about the decaying irrigation infrastructure. Several are interested in the impacts of cleanup activities on water quality.

Most interviewees expressed satisfaction with remedial actions to date, and said they have observed that water quality in the Alamosa River has vastly improved since remediation started. Some said they’ve seen life returning to the river. Some, however, voiced concern that too much taxpayer money has been spent on the cleanup, and that their input had no impact on cleanup decisions. They said there was not much time for community input, suggestions from the community “*went by the wayside,*” and that the downstream community was not part of the process.

One interviewee voiced concern about the location of the new water treatment plant, expressing his preference for it to be built at a lower elevation to take advantage of gravity, rather than to spend dollars pumping water uphill. This interviewee didn’t believe the concerns of his group were really taken into consideration in the final decision about the location of the plant and that any attempt to provide input to agency decisions was “...*whistling in the wind.*” He felt that community involvement efforts are conducted merely to pacify the community.

Others said they were satisfied with opportunities for involvement and with information they have received about the cleanup. Many said they haven’t gotten information recently and would like to get a status update on current activities.

One interviewee has a Master’s Degree in mine reclamation, so has a personal interest in knowing more about the cleanup and impacts to the river. He said he’d driven around the area and noticed the water was a “*weird color of red.*” He’s interested in the economic impacts of the mine closing and cleanup but doesn’t have an opinion on whether the cleanup has been successful.

Congressional staffers said they have had little or no contact from constituents about Summitville. The only exception is discussion with participants in one of the Natural Resource Damage projects.

6.5.2 Communication

Most interviewees said they are satisfied with the quality of information they’ve received about the cleanup, and made the point that there is a lot less community interest in the site than there

was at the beginning. One person said he thought people were just “*tired*.” Several interviewees said it is difficult to keep the community interested over the long-term life of the project. One interviewee suggested that interest might be re-generated using innovative approaches, such as holding meetings at someone’s house or conducting a raffle.

All interviewees are interested in getting regular status reports. Preferences for frequency varied from quarterly to annually. Some interviewees said they would prefer to get updates via email, while others said they don’t have email accounts and would like to receive direct mailings. Others said they feel they are kept adequately informed through their interactions with county commissioners and the RiverKeepers, and others said they feel comfortable that CDPHE Summitville Project Manager, Austin Buckingham, will answer any questions they might have.

Opinions on the usefulness of public meetings were mixed. Some believe they are useful, while others don’t think they are an effective means of communicating with the majority of the community because people are busy and don’t have time to attend meetings. Most preferred getting information through newsletters or newspaper articles in the Valley Courier, and some indicated that the site tours were useful, although there hasn’t been one for awhile. Some of the commissioners said it would be useful for Austin Buckingham to stop by for a visit periodically, possibly once or twice a year. Although most interviewees do not think public meetings are useful or would be well attended, they said that if public meetings are held, they should be in the evenings during winter months in La Jara or Capulin. One interviewee suggested Del Norte, and one other suggested Alamosa.

About half of the interviewees were aware of CDPHE and EPA websites, but most don’t use them. Very few people are aware of the information repositories, and those who are do not often access the information.

7.0 TECHNICAL ASSESSMENT

The purpose of the technical assessment is to evaluate the effectiveness of each operable unit with regard to the three questions provided in the EPA Comprehensive Five-Year Review Guidance; to evaluate if the remedies are functioning as intended by the interim RODs and ROD (Question A); to assess if the various assumptions, ARARs, etc. considered at the time of the remedy selection are still valid and, if not, evaluate the consequences and recommend follow-up actions (Question B); and to discuss additional information that could impact the effectiveness of the remedial actions (Question C).

The effectiveness of the interim and final remedial actions are discussed in this section. The information and data that Tetra Tech evaluated to form the basis for assessment of the remedy's protectiveness are presented for each operable unit. Also, the three questions (A, B and C) provided in EPA Comprehensive Five-Year Review Guidance are addressed here.

7.1 Operable Unit 0 - Water Treatment

On site water is routed to the Summitville Dam Impoundment, or SDI, where it is stored pending treatment. The SDI has a storage capacity of approximately 90 million gallons. Water is pumped from the SDI to the interim WTP for treatment. The interim WTP uses lime-based pH control to precipitate metals in a single-stage from the influent solution. Sludge generated at the plant is mechanically dewatered and disposed on site. The existing plant originally had a treatment capacity slightly in excess of 1,000 gpm or 1.44 mgd. Treated water is discharged from the WTP to Wightman Fork via a pipeline. Design enhancements implemented since 2005 have increased the treatment capacity to approximately 1,400 gpm or 2 mgd.

7.1.1 Remedy Performance, 2005-2009

The quantities of water treated in the 2005 through 2009 period are summarized in Table 7-1.

Table 7-1: Volume of Water Treated at SMSS WTP, 2005-2009

<i>Year</i>	<i>Volume Treated (million gallons)</i>	<i>Average Treatment Rate (gallons per minute)</i>
2005	298	960
2006	244	1,177
2007	356	1,323
2008	322	1,315
2009	300	1,413

Note: Average treatment rate calculated for on-line hours

The mass of metals removed from aqueous waste streams at the site by water treatment over the period 2005 through 2009 are summarized in Table 7-2.

Table 7-2: Mass of Metals Removed at SMSS WTP, 2005-2009

<i>Year</i>	<i>Mass of Metals Removed (tons)</i>				
	<i>Aluminum</i>	<i>Copper</i>	<i>Iron</i>	<i>Manganese</i>	<i>Zinc</i>
2005	148	36.5	184	28.9	15.9
2006	89.9	23.9	99.3	17.6	9.8
2007	142	31.0	148	26.9	14.5
2008	109.3	27.1	128.9	20.1	11.8
2009	79.5	20.4	85.2	15.0	8.9

Note: Metals in the “total” form

Metals removal effectiveness⁷ at the WTP exceeds 99.5 percent for copper, iron and zinc. Aluminum and manganese removal effectiveness is slightly less, ranging from 94.3 to 96.8 percent for aluminum and from 90.1 to 94.2 percent for manganese.

Effluent limits for the interim WTP were established by the EPA in the 1990s and are based on seven-day consecutive average concentrations, and apply to copper, iron, manganese and pH only. New limits for a more extensive suite of parameters will be established for the new WTP. The effluent limits established by EPA for the interim WTP are summarized in Table 7.3.

Table 7-3: Interim WTP Effluent Limits

<i>Analyte</i>	<i>7-Day Consecutive Average (Start-up to May 31)</i>	<i>7-Day Consecutive Average (June 1 to Shut Down)</i>
Copper	1.0 mg/L	0.1 mg/L (goal of 0.03 mg/L)
Iron	N/A	50.0 mg/L
Manganese	N/A	5.6 mg/L
pH (daily composite value)	N/A	6.5 to 9 standard units

Note: Metals in the “total” form

During the 2005 through 2009 period, WTP effluent concentrations and pH values did not exceed the 7-day consecutive average.

The construction of the ditch turnout structures under OUs 4 and 5 has provided CDPHE with greater flexibility in managing water at the site. The volume of water generated during the spring and snow melt typically exceeded the combined capacity of the SDI and the WTP. Prior to the construction of the turnouts, untreated water had to be released directly from the SDI during most spring seasons. With the construction of the turnouts, CDPHE can divert water from select areas of the site, thereby avoiding releases of comingled, higher metals-bearing water from the SDI.

⁷ Metals removal effectiveness calculated as $(\text{Concentration}_{\text{Influent}} - \text{Concentration}_{\text{Effluent}}) / \text{Concentration}_{\text{Influent}}$

7.1.2 Questions

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

No. Effluent discharged from the interim WTP to Wightman Fork meets the current discharge limits. However OU4 assumptions, which affect how the WTP is operated, have not met expectations. As envisioned in the OU5 ROD, following maturation of the OU4 revegetation, the only area tributary to the SDI would be the relatively small drainage basin adjacent to the SDI and the Highwall. However, monitoring has revealed that water generated from other areas at the site, particularly that throughout the Missionary Seeps – Chandler Bowl area, will continue to need to be routed to the SDI for treatment. Therefore, the water balance should be re-evaluated.

Question B: *Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of 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

7.2 Operable Unit 1 – Heap Leach Pad Detoxification/Closure

The cyanide in the Heap Leach Pad (HLP) was detoxified through a rinsing program in 1994 and 1995. Comparison of pre-and post- rinsing program cyanide concentrations indicates that the detoxification program removed 99 percent of the liquid-phase cyanide from the HLP. The HLP was regraded to stable configuration and capped during the 1997 and 1998 construction seasons, and vegetated. Following termination of the rinsing program and before the cap was completed, the water elevation in the HLP rose to a level of approximately 11,530 feet from snowmelt and precipitation, just a few feet below the HLP outfall constructed by the BOR as part of the HLP closure.

As part of the remedial investigation (RI), approximately 13.3 million gallons of water was pumped from the HLP and discharged to the SDI in late 2000. Water levels in the HLP have remained depressed since the completion of the HLP pumping test in 2000. Consequently, the completion of the HLP cap in 1998 has successfully decreased the recharge of water in the HLP from direct infiltration of precipitation.

7.2.1 *Remedy/Performance, 2005-2009*

Sampling of wells and seeps within the HLP (Well OC-27), on the downstream Dike No. 1 and in the Cropsy Creek Valley downstream of the HLP was performed in 2009. The data collected from well OC-27 indicate that approximately 80 million gallons of water remain in the HLP. Although the 1990's rinsing program was an estimated 99 percent effective, approximately 1,000 pounds of dissolved cyanide remain in the HLP along with larger masses of cyanide degradation products such as thiocyanate and ammonia. The pH of the water in the HLP remains basic, indicating that the buffering agents added to the ore during the leaching process have not yet been consumed. Results of the 2009 HLP sampling program are summarized in Appendix D.

Groundwater and seep monitoring on both HLP dikes and in the Cropsy Creek valley downgradient of the HLP in 2009 detect scattered, low concentrations of cyanide and potential cyanide-degradation products (Appendix D). However, these data are not consistent with a large-scale failure of the HLP liner system. Consequently, the drain system below the HLP and in Dike No. 1 that intercepts seepage and routes it to the SDI via the French Drain pipeline apparently continues to capture leakage from the HLP.

Inclinometers were installed in the HLP downstream Dike No. 1 embankment in September 2000. These inclinometers replaced those previously installed by the U. S. BOR that were destroyed during the HLP closure construction. Baseline measurements were obtained in the replacement inclinometers INCLH-1R, -2R and -3R in October 2000 and the inclinometers have been resurveyed annually since then. The survey data obtained indicate that the HLP Dike No. 1 is slowly creeping to the north-northwest. The magnitude of this movement, generally less than 0.25-inches per year, does not currently threaten the stability of the HLP Dike No. 1.

7.2.2 *Questions*

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

Yes. The placement of the cap over the HLP has reduced infiltration as evidenced by the stable water level following the conclusion of the RI pump down test. Monitoring of the downstream Dike No. 1 and groundwater downgradient of the HLP indicates that the structure remains stable.

Question B: Are the exposure assumptions, toxicity data, clean-up levels, and RAOs used at the time of 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. Aside from the creeping inclinometer readings on Dike No. 1, which will be monitored.

7.3 *Operable Unit 2 – Excavation of the Cropsy Waste Pile/Beaver Mud Dump and the Cleveland Cliffs Tailing Impoundment [SDI]/Closure of Mine Pits*

OU2 included the removal of mine wastes from the Cropsy Waste Pile, the Beaver Mud Dump, and the Cleveland Cliffs Tailing Impoundment (now SDI). These and other mine wastes were placed in the former mine pits (Figure 2-1), the south pit was capped, and both pits revegetated (except for the sludge disposal area). Prior to placement of mine wastes, both pits were lined with cement kiln dust to neutralize AMD generated within the mine pits.

7.3.1 *Remedy Performance, 2005-2009*

Consolidation of mine waste materials in the mine pits has not completely isolated these materials from the environment because the mine pool water level fluctuations are causing groundwater levels to rise above the base of the mine pits. As illustrated in Figure 7-1, material in the north mine pit is inundated for the majority of the year. The base of the south pit is approximately 100 feet above the north pit. Consequently, the mine waters in the south pit are not inundated as frequently as those in the north pit.

In July 2009, well RCMW-8 was sampled as part of the OU-5 site-wide monitoring program. Well RCMW-8 is completed at the base of the north mine pit⁸; continuous water level data are available from this instrumented well. The water level data from RCMW-8 are consistent with the mine pool data, indicating that the mine wastes disposed in the north mine pit are alternately saturated and dewatered over the course of the year. A comparison of the selected water quality parameters in well RCMW-8 in 2009 to historical water quality data (2 samples) is presented in the following table:

Table 7-4: Well RCMW-8 Water Quality Comparison

Analyte	RCMW-8 Concentration		
	August 2000	June 2001	July 2009
pH	12.6	3.9	2.9
Aluminum (mg/L)	4.54	291	222
Copper (mg/L)	0.1	44.1	41.7
Iron (mg/L)	0.05	891	617
Manganese (mg/L)	<0.005	61.3	32.4
Zinc (mg/L)	0.07	39.1	30.7

Notes: Metals concentrations represent the dissolved form

Well RCMW-8 was installed in July 2000 and sampled one month later. It is believed that the initial sample was influenced by grout introduced during well construction or by kiln dust displaced by drilling; hence the high pH and low metal concentrations. Recent data indicate that AMD is actively generated within the south mine pit. Because groundwater levels are higher than the top of the cement kiln dust layer, it is likely that AMD generated within the north mine pit migrates laterally into the surrounding bedrock without encountering the liner. In addition,

⁸ The cement kiln dust layer was “tagged” at a depth of 163 feet and drilling was halted at 164 feet. The well was completed with a screened interval of 153 to 164 feet.

given that the pH of the water in contact with the kiln dust layer was 2.9 in 2009, it is not clear how much neutralization capacity remains in the mine pit liner. Exhaustion of the neutralization capacity in the kiln dust liner would allow AMD generated within the mine pits to migrate, under appropriate hydraulic conditions, into the adjacent bedrock.

The removal of mine waste from the Cropsy Waste Pile, along with the remediation of the HLP (Section 7.2), has resulted in significant water quality improvements in Cropsy Creek. As described in Section 4.1.1, three of the top five copper sources were located in the Cropsy basin at the time of the EPA takeover in 1992. With the implementation of the remedial actions in the Cropsy basin, the concentrations of copper at the mouth of Cropsy Creek (Station CC-5) has declined from 10's of mg/L to tenths of mg/L, a decrease of two orders of magnitude (Figure 7-2). However, as discussed later, through 2009 copper sources in the Cropsy basin continued to provide about 20 percent of the copper loading from the Site to Wightman Fork. Sources of copper in the Cropsy basin include seepage in the basin above the HLP and exposed quartz latite in the Campbell Quarry.

The conversion of the Cleveland Cliffs Tailing Impoundment to the SDI during the mid-1990s resulted in a 90 million gallon reservoir to store contaminated waters generated on-site. Combined with the interim WTP, these two features have served as the main mechanism to ameliorate AMD at the site since 1996. Seepage from the basin of the SDI embankment continues to provide copper to Wightman Fork. As discussed later, this seepage (as measured at the SDI-Toe Channel station) accounts for more than 10 percent of the copper loading from the Site to Wightman Fork. The CDPHE has included funding in their FY2011 budget request to complete the design and construction of a system to capture this seepage.

7.3.2 Questions

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

No. However, because OU5 has not been fully implemented the mine wastes disposed in the north mine pit are alternately inundated and dewatered annually (Figure 7-1) leading to the generation of AMD. This AMD may subsequently migrate away from the north mine pit. A similar process may be occurring in the south mine pit but, due to the higher elevation of this pit, the wastes in the south mine pit are only occasionally inundated.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes, the pathways and receptors have not changed. However, as discussed in the response to Question A, the mine wastes have not been isolated from the environment. Inundation of the mine pit wastes by groundwater results in additional metals loadings to the groundwater system. Active management of the mine pool to an elevation below the base of the Chandler Adit is a key component to reduce the inundation of these mine wastes. Management of the mine pool level from the Reynolds Adit pipeline will maintain a relatively stable mine pool elevation below the base of the deeper (north) mine pit.

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

No. The current conditions have not changed since the ROD.

7.4 Operable Unit 4 - Side-Wide Reclamation

Site-wide reclamation was implemented in multiple phases over several years with the major earthwork completed by 2001. Approximately 300 acres of disturbed land was reclaimed at the site. The goals of site-wide reclamation were to remove, reduce, stabilize, and/or contain non-point sources of acid rock drainage to prevent further releases from the site and impacts to aquatic receptors in Wightman Fork, the Alamosa River and Terrace Reservoir.

Reclamation involved reconfiguring disturbed areas to improve slope stabilization, moisture retention, and to reduce soil erosion. Amendments needed to produce topsoil capable of promoting and sustaining plant growth were added to the soil. Lime requirements were determined for either the total acid potential or the acid-base potential of soil samples. Lime application rates for the subsoil were based on the average lime requirement, plus the amount of limestone to neutralize 12 inches of subsoil to the 95 percent confidence level. This could leave an estimated five percent of the total area (15 acres) inadequately neutralized (BOR, 1998).

7.4.1 Remedy Performance, 2005-2009

The individual components of the OU4 remedy are discussed in the following subsections.

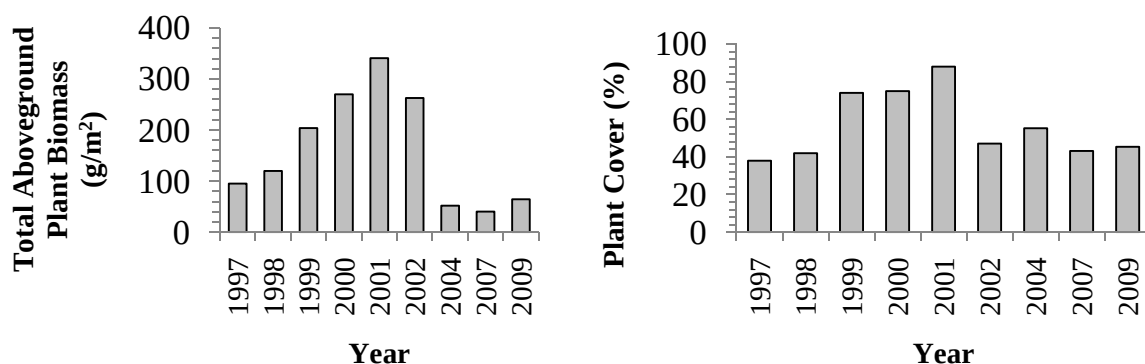
7.4.1.1 Revegetation

Rangeland ecologists from CSU perform field surveys twice within each five year period to evaluate the performance of revegetation efforts undertaken in OU4 and other remedial actions. The 2009 CSU survey results are documented in their report, which is reproduced in Appendix B.

CSU researchers have documented an increase in uniformity of vegetation cover site-wide, an increase in species richness, and a significant shift from a plant community dominated by seeded and short-lived species, to one more similar to the neighboring, subalpine meadow plant community. These observations are consistent with an ecosystem undergoing favorable, natural ecological succession. However localized areas of bare ground are present at the site where soil erosion is occurring, suggesting that further action may be needed in limited areas. Planting of woody plants and localized seeding of a diverse mixture of native species in these trouble spots would slow this degradation and may facilitate faster development of plant communities on the site. In general, the trend of increasing species richness resulting from colonization by native plant species from surrounding areas indicates a desirable trajectory of ecological succession at the site.

Figure 7-3 displays total aboveground biomass (g/m^2) and herbaceous cover (percent cover) from 1997 to 2009 in select long-term north waste dump revegetation test plots⁹ established on the north waste dump. Graminoid (grasses, sedges and rushes) biomass remained relatively constant between 2007 and 2009; however, forb biomass increased substantially from 2007 to 2009. Overall plant biomass in 2009 approximates levels measured in 2002 indicating that total plant biomass has stabilized (CSU 2009).

Figure 7-3: Total Aboveground Plant Biomass and Plant Cover in Test Plot SM from 1997 to 2009



Source: CSU, 2009

Revegetation Test Plot treatment SM has decreased in both plant biomass and total vegetative cover in recent years likely due to the successional processes related to declining soil resources and a shift in plant biomass allocation to belowground structures. (CSU, 2009).

The success of the OU4 reclamation work in reducing non-point source pollution from the disturbed areas at the site is discussed in Section 7.4.1.2.1.

7.4.1.2 Water Management Structures and Improvements

Work on the Water Management Structures and Improvement Project (six turnout structures, groundwater interceptor drains, ditch upgrades, Highwall ditch and detention basin, etc.) was largely completed during 2003. Additional work was performed during 2005 to improve the efficiency of the groundwater interceptor drains along the toe of the NWD and in the vicinity of the Missionary Seeps; water originating from these groundwater interceptor drains is now diverted into ditch systems that lead to the SDI. Additional work was performed in 2006 to relocate CC-ditch flow to the Impact Basin. During the summer of 2008, the A3-1 Turnout (A3-1-TO) was completed to help manage water levels in the SDI.

The objective of the Water Management Structures and Improvements project was to further

⁹ One of eight treatments tested on the NWD since 1995, treatment SM is most similar to the soil amendments used in OU4 and was sampled by CSU in 2004, 2007 and 2009

segregate clean water and contaminated water at the site, thereby optimizing water storage in the SDI. Prior to the construction of the ditch turnouts, the only mechanism for releasing water from the site was via the SDI outlet works. Beginning with the spring 2004 runoff, the ditch turnouts provided the State with the flexibility to release water from several locations at the site prior to the water reaching the SDI. The ability to release water from the turnouts versus the comingled SDI water has resulted in a large decrease in metals loading from the site during the spring runoff season.

Pressure transducers and data loggers are installed at each turnout to provide a continuous record (i.e., 15-minute readings) of water passing through each turnout. Data obtained allow the quantification of flow and loads directed on site towards the SDI or off site to Wightman Fork. A straight line diagram illustrating surface water flow routing at the site during 2009 is provided in Figure 4-2.

7.4.1.2.1 Surface Water Ditches and Turnout Structures

Current management of the site surface water has resulted in improvements in water quality leaving the site. For example, the concentration of total suspended solids (TSS) measured at Wightman Fork monitoring station WF5.5 has decreased over 50 percent with the completion of OU4 activities. The concentration of TSS measured at WF5.5 for the period 1986 through 1994 (mining through initial response actions) are compared to those for periods 2000 through 2005 and 2005 through 2009 as shown in Table 7-5.

Table 7-5: Total Suspended Solids Concentrations at WF5.5

<i>Statistic</i>	<i>TSS Concentration (mg/L)</i>		
	<i>1986 thru 1994</i>	<i>2000 thru 2005</i>	<i>2005 thru 2009</i>
Median Concentration	47	23	22
Number of Samples (<i>n</i>)	117	117	49

These data indicate that the amount of sediment transported off the site has decreased by over 50 percent with the completion of the OU4 activities.

Total copper and pH concentrations measured at the various ditch turnout structures from 2005 to 2009 are illustrated in Figures 7-4 through 7-10. These data are discussed below.

Concurrent with the construction of the L ditch turnout (L-DITCH-TO) in late-2003, the North and South Highwall ditches were constructed to direct water to the Highwall Detention and Sedimentation Pond. Water from the pond and discharge from the Iowa Adit are combined in the Highwall pipeline and discharged to the SDI; whereas historically, flow for these two source areas passed through the L ditch. In late 2006, poor quality water originating just southwest of the Cyanide Destruction Plant (the CC-ditch) was collected and piped to the SDI as well. Water quality at station L-DITCH-TO (formerly L3-1) has improved with the diversion of highwall water and the CC-ditch water away from the L ditch.

The median pH values and total aluminum and copper concentrations measured at the L-DITCH-TO monitoring locations from 2005 through 2009 are summarized and compared to the OU5 Remediation Levels in Table 7-6.

Table 7-6: Water Quality at the L Ditch Turnout (L-DITCH-TO) between 2005 and 2009

<i>Year</i>	<i>Median pH</i>	<i>Median Aluminum Concentration (mg/L)</i>	<i>Median Copper Concentration (mg/L)</i>	<i>Snowpack (% of Normal)</i>
2005	3.5 <i>n</i> = 34	31.0 <i>n</i> = 34	2.8 <i>n</i> = 34	138%
2006	4.0 <i>n</i> = 34	17.7 <i>n</i> = 34	1.9 <i>n</i> = 34	72%
2007	4.1 <i>n</i> = 36	15.4 <i>n</i> = 36	1.2 <i>n</i> = 36	88%
2008	4.8 <i>n</i> = 34	9.4 <i>n</i> = 34	0.82 <i>n</i> = 34	130%
2009	4.7 <i>n</i> = 24	9.6 <i>n</i> = 24	0.86 <i>n</i> = 24	97%
WF5.5 Remediation Levels (Table 4-1)	5.1 (high flow) 6.6 (low flow)	5	1.55 (high flow) 0.035 to 0.4 (low flow)	---

Notes: Concentrations in the total form.
Snowpack based on Wolf Creek Pass snowfall.

Review of these data suggests an improvement of water quality in the ditch system draining the Highwall and mine pits. Median pH values improved over ten times (pH 3.5 to 4.7) between 2005 and 2009; however, pH values still remain strongly acidic. During the same period, median total aluminum and copper concentrations decreased 69 percent. The annual variation of copper and pH in the L-ditch system between 2005 and 2009 is illustrated in Figure 7-4.

The P-ditch system runs along the main haul road and drains the slopes south of the SDI. Except during periods of high flows water from the L-ditch system is routed into the P-ditch via the L ditch turnout structure. The median pH values and total aluminum and copper concentrations measured at the P-DITCH-TO monitoring location from 2005 through 2009 are summarized and compared to the OU5 Remediation Levels in Table 7-7.

Table 7-7: Water Quality at the P Ditch Turnout (P-DITCH-TO) between 2005 and 2009

<i>Year</i>	<i>Median pH</i>	<i>Median Aluminum Concentration (mg/L)</i>	<i>Median Copper Concentration (mg/L)</i>	<i>Snowpack (% of Normal)</i>
2005	3.4 <i>n</i> = 27	29.0 <i>n</i> = 27	3.7 <i>n</i> = 27	138%
2006	3.8 <i>n</i> = 32	24.5 <i>n</i> = 32	4.5 <i>n</i> = 32	72%
2007	3.8 <i>n</i> = 37	18.3 <i>n</i> = 37	2.4 <i>n</i> = 37	88%
2008	3.9 <i>n</i> = 25	13.9 <i>n</i> = 25	1.9 <i>n</i> = 25	130%
2009	4.1 <i>n</i> = 18	16.0 <i>n</i> = 18	2.4 <i>n</i> = 18	97%
WF5.5 Remediation Levels (Table 4-1)	5.1 (high flow) 6.6 (low flow)	5	1.55 (high flow) 0.035 to 0.4 (low flow)	---

Notes: Concentrations in the total form.
Snowpack based on Wolf Creek Pass snowfall.

The presence of the L-DITCH-TO upstream of the P-DITCH-TO monitoring location allows CDPHE to divert water away from the SDI which they commonly do during the spring runoff. Future water quality observed at P-DITCH-TO may vary substantially from year-to-year as it has in the past (Figure 7-5) depending upon snowpack and how CDPHE manages the runoff.

The ditch system draining the northwestern portion of the site is monitored at several locations (Figure 4-2). Depending upon water quality and quantity, CDPHE can divert (turnout) water at five separate locations along the northwestern ditch system. However, CDPHE has routinely only turned out water at the upper two turnout structures; A1-TO and A2-TO. Water quality over the past five years is discussed below from downstream (SC-7) to upstream (A1-TO). Monitoring at the terminus of the ditch system draining the NWD, Chandler Bowl, and Missionary Seeps areas has been performed for several years. With the completion of the water management structures in late-2003, several new sources discharge to this ditch system via the Impact Basin (Figure 4-2). As a result of the addition of the Impact Basin, water quality from monitoring station T-DITCH-TO now represents the influences from the NWD, Chandler Bowl, and Missionary Seeps areas, Highwall and other areas.

The median pH values and total aluminum and copper concentrations measured at the T-DITCH-TO monitoring location from 2005 through 2009 are summarized and compared to the OU5 Remediation Levels in Table 7-8.

Table 7-8: Water Quality at the T Ditch Turnout (T-DITCH-TO) between 2005 and 2009

<i>Year</i>	<i>Median pH</i>	<i>Median Aluminum Concentration (mg/L)</i>	<i>Median Copper Concentration (mg/L)</i>	<i>Snowpack (% of Normal)</i>
2005	3.0 <i>n</i> = 29	138 <i>n</i> = 29	45.3 <i>n</i> = 29	138%
2006	3.0 <i>n</i> = 32	112 <i>n</i> = 32	74.0 <i>n</i> = 32	72%
2007	3.2 <i>n</i> = 36	114 <i>n</i> = 36	28.0 <i>n</i> = 36	88%
2008	3.4 <i>n</i> = 31	34.0 <i>n</i> = 31	15.5 <i>n</i> = 31	130%
2009	3.1 <i>n</i> = 24	143 <i>n</i> = 24	42.0 <i>n</i> = 24	97%
WF5.5 Remediation Levels (Table 4-1)	5.1 (high flow) 6.6 (low flow)	5	1.55 (high flow) 0.035 to 0.4 (low flow)	---

Notes: Concentrations in the total form.

Snowpack based on Wolf Creek Pass snowfall.

Overall, little improvement in water quality is apparent in the T-DITCH-TO data. The presence of turnouts in the NWD ditch system upstream of the T-DITCH-TO monitoring location allows CDPHE to divert relatively clean water away from the SDI. Similar to P-DITCH-TO, the future water quality observed at T-DITCH-TO may vary substantially from year-to-year (Figure 7-6) depending upon snowpack and how CDPHE manages the runoff.

The Q ditch turnout (Q-DITCH-TO) is the fourth of five turnouts along the NWD, Chandler Bowl, and Missionary Seeps ditch drainage system (Figure 4-2); the Q ditch drains the slopes between the Chandler Bowl and the WTP. The median pH values and total aluminum and copper concentrations measured at the Q-DITCH-TO monitoring location from 2005 through 2009 are summarized and compared to the OU5 Remediation Levels in Table 7-9.

Table 7-9: Water Quality at the Q Ditch Turnout (Q-DITCH-TO) between 2005 and 2009

<i>Year</i>	<i>Median pH</i>	<i>Median Aluminum Concentration (mg/L)</i>	<i>Median Copper Concentration (mg/L)</i>	<i>Snowpack (% of Normal)</i>
2005	3.0 <i>n</i> = 27	164 <i>n</i> = 27	73.0 <i>n</i> = 27	138%
2006	3.5 <i>n</i> = 22	42.0 <i>n</i> = 22	21.8 <i>n</i> = 22	72%
2007	3.5 <i>n</i> = 19	14.2 <i>n</i> = 19	4.8 <i>n</i> = 19	88%
2008	3.4 <i>n</i> = 13	23.0 <i>n</i> = 13	10.3 <i>n</i> = 13	130%
2009	3.8 <i>n</i> = 13	3.4 <i>n</i> = 13	1.9 <i>n</i> = 13	97%
WF5.5 Remediation Levels (Table 4-1)	5.1 (high flow) 6.6 (low flow)	5	1.55 (high flow) 0.035 to 0.4 (low flow)	---

Notes: Concentrations in the total form.

Snowpack based on Wolf Creek Pass snowfall.

Review of these data suggests an improvement of water quality at the Q-DITCH-TO between 2005 and 2009. Median pH values have improved but still remain acidic especially during the late summer and fall months (Figure 7-7). During the same period, median total aluminum and copper concentrations decreased approximately 98 percent.

The newest site turnout, the A3-1 ditch turnout (A3-1-TO), is the third of five turnouts along the NWD, Chandler Bowl, and Missionary Seeps ditch drainage system (Figure 4-2). Construction on the A3-1-TO was completed during the summer of 2008. Water quality at A3-1-TO is not as good as that at the two upper A ditch system turnouts, with a median pH of 3.6 and a median copper concentration of 21 mg/L measured in 2009, the first full year of monitoring at this station. Through 2009, no water had been diverted off site via A3-1-TO because seepage into the A3 Ditch just upstream of the turnout adversely impacts water quality (Figure 7-8).

The A2 ditch turnout is the second of five turnouts along the NWD, Chandler Bowl, and Missionary Seeps ditch drainage system (Figure 4-2). The median pH values and total aluminum and copper concentrations measured at the A2-2-TO monitoring location from 2005 through 2009 are summarized and compared to the OU5 Remediation Levels in Table 7-10.

Table 7-10: Water Quality at the A2-2 Ditch Turnout (A2-2-TO) between 2005 and 2009

<i>Year</i>	<i>Median pH</i>	<i>Median Aluminum Concentration (mg/L)</i>	<i>Median Copper Concentration (mg/L)</i>	<i>Snowpack (% of Normal)</i>
2005	3.7 <i>n</i> = 14	9.8 <i>n</i> = 14	2.1 <i>n</i> = 14	138%
2006	5.4 <i>n</i> = 14	4.4 <i>n</i> = 14	0.9 <i>n</i> = 14	72%
2007	4.8 <i>n</i> = 26	12.3 <i>n</i> = 26	1.3 <i>n</i> = 26	88%
2008	6.2 <i>n</i> = 12	8.6 <i>n</i> = 12	0.64 <i>n</i> = 12	130%
2009	5.8 <i>n</i> = 8	9.0 <i>n</i> = 8	0.79 <i>n</i> = 8	97%
WF5.5 Remediation Levels (Table 4-1)	5.1 (high flow) 6.6 (low flow)	5	1.55 (high flow) 0.035 to 0.4 (low flow)	---

Notes: Concentrations in the total form.

Snowpack based on Wolf Creek Pass snowfall.

Historic water quality trends are illustrated on Figure 7-9. Site water at the A2-2 turnout is always directed off site.

The A2-1 ditch turnout is the first and uppermost of five turnouts along the NWD, Chandler Bowl, and Missionary Seeps ditch drainage system (Figure 4-2). The median pH values and total aluminum and copper concentrations measured at the A2-1-TO monitoring location from 2005 through 2009 are summarized and compared to the OU5 Remediation Levels in Table 7-11.

Table 7-11: Water Quality at the A2-1 Ditch Turnout (A2-1-TO) between 2005 and 2009

<i>Year</i>	<i>Median pH</i>	<i>Median Aluminum Concentration (mg/L)</i>	<i>Median Copper Concentration (mg/L)</i>	<i>Snowpack (% of Normal)</i>
2005	5.4 <i>n</i> = 10	0.56 <i>n</i> = 10	0.27 <i>n</i> = 10	138%
2006	6.3 <i>n</i> = 12	0.25 <i>n</i> = 12	0.09 <i>n</i> = 12	72%
2007	5.1 <i>n</i> = 28	4.6 <i>n</i> = 28	0.33 <i>n</i> = 28	88%
2008	6.0 <i>n</i> = 12	3.3 <i>n</i> = 12	0.24 <i>n</i> = 12	130%
2009	6.0 <i>n</i> = 6	2.0 <i>n</i> = 6	0.22 <i>n</i> = 6	97%
WF5.5 Remediation Levels (Table 4-1)	5.1 (high flow) 6.6 (low flow)	5	1.55 (high flow) 0.035 to 0.4 (low flow)	---

Notes: Concentrations in the total form.
Snowpack based on Wolf Creek Pass snowfall.

Historic water quality trends are illustrated on Figure 7-10. Site water at the A1 turnout is always directed off site.

7.4.1.2.2 Groundwater Interceptor Drains

Groundwater interceptor drains were constructed in late 2003 along the toe of the NWD, in the Chandler Bowl area and along the Missionary Seeps. Additional work was performed during 2005 to improve the groundwater interceptor drains along the toe of the NWD and in the vicinity of the Missionary Seeps. The objective of these drains is to capture groundwater underflow, thereby decreasing the non-point source metals load to Wightman Fork. Water originating from these groundwater interceptor drains is diverted into ditch systems that lead to the SDI. A diagrammatic illustration of the current groundwater interceptor drain system is provided in Figure 4-2.

A large non-point source metals load enters Wightman Fork adjacent to the NWD, Chandler Bowl and Missionary Seeps. The majority of this load enters Wightman Fork between surface water monitoring locations WF1.5 and WF2.5 (Figure 4-2). The historic copper concentration at monitoring station WF2 is illustrated on Figure 7-11. Prior to the installation of the Reynolds and Chandler Adit plugs and the development of the mine pool, copper concentrations at WF2 were lower. With the development of the mine pool, copper concentrations increased an order of magnitude. Following the groundwater interceptor drain improvements in 2005, the copper concentrations at WF2 decreased in 2006 and 2007; however, this may have been the result of less than average snowpack (72 and 88 percent) those two years. Copper concentrations at WF2 increased during the 2008 monitoring season when the snowpack was at approximately 130 percent. Even with the groundwater interceptor drains, groundwater underflow in this area remains the largest non-point source of metals loading at the site. For example, springs NWDUS and AXON which emerge between WF1.5 and WF2.5 (Figure 4-2) together account for

approximately 40 percent of the copper loading to Wightman Fork from the Site, as will be discussed later. Copper loading tables for Wightman Fork in years 2005 through 2009 are provided in Appendix F.

A smaller set of drains was installed on Dike No. 1 of the Heap Leach Pad (HLP) in late 2003. Groundwater captured by the HLP drains is routed into the French drain pipeline, which discharges to the SDI. This groundwater is monitored at the French drain pipeline outfall (FD-1) (Figure 4-2). The median aluminum and copper concentrations and loads measured in samples collected from FD-1 over the last five years are summarized in Table 7-12.

Table 7-12: Aluminum and Copper Concentrations and Loads at the French Drain Pipeline Outfall (FD-1) between 2005 and 2009

YEAR	Count	Aluminum		Copper		Snowpack (% of Normal)
		Median Concentration (mg/L)	Median Load (lbs/day)	Median Concentration (mg/L)	Median Load (lbs/day)	
2005	<i>n</i> = 7	105	56.6	27.8	17.7	138%
2006	<i>n</i> = 7	150	80.9	13.6	7.3	72%
2007	<i>n</i> = 7	159	104	23.8	15.5	88%
2008	<i>n</i> = 7	113	61.6	16.2	8.6	130%
2009	<i>n</i> = 22	101	44.7	15.0	7.3	97%

Both concentrations and loads measured at FD-1 vary significantly from year to year and through various snowmelt regimes. In 2009, median aluminum and copper loads were low when compared to the past five years. The lower median concentrations observed in 2009 may be the result of weekly monitoring versus monthly monitoring which occurred between 2005 and 2008.

An issue with the groundwater interceptor drains results from the buildup of iron precipitate on the inside of drains. Over time, these precipitates limit the ability of the drains to effectively transmit flow. The reduction in flow results in backups that overtop drain cleanouts, thus resulting in the resurfacing of captured groundwater flow.

7.4.2 Questions

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

No. The site-wide vegetation is maturing as expected; however AMD and seepage has killed or inhibited the development of vegetation in select areas throughout the Site, most notably in the Chandler Bowl (see Figure 5 in Appendix B). The originally seeded grasses have declined in dominance as a more diverse native plant community becomes established on the site. The amount of sediment exported from the site has significantly decreased over pre-revegetation values and has remained relatively stable since the completion of reclamation activities. Metals loading originating in the Cropsy Valley has significantly decreased since the completion of reclamation activities and continues to decrease. The quality of the water measured at the L, P, and Q ditch turnouts has improved over the past five years; however, the water quality continues to exceed the WF5.5 remediation levels (Table 4-1) during low flow regimes. The interceptor drains are not functioning as intended and non-point source loads continue to flow into

Wightman Fork contributing over 60 percent of the copper load. The site-wide reclamation has resulted in a lower reduction in contaminants than originally envisioned during the development alternatives in the OU5 FS (RMC, 2001b). Consequently, a volume of Site water above that assumed in the OU5 ROD requires management and treatment (Section 8.3).

Question B: *Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. The pathways, receptors and clean up goals have not changed over the last five years.

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

Yes. Non-point source contaminants continue to flow to Wightman Fork which result in exceedances of remediation goals at WF5.5 and downstream water quality standards. As discussed in Section 7.5.2, over 60 percent of the copper load at WF5.5 is attributable to non-point source loads originating predominantly in Wightman Fork between Stations WF1.5 and WF2.5.

7.5 Operable Unit 5 – Final Side-Wide Remedial Action

The following sections describe progress made toward implementation of the Final Site-Wide Remedial Action, and what improvements to water quality and conformance to RAOs and remedial action limits have been realized.

7.5.1 Remedy Components

The OU5 Final Site-Wide Remedy contains several new components or proposed modifications to previously constructed features. The status of these OU5 elements are discussed the following subsections.

7.5.1.1 New Active Water Treatment Plant

The OU5 ROD called for the construction of a new, conventional water treatment plant. The ROD specified that the new plant would be constructed downstream of the onsite impoundment, outside of the 500-year floodplain, with the exact location to be determined in the Remedial Design phase. The new plant was to be located at an elevation such that sufficient pressure will be available to provide gravity operation of the plant. Whereas the interim WTP had effluent limits only for copper, iron, manganese, and pH (Table 7-3), the new WTP will have end-of-pipe effluent limits based on the more stringent water quality standards in place in the downstream Alamosa River Segment 3b (Figure 3-1).

In an August 2003 Explanation of Significant Difference, the location of the new water treatment plant was specified as adjacent to the existing plant, upstream of the SDI and outside the 500-year floodplain. In this new location, the contaminated water from the SDI would be pumped to the new water treatment plant rather than delivered by gravity feed.

CDPHE is the lead agency responsible for the design and construction of the new water treatment plant. CDPHE selected Resources Technologies Group (RTG), now Golder Associates, in November 2002 to design the new water treatment plant. Based on the influent chemistry and the requirement to meet applicable water quality standards in the Alamosa River, a two-stage treatment plant would be required with the initial stage removing aluminum and the second stage removing additional metals (e.g., copper, iron, zinc).

CDPHE initiated a Use Attainability Analyses of the Alamosa River basin to demonstrate the non-attainment of the current aluminum standard due to natural and (non-site) human caused conditions (legacy mine sites) (Tetra Tech, 2005). Based on the evidence presented by CDPHE, the Colorado Water Quality Control Commission revised (upward) the aluminum standards in the Alamosa River basin. With the increased aluminum standard in the Alamosa River, the need for a two-stage treatment plant at the site was eliminated as a single-stage treatment process may reasonably achieve the aluminum discharge goal.

Following the 2007 ruling by the commission, CDPHE contracted with Golder to revise the WTP design to a single-stage plant. The site received \$17 million in federal remedial action funding via the American Recovery and Reinvestment Act of 2009 with a ten percent match from the State of Colorado to construct the redesigned 1,600 gallons-per minute water treatment plant. Construction of the WTP began in September 2009 and is anticipated to be substantially complete in September 2011. The plant is expected to be fully commissioned in 2012.

7.5.1.2 Summitville Dam Impoundment (SDI)

The SDI serves as the storage structure for AMD-impacted water at the site. Historically, the storage capacity of the SDI has been insufficient to hold all the water generated on site during the spring snowmelt. Controlled releases were made via the ditch turnouts each of the past five years during the spring snowmelt to prohibit uncontrolled releases through the SDI spillway.

The major inflows to the SDI over the past five years include the French drain (FD-1), P-ditch, T-ditch (SC-7) and Pumphouse Fault (PF-0-NEW) (Figure 4-2). The T-ditch flows include the impact basin (IMPACT BASIN) which combines the discharges from pipelines conveying contaminated water from the NWD drains, Chandler Adit (CA-0) drain, the Missionary Seep drains, the Highwall and Iowa Adit discharge pipeline¹⁰, and the Reynolds Adit pipeline. The area contributing the largest volume of water and metals loading to the SDI during the past five years has been the NWD and Missionary Seeps area, as measured at terminus of the T-ditch system (Figure 7-5). Figure 4-2 depicts the current configuration of the surface water ditch system, groundwater interceptor drains, and adit portal discharge pipeline conveyance systems.

The SDI pool elevation and the WTP treatment rate are illustrated on Figure 7-12. After treatment plant operations have ceased in the fall, water levels in the SDI gradually increase

¹⁰ Under the OU4 reclamation, the water produced from the Highwall and Iowa Adit no longer passes through the L3-1 ditch, but is diverted into a pipeline that leads to the impact basin.

through the winter months as baseflow from South Mountain reports to the SDI. WTP operations restart in April, and the SDI level is rapidly drawn down in preparation for the spring runoff. Dependent upon the volume of the water in the snowpack and the rapidity at which the snowmelt occurs, the turnouts on the site ditch systems are used to divert (turnout) varying amounts of water off the site (away from the SDI). Diverting water away from the SDI has historically been necessary to keep water from flowing over the reservoir's uncompleted spillway. Prior to construction of the ditch turnout structures, water was released directly from the SDI using the outlet works. The volume of water released from the SDI is illustrated, along with the volume of water treated and the annual snowpack, on Figure 7-13.

Construction on the SDI spillway will be completed in 2010¹¹ and, with the commissioning of the new WTP in 2012, will allow improved water management at the site. Raising the SDI spillway elevation by 3 feet will increase the storage capacity of the reservoir an estimated 11 percent from 90 million gallons to 100 million gallons. In addition, the new WTP will be capable of treating 14 percent more water (1,600 gpm versus recent maximum of 1,400 gpm). Over a minimum runoff period of 30 days, the 200 gpm increase in treatment capacity will result in at least 8.6 million gallons of additional water treatment capacity. The combined increase in SDI storage and WTP rate will result in approximately 18.6 million gallons of additional water that could be stored and treated during spring runoff. Evaluation of Figure 7-13 indicates that, had this increased capacity been available over the past five years and accounting for the water released from the A2-1 and A2-2 turnouts, then no other water would have been released from the site in 2006 or 2007. In 2008 and 2009, the volume of water released from the L ditch could have been reduced by approximately 75 percent and 30 percent, respectively. In 2005, the combined volume of water released through the L, P and T ditches could have been reduced by over 25 percent.

7.5.1.3 SDI Spillway Channel Improvements and Plunge Pool

Historically, the SDI spillway channel would not convey flow all the way from the spillway to Wightman Fork. The existing channel terminated at the USDA Forest Service Road 244 (FS 244). Downstream of the road, had water been released from the SDI via the spillway it would have flowed overland in an uncontrolled manner until it reached Wightman Fork.

Construction on the portion of the spillway channel downstream of FS 244 began in 2008. The construction activities included excavation of a trapezoidal channel between the FS 244 road crossing and Wightman Fork. Spillway excavation activities encountered fine-grained quartz latite rock that weathered rapidly and produced acid-sulfate solutions when exposed to precipitation and runoff from snowmelt. To allow controlled flow of the acidic water produced from the weathering rock and to accommodate future sampling, V-notch channels were excavated along the base of both sides of the channel slopes at the locations of the fine-grained quartz latite rock deposits.

¹¹ Modeling of the new spillway configuration was reviewed and approved by the Colorado State Engineer's Office. The design capacity of the new spillway, 7,050 cfs, is sufficient to pass the Inflow Design Flood, which was based on an Extreme Storm Precipitation event (which exceeded the modeled Probable Maximum Precipitation event).

A plunge pool was constructed to dissipate the energy from the combined flow from the SDI emergency spillway and the Wightman Fork Diversion Channel (discussed in Section 7.5.1.4). Construction of the SDI emergency spillway, upper channel and low water crossing over FS Road 244 will be completed in 2010. Should releases from the SDI be required in future spring runoffs, spillage of dilute water from the surface of the pool will be an option beginning in 2011. Whereas, in the past, releases could only be made from the more concentrated deeper SDI pool tapped by the outlet works.

7.5.1.4 Wightman Fork Diversion Channel Improvements

The Wightman Fork Diversion (WFD) improvements project included the upgrade of the WFD to safely convey the flows generated by the 100-year thunderstorm. Components of the project included modifications/improvements to the upstream channel crossing, main channel and levee (including overflow spillways), downstream channel crossing, and the WFD return channel and plunge pool.

The upstream channel improvements required the existing culvert crossing at the intersection of WFD and the main site access road to be re-graded to prevent Wightman Fork overflow from entering the SDI. This improvement included lowering the existing road surface, placement of armor (riprap) within the road surface, placement of a concrete protection sill, and downstream slope protection.

Improvements were made to the existing WFD channel and levee to safely convey the 100-year design storm to the downstream channel crossing. Additionally, the WFD channel was designed to overflow storms exceeding the 100-year storm up to and including the 500-year storm safely into the SDI in a series of four overflow spillways. The improvements to the channel and levee included:

- Channel widening and additional armoring.
- Raising the levee utilizing earth fill and steel sheet pile.
- Creation of three additional rock rip-rapped emergency overflows and a sheet pile weir to convey flows greater than the 100-year storm event into the SDI.

If the volume of water entering the SDI via the emergency overflow exceeded the SDI's storage capacity, the excess water would be conveyed out of the SDI through the weir and channel back into Wightman Fork via the spillway.

The downstream Wightman Fork channel improvements involved the installation of two 10'-8" x 16'-9" aluminum arch pipe culverts set on a concrete foundation with concrete inlet and outlet headwalls. These aluminum arch culverts replaced four 36-inch diameter corrugated high density polyethylene (HDPE) pipes.

The previous WFD return channel was essentially a rock rundown with no definable channel shape. As a result, higher flows were not fully contained, which resulted in some areas of erosion. Construction activities included the removal of existing rip-rap, excavation of the

channel to design depths, lining of the channel with geotextile fabric, and re-placement of rip-rap.

7.5.1.5 Penstock and Power House

EPA secured funding to design and construct a penstock and powerhouse to direct flows from Wightman Fork to power a microhydro turbine. The turbine will provide supplemental power for the future WTP. Construction on the penstock began in 2008. The project is scheduled for completion in 2010 with the installation of the turbine in the powerhouse.

The penstock includes an intake structure on Wightman Fork upstream of the aluminum arch culverts and pipeline to carry water to the powerhouse located downstream of the SDI embankment and plunge pool. The penstock consists of a 16-inch HDPE pipe from the intake structure to the downstream channel crossing inlet headwall where it changes to 16-inch steel pipe. A secondary containment pipe consisting of a 24 inch PVC pipe is installed around the HDPE pipe. This secondary pipe adds protection for the SDI dam should the inner pipe rupture or leak and cause erosion of the dam embankment.

7.5.1.6 Sludge Disposal Repository

The exiting disposal area for the sludge generated by the WTP was constructed on the south mine pit in 1995. The disposal area has a footprint of about 2 acres, or approximately 87,120 square feet. Runoff from the sludge disposal area is contained by a dike and routed to the SDI via a pipeline.

From 2005 through 2009, the existing WTP treated approximately 1,520 million gallons of water and generated approximately 500,000 cubic feet of sludge (Table 7-13). These totals correlate to an average rate of 332 cubic feet of sludge generated for every million gallons of treated water.

Table 7-13: Summary of Water Treated and Sludge Generated, 2005-2009

<i>Year</i>	<i>Volume Treated (million gallons)</i>	<i>Sludge Generated (cubic feet)</i>
2005	298	140,900
2006	244	67,900
2007	356	126,700
2008	322	97,900
2009	300	70,500

The 500,000 cubic feet of sludge was disposed of at the onsite disposal area. Spread evenly over the 2 acre footprint of the disposal area, this volume of sludge would be approximately 5.8 feet thick. For the 5 year period of data evaluated, this represents a disposal rate of about 1.2 feet per year over the footprint of the disposal area.

It is not known how much airspace remains at the existing sludge disposal area. Consequently, the airspace reserve, or remaining service life of the existing facility cannot be estimated. The OU5 ROD included the construction of an engineered sludge disposal repository on the north pit.

7.5.1.7 *Mine Pool Management*

The OU5 ROD called for maintaining the mine pool at a maximum elevation below the Chandler Adit. The objective of managing the mine pool is to reduce the generation of acid mine drainage by (1) eliminating the fluctuation of the mine pool level thereby minimizing the contact of the mine pool and adjacent groundwater with the oxidized ore zone and wastes disposed in the mine pits (Figure 7-1), (2) reducing the hydraulic gradient thereby decreasing the discharge from seeps and springs, particularly in the Chandler Bowl area (RMC, 2001a), and potentially decreasing the underflow to Wightman Fork (Figure 7-11) and (3) eliminating the seasonal discharge from unplugged adits above the elevation of the Chandler Adit (e.g., Ida Adit, Dexter Adit).

Since 2005, only short duration releases from the mine pool have occurred to permit sampling from the Reynolds Adit pipeline and to test the function of the valves during the adit inspection. Therefore, the mine pool elevation has fluctuated over the past five years. The elevation of the mine pool since 2000, is shown in Figure 7-1. Absent releases, the elevation of the mine pool has risen above the base of the north mine pit for an extended period each year since 2003. However, the elevation of the mine pool only rises above the base of the south mine pit every few years (e.g., 2001, 2005 and 2007), and then only for a short (less than two month) period.

The new water treatment plant and an 11% increase in SDI storage will provide additional capacity. This added capacity may allow releases from the mine pool to be conducted to maintain a lower mine pool elevation. However, such releases would need to be balanced with the desire and necessity to “turnout” surface water.

Additionally, the future disposition of the mine pool has implications on the long-term maintenance requirements of the Reynolds and Chandler adits and plugs. The Chandler Adit plug is currently inaccessible due to a collapse at the portal during the winter of 2006/2007.

7.5.1.8 *Adit Rehabilitation*

The plugs in the Reynolds and Chandler adits were installed during the winter 1994, and the Chandler Adit plug was lengthened in the spring 1995 from 10 to 18 feet due to bulkhead failure. Consequently, both plugs are in the middle of their second decade of service. Timbers were replaced in both adits in 1995 and again in 2000.

A detailed inspection of both the Reynolds and Chandler adits was performed in July 2005 and annual inspections have been conducted every summer since 2005¹². Conditions inside both adits have progressively deteriorated between each inspection. Overall, the access and drainage in the Reynolds Adit is fair. The amount of water within each adit fluctuates yearly and is largely dependent on snowpack. The bulkheads in both adits are in good condition based upon their most recent inspection. The Reynolds Adit pipeline is in working order with the exception that the bulkhead valve has a small leak (<5 gpm). The portal valve on the Reynolds Adit pipeline is operational; however, the operation of the bulkhead valves are questionable. The shaft on the manual bulkhead valve is no longer operational and the actuator of the remotely

¹² The Chandler Adit portal collapsed in the winter of 2006/2007 making the adit inaccessible for inspections from 2007 through 2009.

operated valve is highly corroded and may not be functional. The timbers in both adits are showing signs of aging. The timbers and lagging are deteriorating and the foundations of many of the posts are starting to decay. There are numerous stretches of poor quality timber in the Reynolds Adit and, to a lesser extent, in the Chandler Adit (as observed through 2006). The deteriorating condition of support timbers and lagging within the Reynolds Adit continues to promote ground loss. Adit inspection reports are contained in Appendix D.

CPDHE issued a Request for Qualifications in April 2010 for the design and construction oversight of the Reynolds and Chandler adits improvement project. The tentative schedule for the project is summarized below:

- July 2010: Design contract awarded.
- September 2010 through February 2011: Design and construction documents completed.
- Late Summer 2011: Construction contract awarded.
- FY 2011: Construction.

7.5.2 Remedy Performance, 2005-2009

The onsite environmental monitoring program consists of the weekly or monthly water sampling of key locations throughout the site by Golder. Additional monitoring is performed during the spring run-off period to guide decisions on the configuration of ditch turnouts. Onsite monitoring locations sampled during 2009 are illustrated in Figure 4-2. Additionally, onsite groundwater and seep sampling was performed in July 2009 by Tetra Tech.

Offsite environmental surface water sampling is conducted twice a year (spring and fall) at eight locations from the boundary (Station WF5.5) to Terrace Reservoir. Terrace Reservoir sampling includes the collection of zooplankton samples for identification and copper analyses, as well as annual fish gill netting. Additional monitoring is performed once every five years along Wightman Fork and the Alamosa River to assess macroinvertebrate health, perform stream habitat surveys, and collect fluvial sediment samples.

7.5.2.1 Onsite Monitoring Program

This section will primarily focus on the results of samples collected at the site downstream boundary, Wightman Fork monitoring location WF5.5 (Figure 4-2). Additionally, an overview of the onsite groundwater and seep sampling will be presented.

7.5.2.1.1 Surface Water Monitoring

Historical copper and aluminum concentration data measured at WF5.5 are summarized in the box-whisker plots provided in Figures 7-14 and 7-15, respectively. Noted on the time scale on these figures are significant milestones in the site remediation. The largest improvement in water quality at WF5.5 occurred following the installation of the Reynolds and Chandler Adit plugs in 1994 and 1995. Additional improvements were realized following the consolidation of surface water flows to the SDI and centralized water treatment at the interim WTP in 1996.

Continued work on site-wide reclamation (OU4) activities through 2003 resulted in gradual improvements in water quality.

Remediation goals for select water quality parameters were published in the 2001 ROD for station WF5.5 and apply to times when the WTP is operating and discharging to Wightman Fork (Table 4-1). Water quality data for WF5.5 from 2005 through 2009 are compared to the remediation goals for both low and high flow (Table 7-14).

**Table 7-14: Percent of Samples Achieving OU5 ROD Remediation Levels at WF5.5
2005 - 2009**

<i>Parameter</i>	<i>Low Flow Regime</i>			<i>High Flow Regime</i>		
	<i>Remediation Level (mg/L)</i>	<i>Number of Samples</i>	<i>Percent Achievement</i>	<i>Remediation Level (mg/L)</i>	<i>Number of Samples</i>	<i>Percent Achievement</i>
Aluminum	5	125	16%	5	50	78%
Cadmium	0.002	4	0%	0.014	4	100%
Copper	0.035/0.4	125	0% / 14%	1.55	50	100%
Iron	25	39	100%	55	27	100%
Manganese	15	39	100%	22	27	100%
Zinc	2.8	39	100%	2.45	27	100%
pH (minimum)	6.6	123	0%	5.1	47	74%

Notes:

1. Low flow defined as period July through April.
2. High flow defined as months of May and June.
3. Parameters as total or total recoverable form.
4. Remedial levels in mg/L except pH, which is in standard units.
5. Geochemical modeling performed in support of the ROD predicted that if the pH of the Alamosa River upstream of Wightman Fork is between 5 and 6 during low flow, then the copper remediation level could be in the range of 0.2 to 0.4 mg/L. However, if the pH of the Upper Alamosa River is closer to a value of 4, a remediation level of 0.035 mg/L is more appropriate.

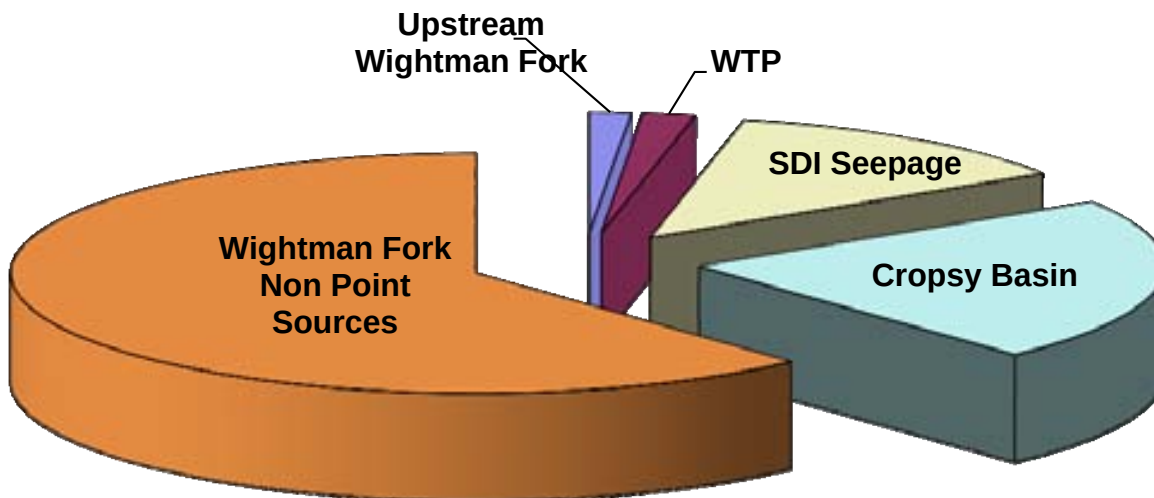
The concentrations of iron, manganese and zinc met (i.e., were less than) their respective remediation goals in all samples (100% attainment). Of the remaining four parameters, attainment of remediation goals occurred more frequently under high flow conditions than under low flow. For aluminum, the remediation goal was attained in 78 percent of the high flow samples; but only 16 percent of the low flow samples. Cadmium concentrations attained the remediation goal in 100 percent of the high flow samples and zero attainment of the low flow samples. Copper concentrations attained the remediation goal in 100 percent of the high flow samples, but only 14 percent of the low flow samples (based on the 0.4 mg/L remediation level). The pH of the WF5.5 samples achieved the remediation goal in 74 percent of the high flow samples; there was zero attainment of the pH remediation goal under low flow conditions.

With the completion of site-wide reclamation (OU4), the majority of the point source discharges to Wightman Fork have been addressed. The remaining point sources include:

- WTP effluent discharge (Station WTP-DIS)
- SDI embankment seepage (non-point seepage channeled through Station SDI-TOECHAN)
- Cropsy Creek (Station CC-5)

These point source discharge locations are illustrated on Figure 4-2. As discussed above, copper concentrations rarely meet the WF5.5 remediation goals under low flow conditions (Table 7-14). Evaluation of surface water data collected along Wightman Fork from 2005 through 2009 indicates that the majority of copper loading from the Site (62 percent) originates as non-point source loading, predominately in the stretch from WF1.5 to WF2.5 (springs NWDUS and AXON account for 70 percent of this non-point source loading, and 40 percent of the copper load at WF5.5). The three point sources identified above account for a combined 37 percent of the Site's copper load (WTP-DIS = 2 percent; SDI-TOECHAN = 13 percent; CC-5 = 22 percent) with the Wightman Fork basin upstream of the Site contributing one percent. The relative contributions of the copper loading sources in Wightman Fork from 2005 through 2009 are illustrated in Figure 7-16. Loading tables for copper along Wightman Fork from 2005 through 2009 are provided in Appendix F.

Figure 7-16: Copper Loading Sources in Wightman Fork, 2005 - 2009



Note: Based on 5-year average total copper load of 25.8 lbs/day at WF5.5

7.5.2.1.2 Groundwater and Seep Monitoring

Monitoring wells and seeps were sampled during July 2009. The locations are shown on Figure 7-17. Review of the analytical results indicates that dissolved copper concentrations are representative of overall onsite water quality. Graphs of dissolved copper concentration versus time are presented in Appendix E.

Interpretation of the data indicates the following:

- Groundwater in the area of the NWD is relatively low in copper, generally less than 4 mg/L. Seeps in the area of the NWD show a decline in copper but remain relatively high in the range of 15 to 40 mg/L.
- Wells in the area of the mine pits produce a wide range in copper concentrations from groundwater impacted by mining to groundwater with little or no impact from mining. Wells ABCMW-1 and BORMW-2 are low in copper ranging from less than 1 mg/L to 5 mg/L. These wells may be representative of the range of background with some seasonal impacts from mining. ABCMW-2 and ECCMW-2 copper levels range from about 90 to 180 mg/L. These wells are impacted by past mining operations. Concentrations in these wells show a decreasing trend with time but appear to be stabilizing at concentrations of about 100 to 200 mg/L.
- Virtually all seeps in the area of the Chandler Bowl, Missionary Seeps, and Wetlands are high in copper generally range from approximately 20 mg/L to approximately 50

mg/L. While the concentrations may be declining over time, the concentrations are stabilizing in the range of 20 to 50 mg/L.

The above information correlates well with surface water data in Wightman Fork (Figures 7-14 and 7-15). Given the stability of the copper concentrations over time in both the monitoring wells and the seeps, the non-point source loads to on-site seeps and to Wightman Fork will continue.

7.5.2.2 *Offsite Monitoring Program*

In this section, data collected as part of the offsite monitoring program over the past five years will be presented and compared to previous data. Surface water metals concentrations are compared to State of Colorado surface water quality standards and excess loads will be quantified, where applicable. The annual Terrace Reservoir zooplankton sampling and fish gill netting programs are described. Additional monitoring is performed once every five years along Wightman Fork and the Alamosa River to assess macroinvertebrate health, perform stream habitat surveys, and collect fluvial sediment samples.

7.5.2.2.1 *Lower Wightman Fork, Alamosa River, and Terrace Reservoir Water Quality*

The offsite monitoring program encompasses eight stations and six stream segments that are illustrated on Figure 3-1 and summarized below:

- Segment 6: Stations WF5.5 and WF0.0¹³
- Segment 3a: Station AR45.5
- Segment 3b: Station AR43.6
- Segment 3c: Station AR41.2
- Segment 3d: Stations AR37.5 and AR34.5
- Segment 8: Station T1A, Terrace Reservoir

Surface water samples are collected sequentially in a downstream order based on estimated travel times between adjacent stations. Between 2005 and 2009, two sampling events were conducted annually during the spring snowmelt (near peak flow) and fall (base flow). Graphs illustrating copper concentrations from the Site (WF5.5) through Terrace Reservoir (TIA) for the period 2005 through 2009 are provided in Appendix F.

Yearly summaries of offsite surface water quality results from the Alamosa River and Terrace Reservoir compared to State of Colorado aquatic life standards for 2005 through 2009 are presented in Tables 7-15 through 7-19. Instances where the sample result exceeded the chronic (> Chronic) or acute (> Acute) aquatic life standards are noted on the tables. Blank cells indicate that sample concentrations were less than the applicable standard. Standards are either ambient standards that are fixed at a specified numerical value or table value standards some of which are calculated using hardness values. Modifications to the aluminum standards in the Alamosa River and Terrace Reservoir became effective December 31, 2007. Consequently, the information

¹³ No inorganic or metals numeric standards are available for Segment 6 (Wightman Fork).

presented in Tables 7-15 through 7-17 reflects much lower aluminum standards; whereas, the information presented in Table 7-18 and 7-19 relate to the higher aluminum standards that reflect naturally elevated background conditions.

The discussion of the water quality in the Alamosa River focuses on the aquatic risk driver, copper. Consistent with the OU5 ROD remedial action objectives, this discussion assesses the attainment of water quality criteria by copper in the Alamosa River Segment 3c and downstream (Figure 3-1).

As a result of remedial actions, copper concentrations in the Alamosa River have decreased over the past five years. This conclusion is supported by the following evidence:

- In Segment 3c (monitoring location AR41.2), the acute copper standard was exceeded during the 2005 and 2007 high flow events (Tables 7-15 and 7-17). However, copper concentrations only exceeded the chronic standard (Tables 7-18 and 7-19) the past two years during high flow.
- In the upper portion of Segment 3d (monitoring location AR37.5), the acute copper standard was exceeded during the 2005 high flow event (Table 7-15). However, copper concentrations only exceeded the chronic standard in two of the past four high flow events (Tables 7-16 through 7-19).
- In the upper portion of Segment 3d (monitoring location AR37.5), the acute copper standard was exceeded during the 2005 and 2006 low flow events (Tables 7-15 and 7-16). However, copper concentrations have been less than the chronic standard in the past three low flow events (Tables 7-17 through 7-19).
- Copper concentrations in the lower portion of Segment 3d (monitoring location AR34.5) were below the chronic standard under both the high and low flow regimes over the past five years (Tables 7-15 through 7-19).
- Copper concentrations have stabilized at low levels in Terrace Reservoir (Table 7-20). Only twice in the past 5 years (2005 and 2009) have copper concentrations exceeded the chronic standard, the most recent of which (Table 7-19) occurring in the sample collected from a depth of 80 feet (copper concentrations at depths of 5 and 30 feet being less than the chronic standard).

In spite of the improvement observed in water quality in the Alamosa River over the past five years, copper concentrations routinely exceed aquatic life standards in Segment 3c and, to a lesser extent, in the upper portion of Segment 3d. Construction of the new water treatment plant, management of the mine pool, collection of seepage from the SDI embankment, and optimization of the A3-1 ditch will improve the water quality of the Alamosa River.

7.5.2.2.2 Excess Copper Loads in the Alamosa River

While copper concentrations have decreased over the past five years, they continue to exceed the State of Colorado aquatic life standards in Segment 3c (AR41.2) (see graphs in Appendix F). The amount by which the copper load exceeds the chronic standard (termed “excess” copper load) is summarized in Table 7-21 by flow regime for 2005 through 2009.

Table 7-21: Excess Copper at Station AR41.2 (Segment 3c)

Year	Excess Copper at AR41.2 in Pounds/Day	
	High Flow (Spring Snowmelt)	Low Flow (fall)
2005	>Standard (see Note)	11.3
2006	<Standard	< Standard
2007	>Standard (see Note)	< Standard
2008	>Standard (see Note)	3.0
2009	>Standard (see Note)	4.3

Note: High runoff during the spring sampling event prevents manual flow measurements; therefore, no metal loading rates were calculated. However, copper concentrations exceeded the chronic standard under high flow conditions in 2005, 2007, 2008 and 2009.

Station AR37.5 is located near the upstream boundary of the Alamosa River stream segment 3d. The amount by which the copper load exceeds the chronic standard (termed “excess” copper load) at AR37.5 is summarized in Table 7-22 by flow regime for 2005 through 2009:

Table 7-22: Excess Copper at Station AR37.5 (Segment 3d)

Year	Excess Copper at AR37.5 in Pounds/Day	
	High Flow (Spring Snowmelt)	Low Flow (fall)
2005	14.5	6.2
2006	< Standard	4.6
2007	0.3	< Standard
2008	< Standard	< Standard
2009	0.3	< Standard

Because copper is not conservative, a one-pound per day reduction at the site boundary (monitoring location WF5.5) may not translate to a one-pound per day reduction in copper load in downstream segments. However, the excess mass of copper in the upper portion of Segment 3d was only 0.3 pounds per day in both 2007 and 2009 (Table 7-22) under high flow conditions. The additional storage and treatment capacity at the site as a result of raising the SDI spillway and WTP construction projects may be sufficient to capture excess spring (high flow) loads that result in these slight exceedances. For example, during the low snow pack year of 2006 (Figure 7-11) when the volume of water diverted off site was minimal, copper concentrations in Alamosa River segments 3c and 3d were below the chronic standard under the spring high flow regime. Copper load reduction from the Site will also be achieved through construction of the SDI embankment capture system, optimization of the A3-1 ditch and water management modifications implemented in the Cropsy basin. However, until mine pool management can be implemented, non-point source copper loading from the Site will continue to inhibit efforts to consistently meet water quality standards in the Alamosa River. As illustrated in Figure 7-16,

non-point sources originating from the mine pool are the dominant source of copper loading from the Site to Wightman Fork and, as illustrated in Figure 5-1, the Site is the principal source of copper in the Alamosa River basin.

7.5.2.2.3 Aquatic Life Monitoring

This section summarizes the aquatic life monitoring performed between 2005 and 2009. Aquatic life monitoring included zooplankton and fish sampling in Terrace Reservoir and macroinvertebrate sampling and habitat surveys in lower Wightman Fork and the Alamosa River.

Zooplankton Sampling

Zooplankton samples were collected in Terrace Reservoir during the spring and fall of each monitoring season in the vicinity of Station T1A. Results of the 2003 through 2009 zooplankton sampling are presented in Table 7-23. Results of zooplankton sampling in Terrace Reservoir indicate that zooplankton are more abundant during the fall than in the spring but the populations have fluctuated both in abundance and diversity from year to year.

Zooplankton are also analyzed for copper content during each sampling event when sufficient biomass is available. The measured tissue residue concentrations of copper in Terrace Reservoir zooplankton varies greatly from year to year and between flow regimes. Measured zooplankton tissue concentrations and corresponding near-surface copper concentrations are presented in Table 7-24. Increased levels of copper in the zooplankton tissue residue appear unrelated to dissolved copper levels in the reservoir and do not seem to have any effect on zooplankton population abundance. Data do not show a clear correlation between zooplankton tissue concentration, abundance or diversity, and the surface water copper concentration.

Fish Sampling

Fish sampling was performed by Tetra Tech in the fall of 2008 and 2009 following re-stocking of the reservoir by the Colorado Division of Wildlife (CDOW) beginning in 2007¹⁴. Results of the recent rainbow trout tissue metals analyses are presented in Table 7-25.

Table 7-25: Rainbow Trout Fillet Metal Concentrations

<i>Year</i>	<i>Mean Rainbow Trout Fillet Metal Concentrations (mg/kg)</i>				
	<i>Cadmium</i>	<i>Copper</i>	<i>Selenium</i>	<i>Mercury</i>	<i>Zinc</i>
September 2008	< 0.05	0.38	0.98	< 0.1	< 0.05
September 2009	< 0.05	0.26	0.74	< 0.1	8.75

Fish fillet cadmium, copper, selenium, and mercury concentrations have been stable or displayed a decreasing trend between 2008 and 2009. Between 2008 and 2009, zinc concentrations significantly increased.

¹⁴ Terrace Reservoir was drained in 2003 to facilitate repairs to the outlet works. It is likely that fish stocked by the CDOW (and sampled by Tetra Tech in 2001 and 2002) did not survive the draining of the reservoir.

Terrace Reservoir is stocked on an annual basis by the CDOW with trout averaging 8.4 cm in length (Walsh Aquatic, 2010). Based on the increase in average fish weight and length, fish may be surviving from year to year in the reservoir (Table 7-26) but, due to the small population netted in 2008, continued monitoring will be required to confirm this.

Table 7-26: Rainbow Trout Physical Characteristics

<i>Event</i>	<i>Mean Rainbow Trout Characteristics</i>		
	<i>Weight (g)</i>	<i>Length (cm)</i>	<i>Count</i>
September 2008	100	20	6
September 2009	186	25	143

Macroinvertebrate Sampling

Macroinvertebrate sampling was performed in Wightman Fork and the Alamosa River in the fall 2009. Sampling was conducted to compare the relative diversity and abundance of macroinvertebrate taxa at various sample locations in lower Wightman Fork and along the Alamosa River. A comparison of macroinvertebrates taxa and total count measured during fall 2009 versus those observed during a fall 2000 survey are presented in Table 7-27:

Table 7-27: Summary of Macroinvertebrate Abundance and Diversity in the Alamosa River, 2000 and 2009

<i>Year</i>	<i>Macroinvertebrate Statistics (Taxa / Total Count)</i>					
	<i>WF0.0</i>	<i>AR45.5</i>	<i>AR43.6</i>	<i>AR41.2</i>	<i>AR37.5</i>	<i>AR34.5</i>
2000	---	1 / 1	1 / 8	3 / 164	4 / 78	4 / 75
2009	2 / 7	0 / 0	1 / 25	1 / 3	3 / 20	7 / 19

Note: "----" indicates location was not sampled.

In both 2000 and 2009, a low number of taxa and total macroinvertebrates is evident at all locations. In general, macroinvertebrate abundance and diversity increases downstream of Wightman Fork. The lowest macroinvertebrate abundance and diversity is present upstream of Wightman Fork (AR 45.5), where natural conditions severely impact aquatic life in the Alamosa River.

Physical Habitat Monitoring

Physical habitat monitoring was performed in the falls of 2000 and 2009. Monitoring was conducted to assess the overall habitat quality at various stations in lower Wightman Fork and along the Alamosa River. A qualitative comparison of the physical habitat monitoring results is provided Table 7-28.

Table 7-28: Summary of Physical Habitat in the Alamosa River, 2000 and 2009

<i>Year</i>	<i>Qualitative Habitat Quality Parameter Scores (Score / Percent of Max)</i>					
	<i>WF0.0</i>	<i>AR45.5</i>	<i>AR43.6</i>	<i>AR41.2</i>	<i>AR37.5</i>	<i>AR34.5</i>
2000	---	141 71%	154 77%	141 71%	155 78%	165 83%
2009	153 76%	146 73%	145 72%	124 62%	137 68%	121 60%

Note: Maximum habitat quality parameter score is 200.

The habitat quality at upper Alamosa River Stations AR45.5 and AR43.6 assessed in 2009 remains relatively equal to that observed in 2000. However, the quality present at Stations AR41.2, AR37.5 and AR34.5 appears to have decreased somewhat over the past decade.

7.5.2.2.4 *Fluvial Sediment Sampling*

Fluvial sediment sampling was performed in the lower Wightman Fork/Alamosa River system in October 2009 as part of the five-year review. Historically, fluvial sediment samples were collected at various times in 1994, 2000, and 2001. Fluvial sediment analytical results from these various events are summarized in Table 7-29.

The concentrations of the metallic contaminants of concerns (copper, iron and zinc) have decreased over the past decade at the mouth of Wightman Fork and in the Alamosa River downstream of the confluence. With few exceptions, the concentrations of other metals (aluminum, manganese and zinc) have also decreased in the past decade in and downstream of Wightman Fork. Cadmium levels remain low, but appear to have increased somewhat over historical levels with the largest increase occurring in the Alamosa River upstream of the confluence with Wightman Fork (monitoring location AR45.5).

7.5.3 *Questions*

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

No, but there are substantial final remedy elements that have not been completed. Specifically, the storage capacity of the SDI will be increased in 2010 and a new water treatment plant will be commissioned in 2012. It is likely that additional O&M improvements will continue to be necessary along Wightman Fork near the North Waste Dump, Chandler Bowl, and Missionary Seeps to capture and treat non-point source flows. As indicated in Table 7-5, the erosion and transport of sediment off the Site has been greatly reduced. The placement of cover soils and revegetation success (Appendix B) has similarly reduced airborne (dust) emissions from the Site.

Question B: *Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?*

Yes. There have been no significant changes in pathways or receptors, on or off the site.

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

Yes. Non-point source loads in Wightman Fork are not completely captured by the groundwater interceptor drains. Additional work will be required to evaluate this source and develop an optimization plan (if not addressed by mine pool management and/or treatment).

8.0 ISSUES

Some issues have arisen since the publication of the ROD and construction of select components at the site. Most of the issues discussed in this section were described in the second five-year review in 2005. The status of the 2005 issues is summarized in Table 5-2 and, for those ongoing issues, their status is updated in this section. The current/future affect of these issues is summarized in Table 8-1.

8.1 OU4 Site-Wide Reclamation Assumptions

The U.S. Bureau of Reclamation (BOR) assumed that the OU4 site-wide reclamation efforts would be, at best, 95 percent effective (BOR, 1998). Based on this postulation, the alternatives developed in the FS (RMC, 2001b) assumed that the Highwall basin (Basin D on Figure 4-3) and the basin immediately adjacent to the SDI (the Beaver Mud Dump) would be the only portion of the site that would contribute water to the existing SDI for storage prior to treatment. Further, based on the timing (60-days) and the volume (136 million gallons) of water generated from the combined 68 acres in these two areas during the critical design snow melt period, a 1,000 gpm (1.44 MGD) capacity was assumed sufficient for the design of a future WTP (RMC, 2001b).

The reduction in surface water metals loading from areas remediated under OU4 has been less than anticipated. As described in Section 7.4.1.2.1, copper concentrations in the ditches draining water from the majority of the A basin and the C basin (Figure 4-3) exceed the WF5.5 remediation goals for at least a portion of the year. As a result, water generated from a larger portion of the Site than envisioned in the sizing of the storage and treatment facilities in the FS (RMC, 2001b) and carried forward into the ROD (CDPHE, 2001) has been directed to the SDI over the past five years.

The A basin (Figure 4-3) contains approximately 211 acres. In the FS (RMC, 2001b), only the 19 acres of the A basin (9 percent) immediately adjacent to the SDI were assumed to contribute water to the SDI for the purposes of sizing future Site contaminated water storage and treatment facilities. As discussed in Section 7, over the past five years only water originating in that portion of the A basin upstream of the A2-1 and A2-2 turnouts (Figures 4-2 and 4-3) has been judged to be of sufficient quality to consistently discharge offsite. The portion of the A basin tributary to the A2-1 and A2-2 turnout structures totals approximately 37 acres. Consequently, water originating from the remaining 174 acres of the A basin (82 percent) has been directed to the SDI for storage and treatment over the past five years.

The C basin (Figure 4-3) contains approximately 118 acres. In the FS (RMC, 2001b), water generated from this entire basin was assumed to be directed off the Site for the purposes of sizing future Site contaminated water storage and treatment facilities. As discussed in Section 7, over the past five years water originating in the C basin has been judged to be not of sufficient quality to discharge offsite for a portion of each year and, consequently, this water has also been directed to the SDI for storage and treatment.

In summary, the sizing of the contaminated water storage and treatment facilities developed in the FS (RMC, 2001b) and selected in the OU5 ROD (CDPHE, 2001) was based on the

assumption that the OU4 site-wide reclamation efforts would result in water of sufficient quality to be discharged from the majority of the site without storage and treatment during the critical 30-day snow melt period. Only water generated from 68 acres was assumed to be stored and treated. In practice, because the mine pool has not been managed, water generated from an additional 174 to 292 acres at the Site has been directed to the SDI for storage and treatment. Over the past three years¹⁵ the volume of water directed to the SDI from these additional areas in the A and C Basins has ranged from 130 million gallons to 160 million gallons¹⁶.

8.2 Interim Water Treatment Plant and SDI Storage Capacity

The WTP and several site facilities were constructed as temporary structures when implementing the interim ROD for OU0. These facilities were not intended to be permanent, though they have been operating for approximately 15 years. Significant upgrades were made to the WTP over the past five years to address safety concerns and to improve efficiency. The result of this investment has been an increase in the treatment rate from 1,000 gpm to 1,400 gpm and enhancing worker safety while still meeting discharge goals. The new water treatment plant construction is anticipated to be finished in fall 2011, with plant commissioning in 2012. Therefore, the existing plant may have to operate for at least two more seasons; 2010 and 2011.

Historically the combined SDI storage capacity and WTP treatment rate has been insufficient to treat the volume of water generated at the site during the spring snowmelt. Consequently, releases of untreated waters were required to prevent overtopping of the SDI spillway even under below average snowpack years (Figure 7-13). Prior to the construction of the ditch turnouts, these releases were made from the SDI via the outlet works. Since their construction in 2003, these releases have been made via the ditch turnout structures. With the raising of the SDI spillway in 2010 and the new treatment plant coming online in 2012, the storage/treatment capacity during the critical 30-day snowmelt period will be increased by approximately 18.6 million gallons. Review of the previous five years data suggests that, had this increased capacity been available, unplanned releases would not have been required in two of these years, and releases in the other three years could have been reduced between 25 and 75 percent during snow melt periods. An additional turnout structure, A3-1 DITCH-TO, was constructed at the site in 2008 to provide more flexibility in the site's water management plan. However, to date water quality has not been adequate to allow diversion of water off site at the A3-1 ditch turnout structure (Figure 7-8).

The volume of water contained in the underground workings that are connected to the Reynolds Adit has ranged from 6.5 million to 13.8 million gallons over the past five years based on the annual fluctuation of the mine pool (Figure 7-1). However, an additional 48 million gallons of water are estimated to be contained in the bedrock that is connected to the mine workings at the Reynolds Adit level (RMC, 2001a). This connection was demonstrated during the short term drawdown test performed in 2000, when release of 12 million gallons of water resulted in the cone of depression illustrated in Figure 9-1. During 2003, mine pool releases were made with the objective of maintaining the mine pool elevation at the Chandler Adit. Releases started on

¹⁵ Data from 2005 and 2006 were incomplete.

¹⁶ During the time when monitoring occurred, generally from April through October.

June 17, after the peak runoff, and continued for 86 days until September 11. Releases totaling 17.1 million gallons of water were made in 2003. At the Chandler Adit level, the combined volume of water in the mine workings and connected bedrock is estimated to be approximately 30 million gallons.

The added SDI and WTP capacity noted above could treat the approximately 30 million gallons of water in mine workings/bedrock in about 1 ½ months time (note that 30 million gallons is equivalent to 1/3 of the existing SDI capacity and also represents approximately 10 percent of the five-year average quantity of water treated by the WTP). Management of the mine pool at an elevation below that of the Chandler Adit would require releases between 30 million and 62 million gallons of water annually. The volume of the mine pool increases rapidly in the late-spring and early summer months (Figure 7-1) at about the same time that the SDI is at its fullest and the WTP is operating at maximum capacity (Figure 7-12). Management of the Site water with the added storage and treatment capacity will provide operational data that can be used to assist in the development of the Mine Pool Management Plan.

In summary, with the raise of the SDI spillway completed in 2010 and the new water treatment plant commissioned in 2012 the protectiveness of the OU0 remedy will be enhanced (Table 5-2). Until then, the aging infrastructure of the existing plant and the shortage in water storage/treatment capacity may impact the protectiveness of the snowpack dependent remedy. However, even with the increased storage and treatment capacity, only water flowing to the SDI will be stored and treated. During spring runoff that volume of water judged to be in excess of the SDI capacity will be managed by routing it offsite. Additionally, groundwater underflow will continue to contribute non-point source loads to Wightman Fork until such time that mine pool management can be implemented. Until these additional sources can be stored, treated, or otherwise reduced, it is likely that water quality standards will continue to be exceeded in the Alamosa River.

8.3 Non-Point Source Contaminant Loading

Current point sources contributing to contaminant loads in Wightman Fork and the Alamosa River are limited to the Water Treatment Plant effluent discharge and the ditch turnout structures. Despite the large reduction in point source loading from the site, remediation goals for copper have not been met at WF5.5 under low flow conditions (Table 7-14) primarily as a result of non-point source loading. The persistent non-point source loads from the Site are:

- Groundwater underflow to Wightman Fork in the stretch between WF1.5 and WF2.5;
- Seepage from the SDI embankment; and
- The Cropsy Creek basin within the site boundary.

These non-point source loads were identified as issues in the previous five-year review. These locations are shown on Figure 4-2.

In addition to the offsite impacts, non-point seepage also impacts water management on-site. This is particularly evident in the lower elevations along the northern margin of the Site from just west of the A3-Ditch Turnout, through the Chandler Bowl, to the Missionary Seeps, or from

about seep sample locations SA2 through MS-T shown on Figure 7-17. Seepage in this area has prevented the establishment of vegetative cover in the Chandler Bowl (see Figure 5 in Appendix B), leading to increased sediment yield which blocks infiltration into the groundwater interceptor drains and silts in the SDI (taking away storage capacity). Seepage upstream of the A3-Ditch Turnout degrades water quality to the point that CDPHE cannot utilize this structure to divert water offsite. Seepage throughout the eastern half of Basin A also leads to the development of ferricrete deposits at the surface, again inhibiting infiltration of water into the interceptor drain systems.

8.3.1 Groundwater Underflow to Wightman Fork Adjacent to the NWD

Non-point source metals loading to Wightman Fork occurs in the reach starting approximately 500 feet downstream of confluence with Pipeline Creek. Diffuse metals loading occurs throughout the next approximately 1,000 feet down to monitoring location WF2.5 (Figure 4-2). Tracer injection tests performed by the USGS determined that the majority of the loading entered Wightman Fork near the upper end of this reach. Monitoring from 2005 through 2009 continues to support the USGS findings, with approximately two-thirds of the copper loading between WF1.5 and WF2.5 entering in the stretch above WF2.

Copper concentrations measured at WF2 are illustrated in Figure 7-11. One of the objectives of the construction of the interceptor drains along the toe of the NWD and Chandler Bowl was to reduce groundwater loading to Wightman Fork through this reach. Comparing 2009 (snow pack = 106% of normal) to 2001 data (snow pack = 108% of normal), there appears to be a decrease in copper concentration at WF2 (Figure 7-11). However, this area remains the largest non-point source of metals loading to Wightman Fork (Section 7.5.2.1.1). Springs NWDUS and AXON are located in this area (Figure 4-2) and, combined, contribute approximately 40 percent of the copper load observed in Wightman Fork at the Site boundary (WF5.5). Over the period 2005 through 2009, total copper concentrations from these two seeps have averaged approximately 20 mg/L to 24 mg/L (Appendix F) compared to the maximum (high flow) WF5.5 copper remediation level of 1.55 mg/L (Table 4-1).

8.3.2 Seepage from the SDI

Non-point source metals loading to Wightman Fork occurs as a result of seepage through the SDI embankment. Seepage is channeled from the base of the embankment and joins Wightman Fork above monitoring location WF5.5. The seepage from the SDI embankment is measured at location SDI-TOECHAN (Figure 4-2). Additional subsurface seepage may also be present. Seepage rates are greatest when the SDI is full but, on average, accounts for more than ten percent of the total copper loading from the Site (Figure 7-16).

Recognizing the deleterious impact of the SDI embankment seepage on copper concentrations in Wightman Fork and the Alamosa River, CDPHE included the capture of this seepage in the scope of the WFD and SDI improvements project, which began in 2008. Results from the design investigations performed during the early stages of this project indicated that the bedrock elevation conditions near the toe of the SDI embankment were significantly different than expected. Therefore, the capture of this seepage would require a redesign and a more expensive

remedial action than envisioned when funding for the project was secured. Consequently, the design and construction of the SDI embankment seepage system was tabled pending additional funding. CDPHE has included funding to complete the SDI seepage work in the FY 2011 O&M budget request to EPA.

8.3.3 Cropsy Creek Basin

Cropsy Creek flows into Wightman Fork just upstream of monitoring location WF5.5. Cropsy Creek discharge into Wightman Fork is monitored at location CC-5 (Figure 4-2). This entire basin (subbasin B in Figure 4-3) is turned out to Wightman Fork all the time. The upper Cropsy Creek basin contains mineralized waste piles from legacy mines above the site. Water entering from the upper Cropsy Creek basin is monitored at CC-1. Water can also be imported into the Cropsy Creek basin from the mine pits area (subbasin C in Figure 4-3) through the L3-1/L-DITCH TO location when this water is “turned out” (i.e., it does not flow to the SDI).

As discussed in Section 7.5.2.1.1, on average the Cropsy basin provides more than 20 percent of the copper load measured at WF5.5 (Figure 7-16). Sources of this load origination with the Site include seepage in the basin upgradient of the HLP and quartz latite exposed in the Campbell Quarry.

8.3.4 Summary

The status of the three non-point source loading sources is presented in Table 5-2. In summary, groundwater underflow to Wightman Fork along the stretch adjacent to the NWD (Section 8.2.1) will continue to affect the protectiveness of the OU5 remedy until such time that mine pool management can be initiated. Non-point seepage related to the mine pool also impacts water management on-site in the form of unsuccessful revegetation efforts in the Chandler Bowl (see Figure 5 in Appendix B), degraded water at the A3-Ditch Turnout structure which inhibits its use, and increased sediment yield (due to lack of vegetation) that impacts the efficiency of the interceptor drains (and increases O&M costs) and consumes water storage space in the SDI. The CDPHE has requested funding to design and install the SDI seepage capture system and to direct seepage downstream of the A3-Ditch Turnout. Until funding is secure and this non-point source curtailed through engineering controls, seepage from the SDI embankment will continue to affect the protectiveness of the OU5 remedy. Finally, the small non-point source loading from the Cropsy Creek basin was addressed in 2010 by redirecting water from the upper basin back into the Cropsy Creek Division, which will reduce flow through the site (Table 5-2). Additionally, future reclamation of the Campbell Quarry is being considered. These actions will increase the protectiveness of OU4 specific to the Cropsy Valley.

8.4 Mine Pool Management

Management of the mine pool is a key component of the Selected Remedy. The objective of this component is to maintain the elevation of the mini pool below the Chandler Adit to remove point sources from the Dexter, Ida, and Chandler Adits, non-point seepage in the Chandler Bowl and adjacent areas, and non-point source loading to Wightman Fork, and to cease the inundation of mine wastes placed in the mine pits under OU2. The historic elevation of the mine pool is illustrated in Figure 7-1. Absent releases from the mine pool, mine wastes in the north mine pit

become saturated for an extended period each year. Mine wastes in the south mine pit (which is approximately 100 feet in elevation above the north mine pit) only become saturated every few years (e.g., 2001, 2005 and 2007) and then only for a short period. AMD generated within the north mine pit likely migrates into the adjacent bedrock daylighting as seepage in the Chandler Bowl and eventually contributing to copper loads in Wightman Fork. Figure 8-1 provides a conceptual cross-section of South Mountain and illustrates the relationship of select underground features at the Site to the Chandler Bowl and Wightman Fork.

Two unplugged adits, Ida and Dexter, are located approximately 105 feet in elevation above Chandler Adit. The Ida Adit portal is located on a slope just southeast of Chandler Adit. Although covered during OU4 reclamation activities, AMD emanates from the general location of the Ida Adit portal when the mine pool reaches the elevation of this adit. This AMD flows over the reclaimed hillside until it encounters the site ditch system where it is captured and routed to the SDI. However, the slope below the Ida Adit is eroded and devoid of vegetation. Dexter Adit was completely buried during the OU4 reclamation activities, and is in a protected location where snow drifts linger late into the season. Consequently, flow that can be credited to Dexter Adit has not been observed in several years. However, like the Ida Adit, it can reasonably be assumed that the flow emanates from the Dexter Adit portal when the mine pool reaches an elevation above the adit.

Mine pool releases during the early 2000s demonstrated that water levels in wells adjacent to the mine pits quickly decreased in response to lowering the elevation of the mine pool. In addition, flow from seeps in the Chandler Bowl and other adjacent areas that are topographically below the elevation of the Chandler Adit decreased in response to lowering of the mine pool. Copper concentrations measured at WF2 were also much lower prior to the plugging of the Reynolds and Chandler Adits (Figure 7-11). This information suggests that maintaining the mine pool at an elevation below that of the Chandler Adit would likely decrease non-point source loads in Wightman Fork. Maintaining a lower mine pool elevation would, however, require continuous releases of water through the Reynolds Adit pipeline or via another mechanism. Other mechanisms to dewater the mine pool (e.g., horizontal boring, vertical well) will be evaluated during the alternatives evaluation performed for the upcoming adit rehabilitation project (Section 7.5.1.8).

A mine pool management plan that involves continuous releases cannot be implemented until there is additional capacity in the SDI and treatment plants. A revised site-wide water balance will be required. Completion of the Reynolds Adit rehabilitation project also plays a crucial role in the future management of the mine pool.

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

This section provides a discussion of recommendations and follow-up actions that could occur at the site or in the Alamosa River basin downstream of the site. These recommendations and follow-up actions are summarized in Table 9-1 and address the issues identified in Section 8 and also lay the foundation to collect data and information for the performance of the next five-year review in 2015.

9.1 Recommendations

This section describes actions that could be taken on specific items to either increase the protectiveness or assess the cost-effectiveness of a remedy.

1. The Site water balance should be updated to reflect the new WTP design capacity and the storage capacity gained in the SDI following the spillway raise.
2. Funding to complete the design and construction of the SDI embankment seepage collection and pumpback system should be secured to reduce the copper loading from this source.
3. Efforts to refine water management in the Cropsy basin should continue to reduce the copper loading from this area. This could include minimizing the contact of Ditch R water with AMD producing rock in the Campbell Quarry.
4. Funding to construct a system to route AMD seepage from upstream to downstream of the A3-Ditch Turnout should be secured. Improvement of water quality at this location will provide the CDPHE with additional options to manage Site surface water.
5. Continue to evaluate measures to revegetate the Chandler Bowl. Successful revegetation may decrease sediment production from this area which has impacted the efficiency and effectiveness of the Site's water management system.
6. Develop a strategy for management of the mine pool. Mine pool management will decrease non-point source loading to Wightman Fork, which will reduce copper concentrations in the Alamosa River. Mine pool management will also improve the CDPHE's ability to revegetate the Chandler Bowl.
7. Continue the annual monitoring of Site and offsite media. This information will be utilized during the next five-year review to assess the protectiveness of the final remedy following the implementation of the above recommendations.

9.2 Follow-up Actions for the Next Five-Year Review Period

In addition to the recommendations described in Section 9.1 that specifically lower the risk posed by the site, these general actions could be considered prior to the next Five-Year Review in 2015:

1. Evaluate the remaining capacity of the existing sludge disposal repository. If additional capacity is needed within the next five years, solicit proposals for design and construction of new facility
2. Commission the new WTP.

3. Evaluate the site remediation levels (goals) at WF5.5 to reflect the current aluminum standards.
4. Continue to explore remedies that might result in permanent, passive or semi-passive control of contaminant sources as these technologies continue to evolve.

Other follow-up items that EPA and CDPHE will review and discuss further include:

1. Status of existing WTP following commissioning of the new WTP.
2. Removal of fluid from the HLP to enhance the long-term protectiveness of the OU1 remedy.
3. Restore access to the Chandler Adit to increase flexibility in Mine Pool Management.
4. Assess the potential for in-situ or ex-situ treatment of the mine pool.

10.0 PROTECTIVENESS STATEMENTS

The protectiveness of the interim and final RODs is evaluated in the following subsections.

10.1 Operable Unit 0 Water Treatment

The existing WTP operating under the OU0 remedy is not protective of the environment. The existing water treatment plant will operate in its current capacity, with periodic repairs, upgrades and safety (OSHA) improvements, through the 2010 and 2011 treatment seasons. The new water treatment plant is currently under construction. Commissioning of the new plant is anticipated in spring 2012. Following commissioning of the new WTP, protectiveness determination of the Site water treatment operations will be included in the OU5 assessment (Section 10.6).

10.2 Operable Unit 1 Heap Leach Pad Detoxification/Closure

The remedy at OU1 currently protects human health and the environment because 99 percent of the dissolved cyanide has been removed, the cap effectively inhibits recharge from snowmelt and precipitation, annual surveys indicate that the downstream Dike No. 1 is stable, and groundwater/seep monitoring does not suggest large-scale failure of the liner system. However, removal of the remaining fluid (containing an estimated 1,000 pounds each of cyanide and copper) is necessary to ensure long-term protectiveness. Until such time that the remaining fluid is removed, monitoring will ensure the protectiveness of the remedy.

10.3 Operable Unit 2 Excavation of Cropsy Waste Pile, Beaver Mud Dump, and Cleveland Cliffs Tailing Pond/Mine Pit Closure

The remedy at OU2 is not protective because all OU5 remedy elements have not been implemented. Specifically:

1. The seasonally fluctuating mine pool inundates mine rock and mine wastes placed in the mine pits, which leads to the generation of acid mine drainage (AMD).
2. The (AMD) subsequently migrates into the bedrock groundwater system.
3. Once in the bedrock groundwater system, the AMD may report to the site ditch/groundwater inceptor drain system or, more importantly, it may migrate offsite and contribute to the non-point source loading observed in the upper reaches of Wightman Fork.

Once all OU5 elements have been implemented, the OU2 remedy will be protective.

10.4 Operable Unit 3 South Mountain Groundwater

OU3 has been incorporated into OU5, the Final Site-Wide Remedy.

10.5 Operable Unit 4 Site-Wide Reclamation

OU4 is not protective of the environment. The U.S. Bureau of Reclamation (BOR) assumed that the OU4 site-wide reclamation efforts would be, at best, 95 percent effective (BOR, 1998). Based on this postulation, the sizing of the contaminated water storage and treatment facilities developed in the FS (RMC, 2001b) and selected in the OU5 ROD (CDPHE, 2001) was based on the assumption that the OU4 site-wide reclamation efforts would result in water of sufficient quality to be discharged from the majority of the site without storage and treatment. Only water generated from 68 acres were assumed to be stored and treated. In practice, at least 100 million gallons of water generated from an additional 174 to 292 acres at the Site has been directed to the SDI for storage and treatment each of the past three years.

The additional storage and treatment capacity added by the raise of the SDI spillway and the commissioning of the new water treatment plant (OU5) may negate some of this extra water requiring treatment. However, water from this additional acreage may continue to inhibit the ability of the CDPHE to implement mine pool management; non-point source loading related to the mine pool is the largest contributor to the copper load from the Site. Copper originating from the Site prevents the attainment of water quality standards in the Alamosa River, thereby resulting in the Final Site-Wide Remedy as currently not being protective of the environment.

10.6 Operable Unit 5 Final Site-Wide Remedy

Protectiveness Statement: The Site does not pose a risk to human health. Threats to the environment have been reduced but the Final Site-Wide Remedy is currently not protective of the environment. All imminent threats at the site have been addressed. The remedy is expected to continue to be protective of human health. Protection of the environment will continue to improve as the remaining elements of the Final Site Wide Remedy (ROD, 2001) are completed. To be protective in the long term the following actions must be completed:

1. Evaluation of the performance of the new water treatment plant (commission date of spring 2012).
2. Evaluation of the impact of the increased the SDI capacity (through raising the spillway) and completion of the SDI spillway channel (construction completed in fall 2010).
3. Completion of the Reynolds Adit Improvement Project (construction completed in FY 2011).
4. Evaluation of the impact of the capture of SDI embankment seepage (construction completed in FY 2011), continued refinement of water management in the Cropsy basin (construction completed in FY 2011), optimization of the A3-Ditch Turnout (construction completed in FY 2011), and revegetation of the Chandler Bowl (date uncertain, dependent upon mine pool management or treatment).
5. Revision of the site water balance model, including options for mine pool management (prior to 2013 Five Year Review).

It is estimated that these actions may take up to five years to complete, or within the next five-year review at which time a protectiveness determination will be made.

11.0 *NEXT REVIEW*

The Summitville Mine Superfund Site is a site that requires ongoing statutory five-year reviews. The next review will be conducted by EPA within five (5) years of the completion of this five-year review report. The completion date is the date of the signature shown on the signature cover page.

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