1769520

HRS DOCUMENTATION RECORD COVER SHEET

Name of Site: Bonita Peak Mining District
EPA ID No.: CON000802497

Contact Person
Site Investigation and
Documentation Record:

Victor Ketellapper (303) 312-6578
NPL Coordinator, Acting
U.S. Environmental Protection Agency, Region 8
1595 Wynkoop Street, Mail Code: 8EPR-AR
Denver, Colorado 80202-1129

Robert Parker (303) 312-6664
NPL Coordinator
U.S. Environmental Protection Agency, Region 8
1595 Wynkoop Street, Mail Code: 8EPR-B
Denver, Colorado 80202-1129

The Bonita Peak Mining District (BPMD) site is located in San Juan County, Colorado.

Pathways, Components, or Threats Not Scored

Ground Water Migration Pathway

There are no municipal wells located within the four mile radius that serve as potable supplies and a low population density in the mining area so therefore, the pathway is unlikely to greatly impact the site score. The groundwater pathway will not be scored as part of this Hazard Ranking System (HRS) package.

Soil Exposure Pathway

Although several contaminants are present at elevated concentrations in soils, the distance to nearby residents and populations does not influence the site score. The mine releases, including the waste piles do pose a threat to sensitive terrestrial environments, including the habitat of the Canada Lynx. However, as the threat posed by the release to the Surface Water Pathway is sufficient alone to qualify the site for the National Priorities List (NPL), this threat is not scored.

Air Migration Pathway

There are no data to satisfy HRS requirements for establishing an observed release to the air migration pathway. As such, the air migration pathway will not be scored as part of this HRS package.

HRS DOCUMENTATION RECORD

Name of Site:	Bonita Peak Mining District	Date Prepared: April 2016
EPA Region:	8	
Street Address of Site*:	Unincorporated San Juan County, Colorado	
City, County, State:	Silverton, San Juan County, Colorado 81433	
General Location in the State:	The site is located near Bonita Peak within the Headwaters of the Animas River watershed in unincorporated San Juan County, Colorado (Figure 1). The sources are comprised within HUC 1408010401.	

Latitude*: 37.904031° North

Longitude*: 107.616619° West

Latitude and Longitude coordinates were measured at the approximate center of the Headwaters Animas River watershed which is the approximate center of the site and were determined using scaled aerial U.S. Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) imagery (Ref. 48).

* The street address, coordinates, and contaminant locations presented in this HRS documentation record identify the general area the site is located. They represent one or more locations the United States Environmental Protection Agency (EPA) considers to be part of the site based on the screening information EPA used to evaluate the site for NPL listing. EPA lists national priorities among the known "releases or threatened releases" of hazardous substances; thus, the focus is on the release, not precisely delineated boundaries. A site is defined as where a hazardous substance has been "deposited, stored, disposed, or placed, or has otherwise come to be located." Generally, HRS scoring and the subsequent listing of a release merely represent the initial determination that a certain area may need to be addressed under CERCLA. Accordingly, EPA contemplates that the preliminary description of facility boundaries at the time of scoring will be refined as more information is developed as to where the contamination has come to be located.

<u>Scores</u>

Air Migration Pathway	NS
Ground Water Migration Pathway	NS
Soil Exposure Migration Pathway	NS
Surface Water Migration Pathway	100.00
HRS Site Score	**50.00**

NS – Not Scored

WORKSHEET FOR COMPUTING HRS SITE SCORE

		S	S^2
1.	Ground Water Migration Pathway Score (S_{gw}) (from Table 3-1, line 13)	NS	NS
2a.	Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	100.00	10,000
2b.	Ground water to Surface Water Migration Component (from Table 4-25, line 28)	NS	NS
2c.	Surface Water Migration Pathway Score (S_{sw}) Enter the larger of lines 2a and 2b as the pathway score.	100.00	10,000
3.	Soil Exposure Pathway Score (S_s) (from Table 5-1, line 22)	NS	NS
4.	Air Migration Pathway Score (S_a) (from Table 6-1, line 12)	NS	NS
5.	Total of $S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2$		10,000
6.	**HRS Site Score** Divide the value on line 5 by 4 and take the square root	50.00	

NS = Not Scored

TABLE 4-1

SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE SHEET

Factor Categories and Factors	Maximum Value	Value Assigned
Drinking Water Threat		
<u>Likelihood of Release</u>:		
1. Observed Release	550	550
2. Potential to Release by Overland Flow:		
2a. Containment	10	NS
2b. Runoff	25	NS
2c. Distance to Surface Water	25	NS
2d. Potential to Release by Overland Flow (lines 2a[2b+2c])	500	NS
3. Potential to Release by Flood:		
3a. Containment (Flood)	10	NS
3b. Flood Frequency	50	NS
3c. Potential to Release by Flood (lines 3a×b)	500	NS
4. Potential to Release (lines 2d+3c, subject to a maximum of 500)	500	NS
5. Likelihood of Release (higher of lines 1 and 4)	550	550
<u>Waste Characteristics</u>:		
6. Toxicity/Persistence	(a)	NS
7. Hazardous Waste Quantity	(a)	NS
8. Waste Characteristics	100	NS
<u>Targets</u>:		
9. Nearest Intake	50	NS
10. Population		
10a. Level I Concentrations	(b)	NS
10b. Level II Concentrations	(b)	NS
10c. Potential Contamination	(b)	NS
10d. Population (lines 10a+10b+10c)	(b)	NS
11. Resources	5	NS
12. Targets (lines 9+10d+11)	(b)	NS
<u>Drinking Water Threat Score</u>:		
13. Drinking Water Threat Score ([lines 5×8×12]/82,500, subject to a maximum of 100)	100	NS
Human Food Chain Threat		
<u>Likelihood of Release</u>:		
14. Likelihood of Release (same value as line 5)	550	550

(continued)
TABLE 4-1

SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE SHEET

Factor Categories and Factors	Maximum Value	Value Assigned
<u>Waste Characteristics</u>:		
15. Toxicity/Persistence/Bioaccumulation	(a)	5×10^8
16. Hazardous Waste Quantity	(a)	10,000
17. Waste Characteristics	1,000	1,000
<u>Targets</u>:		
18. Food Chain Individual	50	45
19. Population		
19a. Level I Concentrations	(b)	0
19b. Level II Concentrations	(b)	0.06
19c. Potential Human Food Chain Contamination	(b)	0
19d. Population (lines 19a+19b+19c)	(b)	0.06
20. Targets (lines 18+19d)	(b)	45.06
<u>Human Food Chain Threat Score</u>:		
21. Human Food Chain Threat Score ([lines 14×17×20]/82,500, subject to a maximum of 100)	100	100.00
Environmental Threat		
<u>Likelihood of Release</u>:		
22. Likelihood of Release (same value as line 5)	550	550
<u>Waste Characteristics</u>:		
23. Ecosystem Toxicity/Persistence/Bioaccumulation	(a)	5×10^8
24. Hazardous Waste Quantity	(a)	10,000
25. Waste Characteristics	1,000	1,000
<u>Targets</u>:		
26. Sensitive Environments		
26a. Level I Concentrations	(b)	0
26b. Level II Concentrations	(b)	75
26c. Potential Contamination	(b)	NS
26d. Sensitive Environments (lines 26a+26b+26c)	(b)	75
27. Targets (value from line 26d)	(b)	75
<u>Environmental Threat Score</u>:		
28. Environmental Threat Score ([lines 22×25×27]/82,500, subject to a maximum of 60)	60	60.00

TABLE 4-1

SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE SHEET

Factor Categories and Factors	Maximum Value	Value Assigned
Surface Water Overland/Flood Migration Component Score for a Watershed		
29. Watershed Score[c] (lines 13+21+28, subject to a maximum of 100)	100	100.00
Surface Water Overland/Flood Migration Component Score		
30. Component Score (S_{of})[c] (highest score from line 29 for all watersheds evaluated, subject to a maximum of 100)	100	100.00

NS = Not Scored.
(a) = Maximum value applies to waste characteristics category
(b) = Maximum value not applicable
(c) = Do not round to the nearest integer

APPENDICES

Appendix A Mine-Specific Scoring

REFERENCES

Ref. No. — Description of the Reference

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Figure 1. Bonita Peak Mining District
Site Location Map

0 5.5 11 Miles

0 5.5 11 Kilometers

Date: March 30, 2016

Data Sources:
Mine Locations - U.S. EPA Region 8 (Ref. 6e);
Streams - CDOW (Ref. 34, pp. 1-8);
Base Map - USDA NAIP Imagery 2015 San Juan, San Miguel, Ouray, Hinsdale, La Plata, and Dolores Counties, Colorado (Ref. 48)

Map Projection: UTM, Meters, Zone 13N, NAD83

N

Colorado

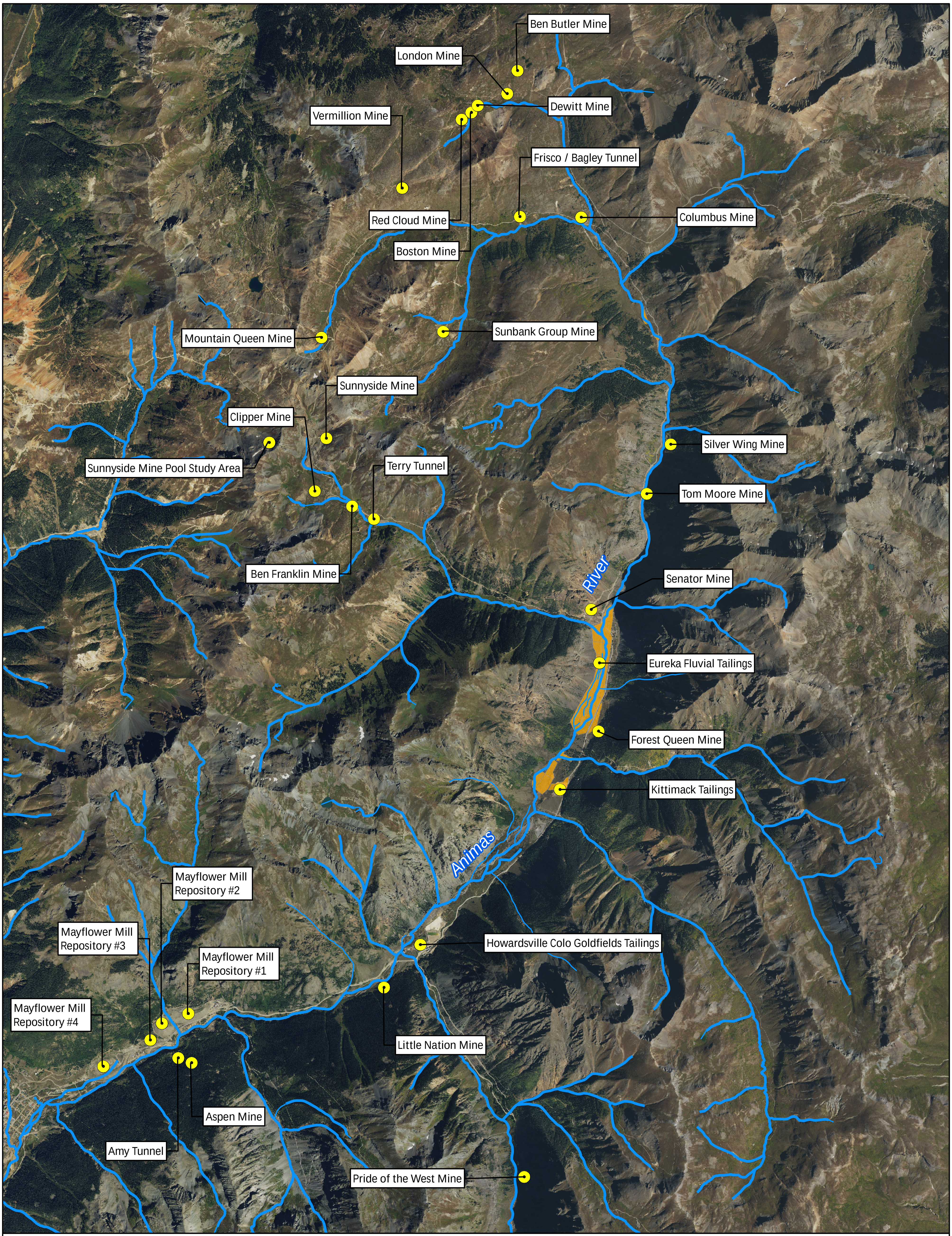

Figure 2. Bonita Peak Mining District

Upper Animas Area
Source Mine Locations

HRS Evaluated and Other Possible Sources

Eureka Fluvial Tailings

Perennial Streams

Intermittent Streams

0 2,000 4,000 Feet

0 500 1,000 Meters

Date: March 30, 2016

Data Sources:
Surface Water, Mine Locations - U.S. EPA Region 8 (Ref. 6e; 59);
Streams - CDOW (Ref. 34, pp. 1-8);
Base Map - USDA NAIP Imagery 2015
San Juan County, Colorado (Ref. 48)

Map Projection: UTM, Meters, Zone 13N, NAD83

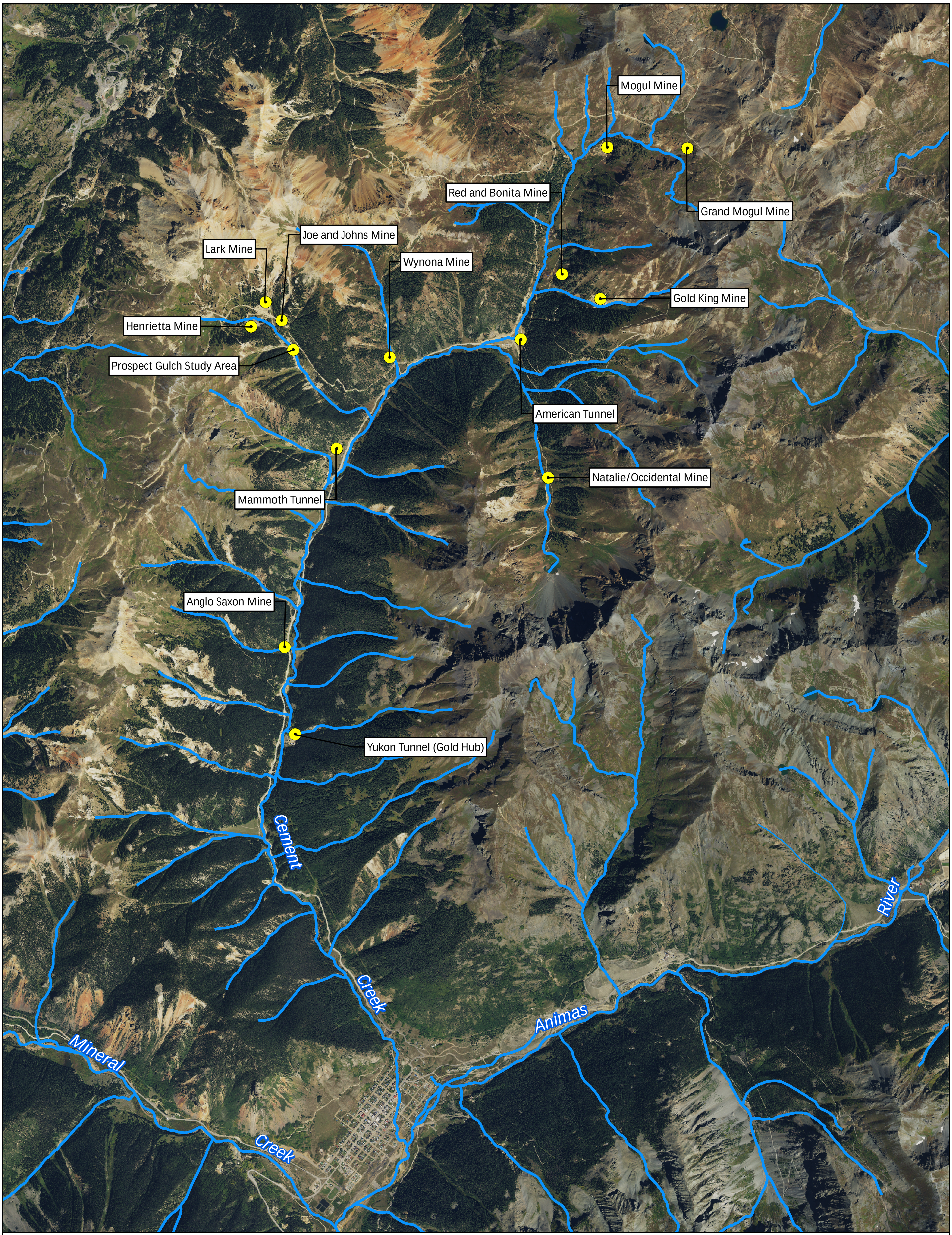

Figure 3. Bonita Peak Mining District
Cement Creek
Source Mine Locations

HRS Evaluated and Other Possible Sources

Perennial Streams

Intermittent Streams

0 2,000 4,000 Feet

0 490 980 Meters

Date: March 30, 2016

Data Sources:
Mine Locations - U.S. EPA Region 8 (Ref. 6e; 59);
Streams - CDOW (Ref. 34, pp. 1-8);
Base Map - USDA NAIP Imagery 2015 San Juan County, Colorado (Ref. 48)

Map Projection: UTM, Meters, Zone 13N, NAD83

N

Colorado

Area of Interest

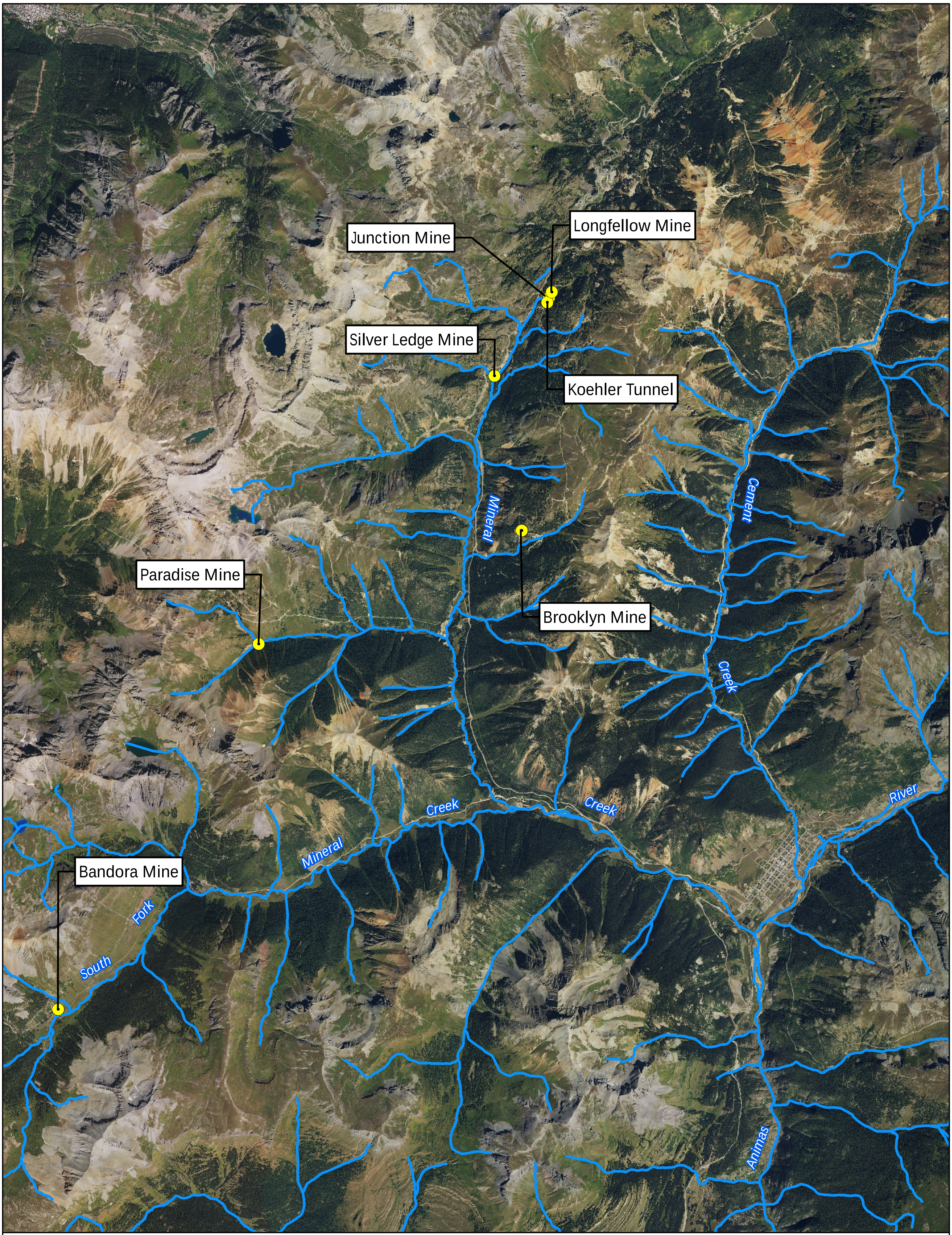

Figure 4. Bonita Peak Mining District
Mineral Creek
Source Mine Locations

- HRS Evaluated and Other Possible Sources
- Perennial Streams
- Intermittent Streams

0 2,500 5,000 Feet

0 500 1,000 Meters

Date: March 30, 2016

Data Sources:
Mine Locations - U.S. EPA Region 8 (Ref. 6e);
Streams - CDOW (Ref. 34, pp. 1-8);
Base Map - USDA NAIP Imagery 2015 San Juan County, Colorado (Ref. 48)

Map Projection: UTM, Meters, Zone 13N, NAD83

N

Colorado

Area of Interest

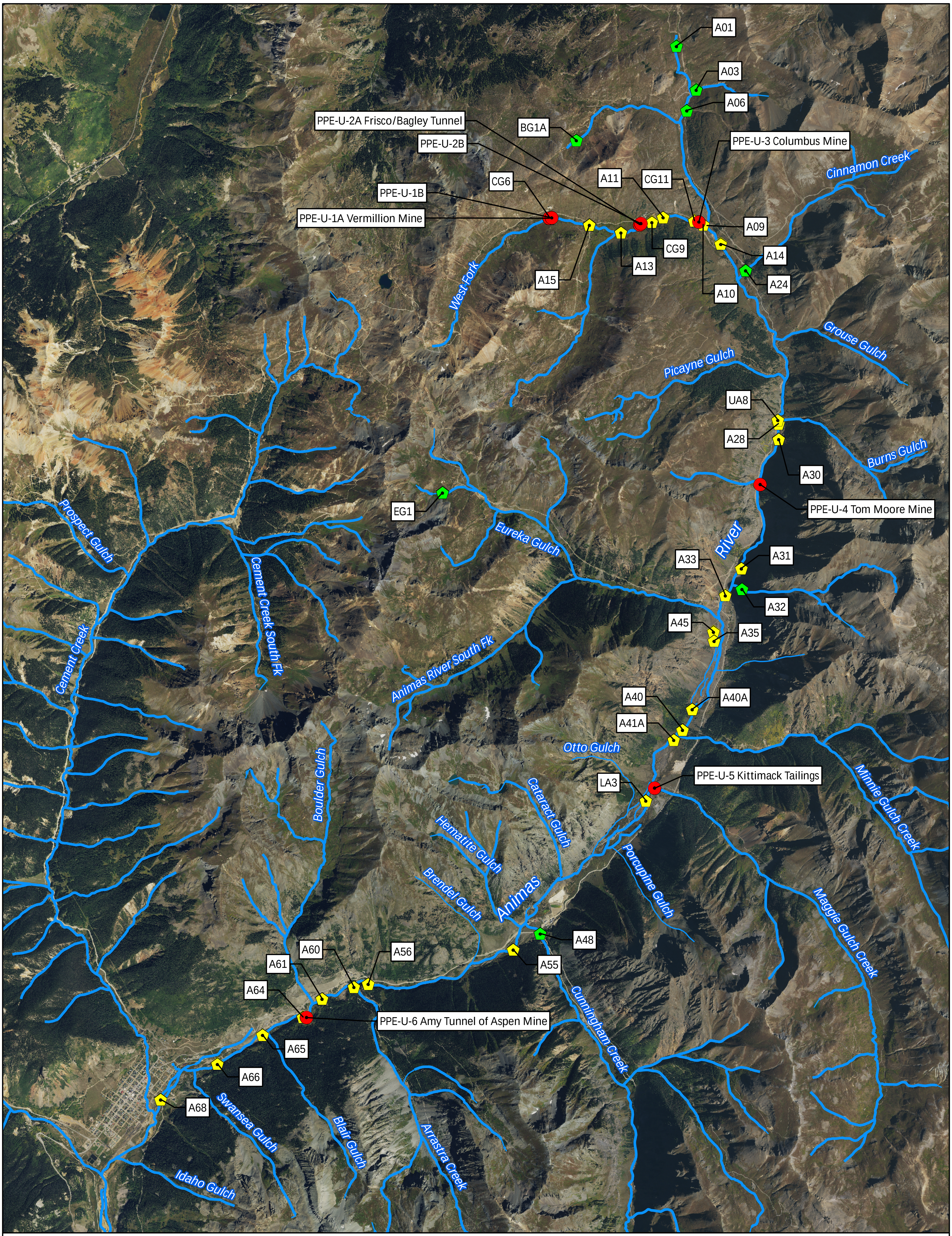

Figure 5. Bonita Peak Mining District

Probable Points of Entry and Surface Water Sample Locations

Upper Animas Area

- Bonita Peak PPEs
- Sample Locations Exhibiting Elevated Concentrations
- Background Sample Locations
- Perennial Stream
- Intermittent Stream

0 2,000 4,000 Feet

0 500 1,000 Meters

Date: March 30, 2016

Data Sources:
Surface Water, Mine Locations - U.S. EPA Region 8 (Ref. 6e);
Streams - CDOW (Ref. 34, pp. 1-8);
Base Map - USDA NAIP Imagery 2015 San Juan County, Colorado (Ref. 48)

Map Projection: UTM, Meters, Zone 13N, NAD83

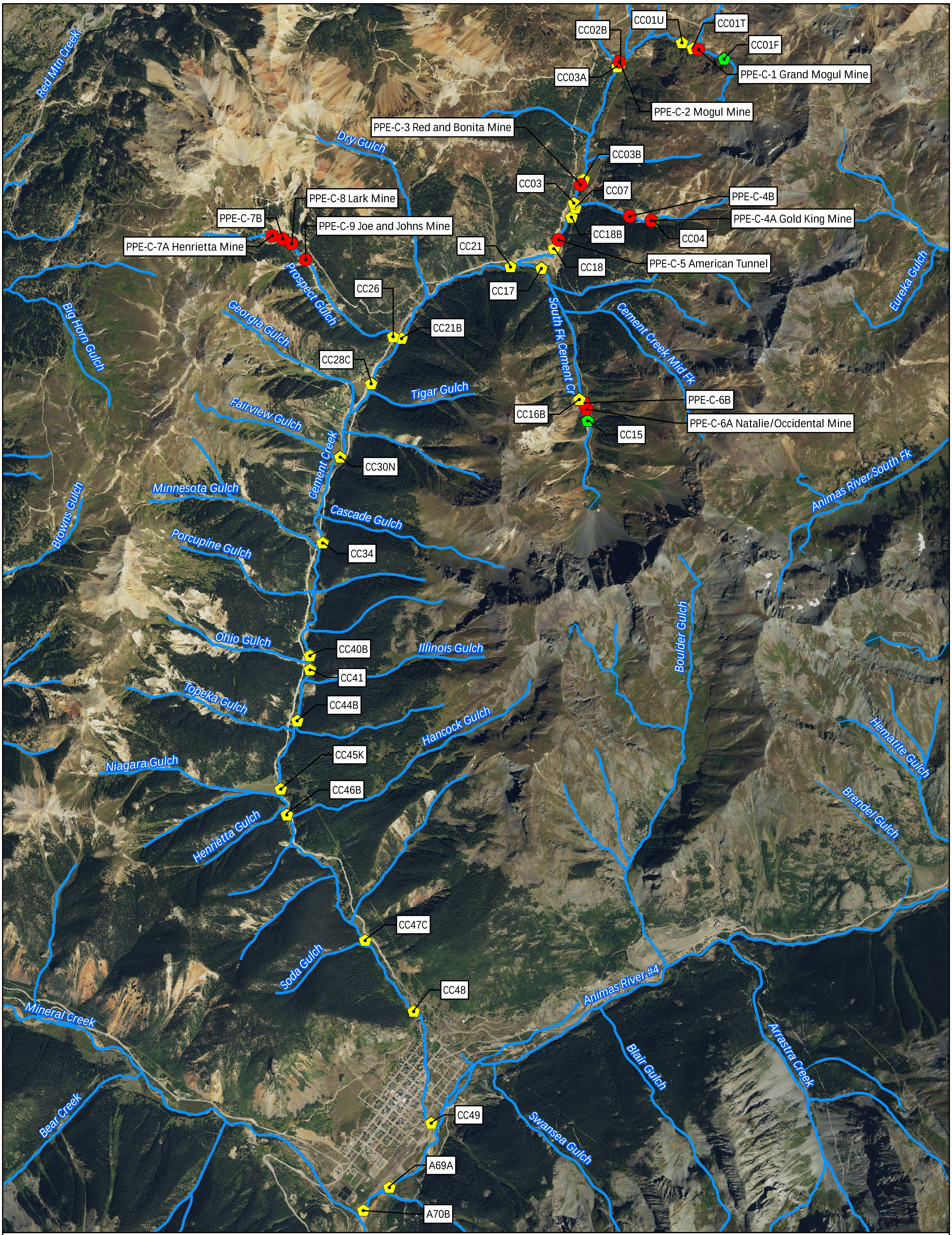

Figure 6. Bonita Peak Mining District

Probable Points of Entry and Surface Water Sample Locations

Cement Creek Area

- Bonita Peak PPEs
- Background Sample Locations
- Sample Locations Exhibiting Elevated Concentrations
- Perennial Stream
- Intermittent Stream

0 1,500 3,000 Feet

0 400 800 Meters

Date: March 30, 2016

Data Sources:
Surface Water, Mine Locations - U.S. EPA Region 8 (Ref. 6e);
Streams - CDOW (Ref. 34, pp. 1-8);
Base Map - USDA NAIP Imagery 2015 San Juan County, Colorado (Ref. 48)

Map Projection: UTM, Meters, Zone 13N, NAD83

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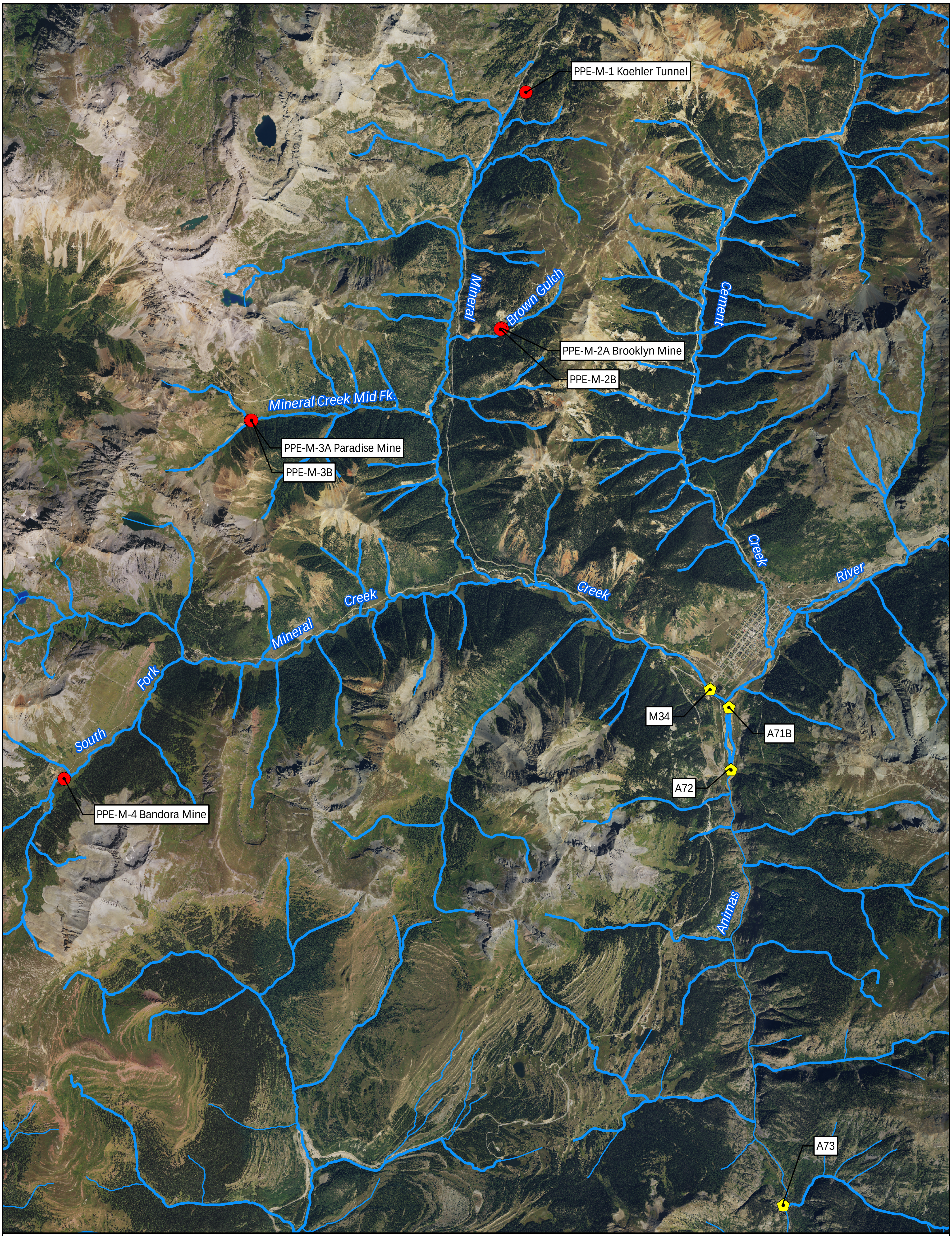

Figure 7. Bonita Peak Mining District

Probable Points of Entry and Surface Water Sample Locations

Mineral Creek Area

Bonita Peak PPEs

Sample Locations Exhibiting Elevated Concentrations

Perennial Streams

Intermittent Streams

0 2,400 4,800 Feet

0 500 1,000 Meters

Date: March 30, 2016

Data Sources:
Mine Locations - U.S. EPA Region 8 (Ref. 6e);
Streams - CDOW (Ref. 34, pp. 1-8);
Base Map - USDA NAIP Imagery 2015 San Juan County, Colorado (Ref. 48)

Map Projection: UTM, Meters, Zone 13N, NAD83

N

Colorado

Area of Interest

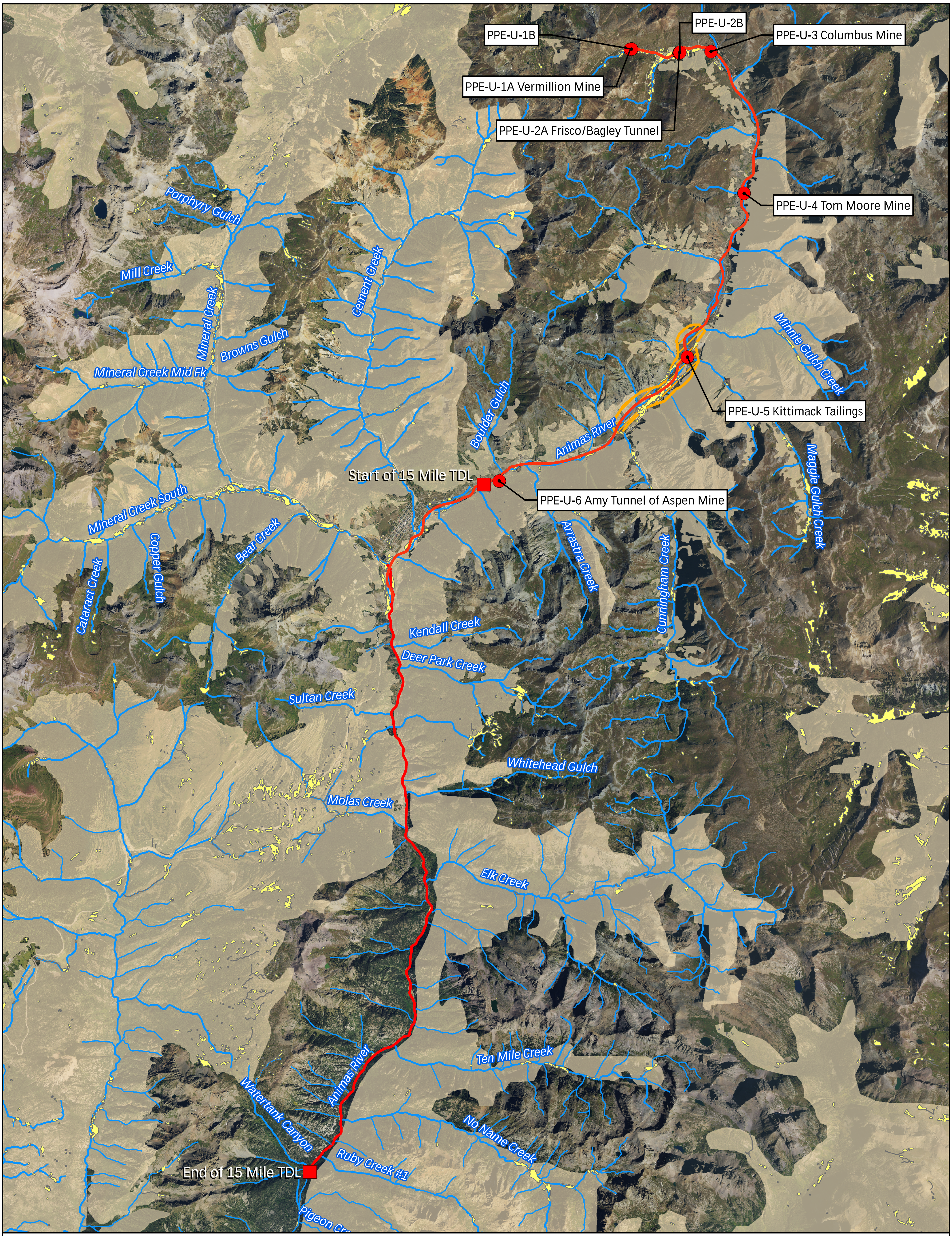

Figure 8. Bonita Peak Mining District

In-Water Segments, Target Distance Limits, and Targets

Upper Animas

- Bonita Peak PPEs

Note: For targets associated with PPEs, Level II Actual Contamination is assigned due to Observed Release by Direct Observation [Ref. 1, Section 2.5]

- Level II Documented Fishery Location
- Upper Animas In-Water Segment
- Perennial Stream
- Intermittent Stream
- HRS Eligible Wetlands
- Habitat known to be used by a Federal designated threatened species (Canada Lynx)

0 3,600 7,200 Feet

0 950 1,900 Meters

Date: March 30, 2016

Data Sources:

PPEs: U.S. EPA Region 8 (Ref. 55);
Rivers and Streams: CDOW 1:24k (Ref. 34, pp. 1-8);
Fishery Locations: (Refs. 42, pp. 25-28; 43, pp. 20-22; 44, pp. 1-2);
Wetlands: USFWS (Refs. 27, pp. 1-9; 28, p. 13; 47, p. 1);
Lynx Habitat: CPW, USFWS (Refs. 29, pp. 1-2; 30, p. 1, 6; 45, p. 1; 54);
Image: USDA NAIP Imagery 2015
San Juan County, Colorado (Ref. 48)
Map Projection: UTM, Meters, Zone 13N, NAD83

N

Colorado

Area of Interest

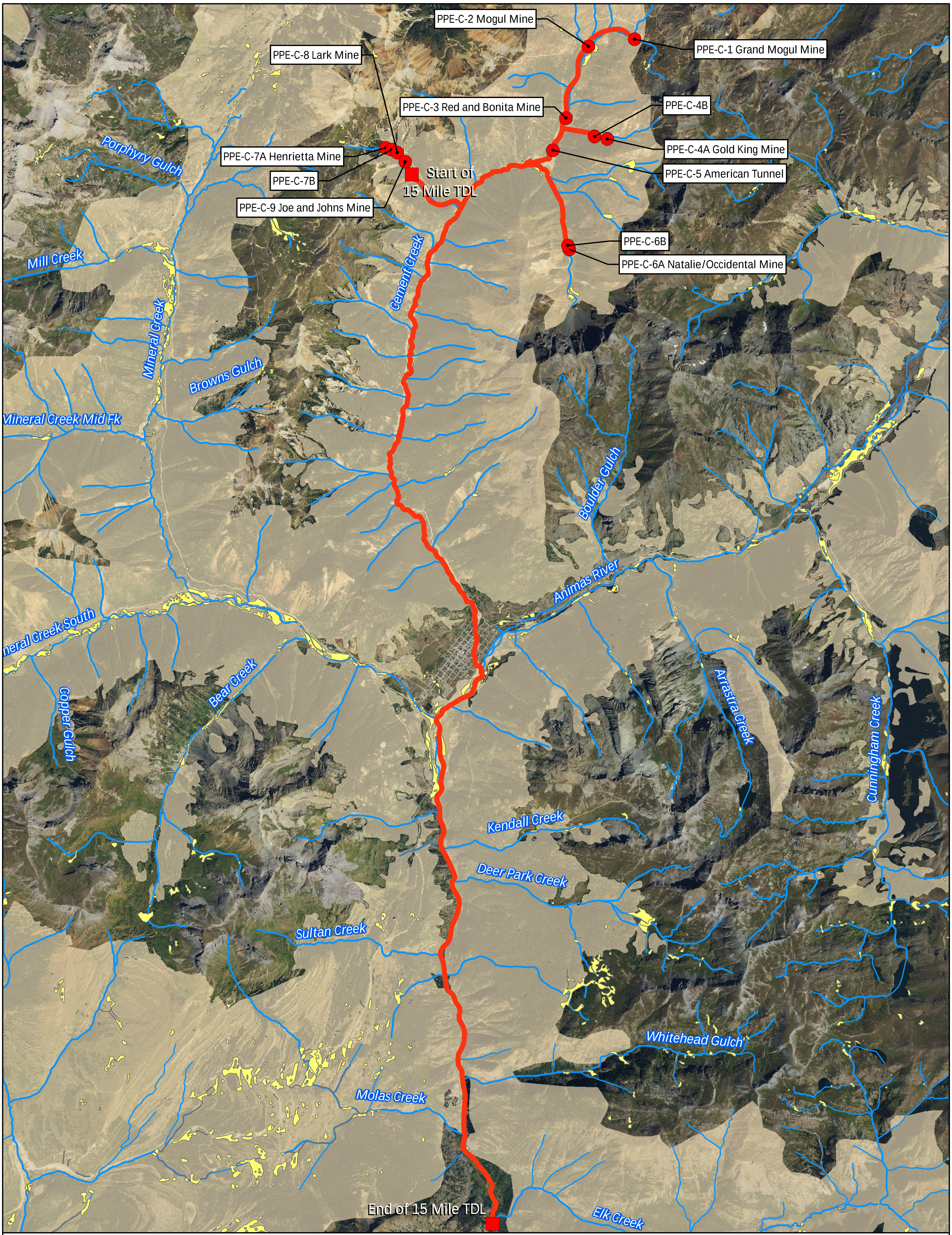

Figure 9. Bonita Peak Mining District
In-Water Segments, Target Distance Limits, and Targets
Cement Creek Area

Bonita Peak PPEs

Note: For targets associated with PPEs, Level II Actual Contamination is assigned due to Observed Release by Direct Observation [Ref. 1, Section 2.5]

Cement Creek In-Water Segment

Perennial Stream

Intermittent Stream

HRS Eligible Wetlands

Habitat known to be used by a Federal designated threatened species (Canada Lynx)

0 2,400 4,800 Feet

0 660 1,320 Meters

Date: March 30, 2016

Data Sources:
PPEs: U.S. EPA Region 8 (Ref. 55);
Rivers and Streams: CDOW 1:24k (Ref. 34, pp. 1-8);
Wetlands: USFWS (Refs. 27, pp. 1-9; 28, p. 13; 47, p. 1);
Lynx Habitat: CPW, USFWS (Refs. 29, pp. 1-2; 30, p. 1, 6; 45, p. 1; 54);
Image: USDA NAIP Imagery 2015
San Juan County, Colorado (Ref. 48)
Map Projection: UTM, Meters, Zone 13N, NAD83

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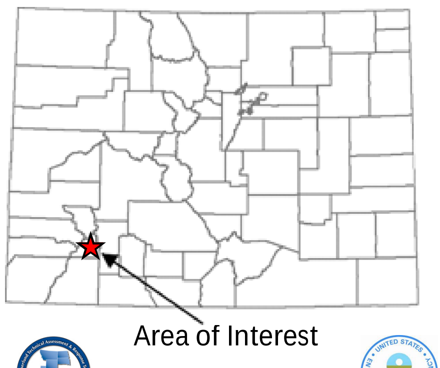

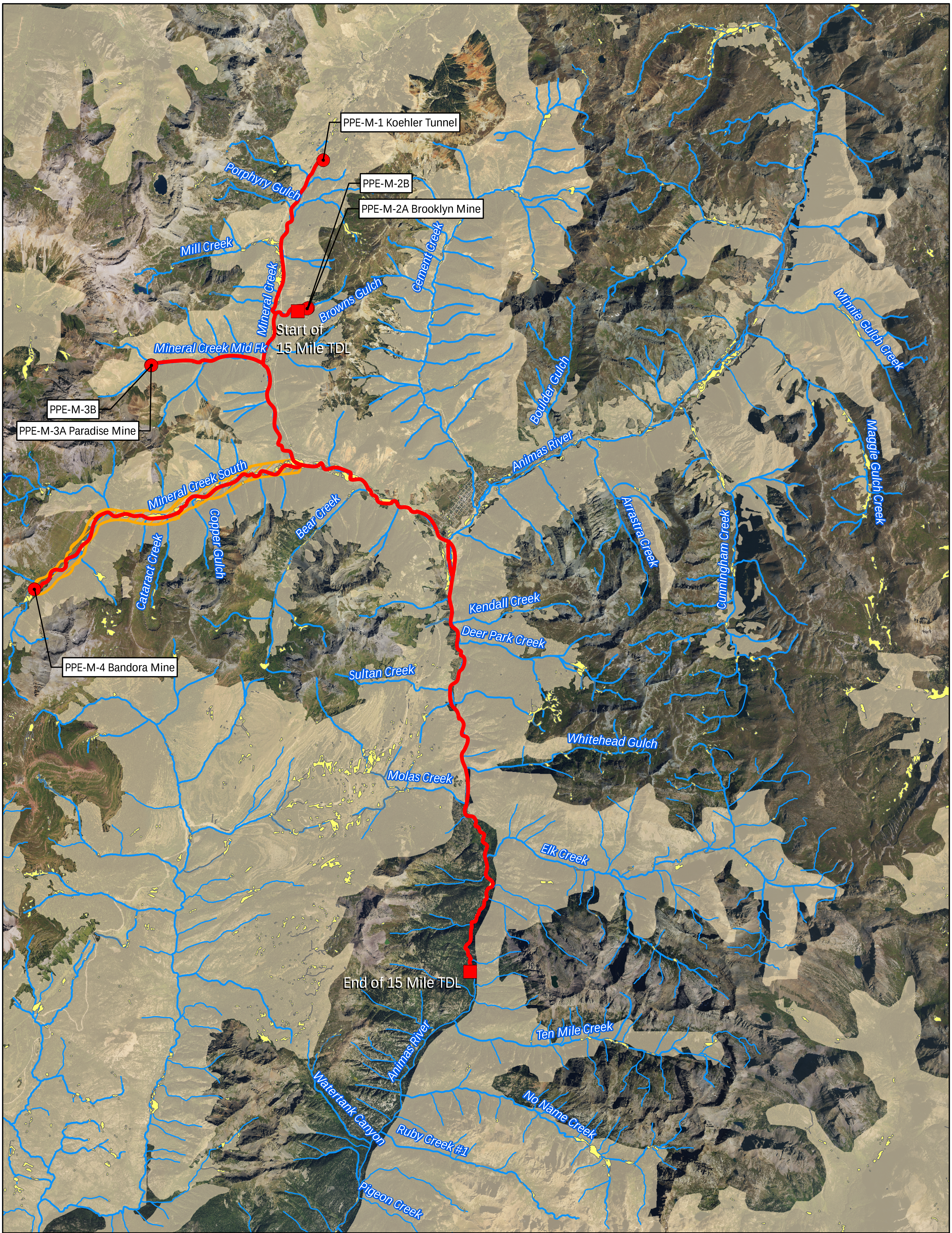

Figure 10. Bonita Peak Mining District
In-Water Segments, Target Distance Limits, and Targets
Mineral Creek Area

Bonita Peak PPEs

Note: For targets associated with PPEs, Level II Actual Contamination is assigned due to Observed Release by Direct Observation [Ref. 1, Section 2.5]

Level II Documented Fishery Location

Mineral Creek In-Water Segment

Perennial Stream

Intermittent Stream

HRS Eligible Wetlands

Habitat known to be used by a Federal designated threatened species (Canada Lynx)

0 4,000 8,000 Feet

0 1,000 2,000 Meters

Date: March 30, 2016

Data Sources:
PPEs: U.S. EPA Region 8 (Ref. 55);
Rivers and Streams: CDOW 1:24k (Ref. 34, pp. 1-8);
Fishery Locations: (Refs. 42, pp. 25-28; 43, pp. 20-22; 44, pp. 1-2);
Wetlands: USFWS (Refs. 27, pp. 1-9; 28, p. 13; 47, p. 1);
Lynx Habitat: CPW, USFWS (Refs. 29, pp. 1-2; 30, p. 1, 6; 45, p. 1; 54);
Image: USDA NAIP Imagery 2015 San Juan County, Colorado (Ref. 48)
Map Projection: UTM, Meters, Zone 13N, NAD83

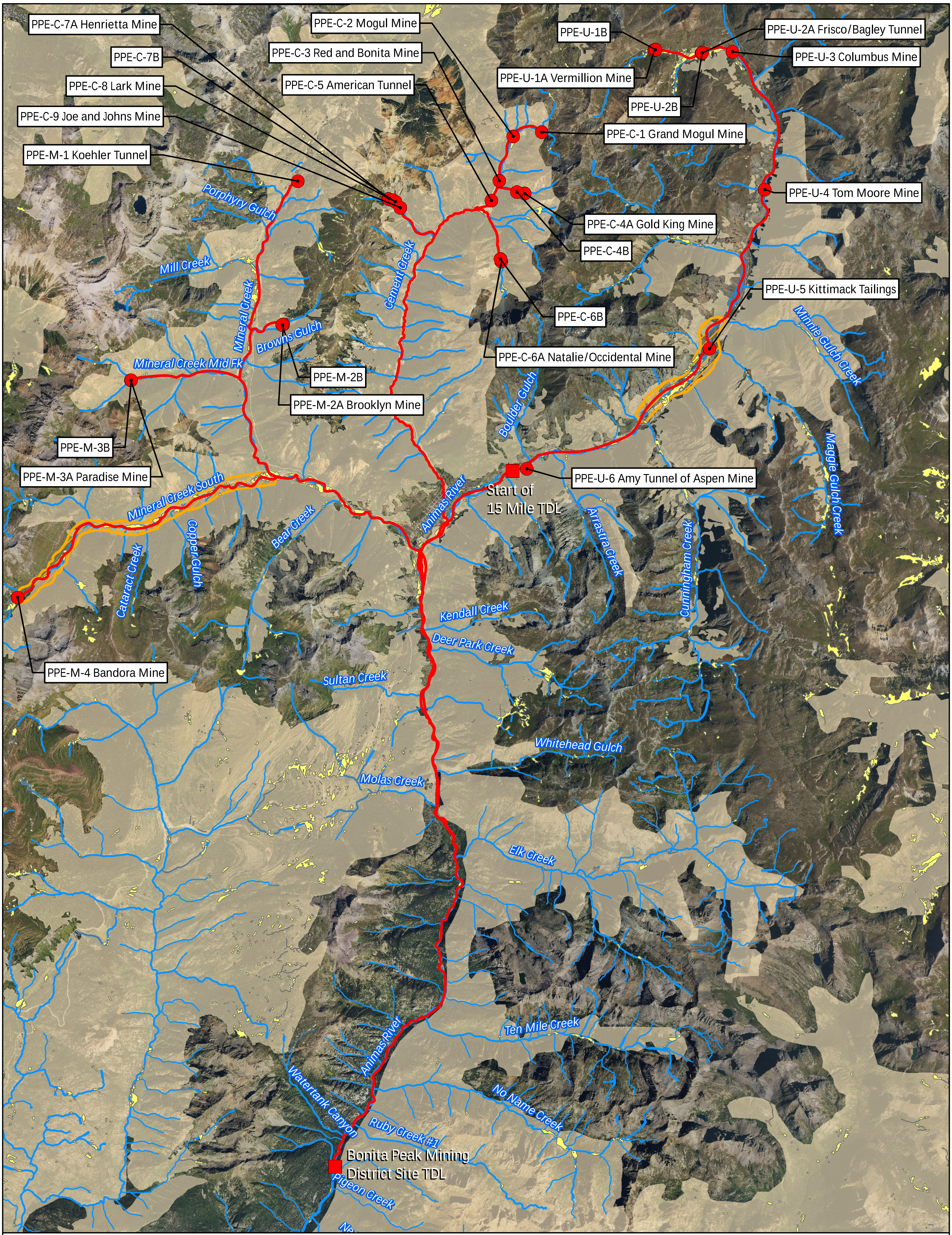

Figure 11. Bonita Peak Mining District

Combined In-Water Segments, Target Distance Limits, and Targets

Bonita Peak Area

Bonita Peak PPEs

Note: For targets associated with PPEs, Level II Actual Contamination is assigned due to Observed Release by Direct Observation [Ref. 1, Section 2.5]

Baker's Park In-Water Segment

Perennial Stream

Intermittent Stream

Level II Documented Fishery Location

HRS Eligible Wetlands

Habitat known to be used by a Federal designated threatened species (Canada Lynx)

0 3,750 7,500 Feet

0 975 1,950 Meters

Date: March 30, 2016

Data Sources:

PPEs: U.S. EPA Region 8 (Ref. 55);
Rivers and Streams: CDOW 1:24k (Ref. 34, pp. 1-8);
Fishery Locations: (Refs. 42, pp. 25-28; 43, pp. 20-22; 44, pp. 1-2);
Wetlands: USFWS (Refs. 27, pp. 1-9; 28, p. 13; 47, p. 1);
Lynx Habitat: CPW, USFWS (Refs. 29, pp. 1-2; 30, p. 1, 6; 45, p. 1; 54);
Image: USDA NAIP Imagery 2015
San Juan County, Colorado (Ref. 48)
Map Projection: UTM, Meters, Zone 13N, NAD83

Colorado

SITE DESCRIPTION

The Bonita Peak Mining District site is located within Headwaters of the Animas River watershed in the San Juan and Silverton calderas which were subject to intensive hardrock mining beginning in the 1870s (Ref. 50, p. 3). The site is the result of the release of hazardous substances, mainly metals, due to the operation and abandonment or discontinued operation of mines (Ref. 6b, p. 6, Figure 1) in the Upper Animas, Cement Creek and Mineral Creek Drainages of the Animas River (Ref. 6a, p. 9). The USGS reported that this history of "[m]ining at large and small mines and excavating at countless prospects have disturbed millions of tons of mineralized rock in the Silverton area and resulted in chemical reactions that release acid and metals to receiving waters in the watershed." (Ref. 6c, p. 5) Mining of the ore bodies in this mining district has resulted in the exposure of the ore in mine shafts and in mine tailings piles to aerobic conditions, which has in turn lead to pH depression and solubilization and mobilization of toxic metals. (Ref. 6a, p. 12-13) Ground water seeping into the mines and snow and rain falling on and running over the mine tailings piles associated with the mines has led to what is commonly referred to as acid mine drainage. (Ref. 6c, p. 5) This drainage flows into and has contaminated the creeks in the three drainages.

The acid mine drainage discharge has been measured to be in the millions of gallons a day and estimated to involve the loading of at least hundreds of pounds of hazardous substances a day, and has resulted in pH depression and increases in dissolved toxic metal concentrations in surface water, including, but not limited to, cadmium, copper, zinc, manganese and aluminum (Ref. 2; 6a, pp 12-13; 13; 14; 15; 56, p. 301). The contaminated surface water from the acid mine drainage extends throughout the drainage basins. This contamination threatens not only human food chain fisheries, wetlands and wildlife habitat, including endangered species habitat, but also has the potential to impact downstream drinking water supplies serving thousands of people.

The San Juan caldera and the Silverton caldera together form the dominant geologic feature of the site and vicinity (Ref 36., p. 3, Figure 2). The calderas formed between approximately 28 and 27 million years ago (Ma), with the smaller, younger Silverton caldera being situated within the larger, older San Juan caldera. (Ref. 6a, p. 32). Volcanotectonic events that occurred during and subsequent to the caldera formation period introduced extensive Tertiary-aged volcanic rock and extensive mineralization within fractured host rock. There were "multiple hydrothermal alteration and mineralization events that span a 20 m.y. [million year] history from about 27 Ma to 10 Ma". (Ref. 6a, p. 35) Luedke and Burbank (with the USGS) noted that "the highly fractured and broken country rock provided an easily penetrable route for intrusive igneous material such as the dikes, stocks, and other plutons as well as for hydrothermal fluids." (Ref. 36, pp. 3-4). Free, Hutchinson and Koch reported that the Eureka graben, which formed within the calderas due to subsidence of Silverton volcanic doming, "is an important controlling structure for later mineralization" and that the graben's "bounding faults and subsidiary fractures became important ore carriers during the following base metal and even younger precious metal mineralization." (Ref. 37, p. 136)

Some of the mining activities in the caldera were small operations lasting for a decade or so, but others employed hundreds of miners, operated for 50 years or more and mined millions of tons of ore. (Ref. 6c, p. 5) At most of these mines, when operation were terminated, no activities were taken to prevent acid mine drainage from continuing to form and discharge to surface water. (Ref. 6a, p. 11-12) Some actions (Ref. 6a, p. 36) have been taken since cessation of mining operations to prevent flow from mine shaft adits, however, these actions were not comprehensive in scope. Although some actions also have been taken to minimize and contain acid mine drainage from some of the tailings piles, many mine tailings piles were abandoned with no mitigating measures to prevent acid mine drainage from forming or to contain and treat the acid mine drainage prior to its migration to surface water.

The Bonita Peak Mining District site scope is limited to 46 specific mines and two additional study areas where additional characterization is needed to determine whether and what additional actions under CERCLA are appropriate. To address the release of hazardous substances due to the mining operations at these 48 locations within the Bonita Peak Mining District, EPA is evaluating the release for the NPL. These 48 locations were identified based on analysis completed by the Animas River Stakeholders Group, the U.S. Geological Survey, Colorado Division of Minerals and Geology, Bureau of Land Management, U.S. Forest Service and the U.S. EPA (Refs. 2; 3; 4; 5; 6; 13; 14; 15; 22; 24; 26; 31; 32; 49; 50; 56). As is shown in this HRS documentation record, this release qualifies for listing on the NPL based on an HRS score for the comingled release of acid mine drainage from the mining operations in the mining district. In addition, it is also shown in this HRS documentation record that, where sufficient information is available to adequately evaluate the release from each mine operation or drainage individually, the HRS score is also sufficient to qualify the release from individual mines or drainages for placement on the NPL (see Appendix A).

The Bonita Peak Mining District site involves contamination affecting surface water bodies in the San Juan caldera: the upper portion of the Animas River (hereinafter “the Upper Animas River”); the river’s two main tributaries in the Silverton area, Cement Creek and Mineral Creek; and numerous smaller tributaries to all three streams. The headwaters of all these water bodies are located in the high mountain peaks surrounding Silverton, and Cement Creek and Mineral Creek flow into the Animas River at Silverton. For the purposes of this HRS evaluation (and for clarity in the site and pathway definitions), the site is evaluated according to the three drainage areas (i.e., the Upper Animas River, Cement Creek, and Mineral Creek drainages).

The USGS noted that surface water flow “typically peaks in May or June and decreases in July” and that “low streamflow conditions are typical from late August to March” (Ref 6a, p. 27). The USGS also noted that “fractures that are densely spaced, interconnected, and unfilled by mineralization processes help to focus near-surface ground-water flow at the local or sub-basin scale.” (Ref. 6a, p. 27) Both the USGS and the State of Colorado maintain various gauging stations in the area (Ref. 6a, p. 27).

2.2 SOURCE CHARACTERIZATION – UPPER ANIMAS RIVER

Although there are many possible sources contributing to surface water contamination associated with this site, this portion of the HRS documentation record is focused solely on the Upper Animas River drainage (above Silverton), to make discussion easier. In addition, multiple sources were identified in the Upper Animas River drainage (Figure 2). Each source is detailed in the tables below to include an assigned source number, source name, type, description, location as well as hazardous substances associated with the source, hazardous substances available to a pathway and hazardous waste quantities. A complete source identification for each source in the Upper Animas River drainage follows the tables below:

Source No.	Source Name and Description	Source Type	Location (Figure 2)	Reference
U-1A	Vermillion Mine Adit Discharge. The Vermillion Mine has been observed to have one flowing adit (a horizontal passage leading into a mine for the purposes of access or drainage).	Other (adit)	West Fork/ Placer Gulch latitude N37°56’09.1” longitude W107°36’0.01” elevation: 12,440 ft	14, pp. 71-72
U-1B	Vermillion Mine Waste Rock Pile. The Vermillion Mine has one waste rock (valueless rock that must be fractured and removed in order to gain access to or upgrade ore) pile.	Pile		14, p. 72
U-2A	Frisco/Bagley Tunnel Adit Discharge. The Frisco/Bagley Tunnel (a passage that goes under the ground, through a hill or mountain, etc.) has one draining adit.	Other (adit)	West Fork/ Placer Gulch latitude N37°55'54.4" longitude W107°34'53.2" elevation: 11,440 ft	14, p. 75
U-2B	Frisco/Bagley Tunnel Waste Rock Piles. The Frisco/Bagley Tunnel has two waste piles.	Pile		14, p. 78
U-3A	Columbus Mine Adit Discharge. The Columbus Mine has been observed to have one flowing adit.	Other (adit)	West Fork/ Placer Gulch latitude N37°55’59.7” longitude W107°34’14.7” elevation: 11,240 ft	14, pp. 80-82
U-3B	Columbus Mine Waste Rock Piles. The Columbus Mine contains two levels of waste rock.	Pile		14, p. 81
U-4A	Tom Moore Mine Adit Discharge. The Tom Moore Mine has been observed to have one perennially flowing adit.	Other (adit)	Animas River, upgradient from Eureka latitude N37°53'59.0" longitude W107°33'31.9"	14, p. 97-98
U-4B	Tom Moore Mine Waste Rock Pile. The Tom Moore Mine has one waste rock pile.	Pile		14, p. 97

CON000802497

Source No.	Source Name and Description	Source Type	Location (Figure 2)	Reference
			elevation: 10,360 ft	
U-5B	Kittimack Tailings Waste Pile. The Kittimack Tailings location has one mill tailings pile (the materials left over after the process of separating the valuable fraction from the uneconomic fraction of an ore).	Pile	Animas River, Eureka to Middleton latitude N37°51 '32.2" longitude W107°34'14.1" elevation: 9,740 ft	15, p.128
U-6A	Amy Tunnel of Aspen Mine Adit Discharge. The Amy Tunnel of the Aspen Mine has been observed to have one flowing adit.	Other (adit)	Animas River below Middleton latitude N37°49’16.2” longitude W107°37’49.8” elevation: 9,760 ft	15, pp. 141-143

2.2.1 SOURCE IDENTIFICATION- UPPER ANIMAS RIVER

Source Number: U-1A

Name of Source: Vermillion Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 2)

The Vermillion mine is located in a large gentle swale high on the north side of California Gulch near the southwestern flank of Houghton Mountain (Ref. 14, p. 71). The mine is located at latitude N37°56'09.1", longitude Wl07°36'00.1". (Ref. 14. pp. 71). The mine adit is at an elevation of 12,440 ft. There was 8 to 34 gallons per minute (gpm) of pH 3.1 to 3.7 drainage flowing from the Vermillion Mine during a 1997/98 site investigation (Ref. 14, p. 72). This mine produced up to 7 pounds (lbs.) of metal per day during low-flow and 14 lbs. of metal per day during high-flow. This source is believed to be on the Parallel patented mining claim. The adit discharge is a small, perennial tributary draining into California Gulch (Ref. 14. pp. 71-73). The adit discharge also infiltrates into the waste rock pile (Ref. 14. pp. 71-73). The adit discharge flows south over soil for approximately 54 feet ft before infiltrating into the waste rock pile in a southwestern direction for approximately 123 ft (Ref. 14, pp. 71-73; 55, p. 1). The drainage continues to flow approximately 1,997 ft south and southeast into the West Fork Animas River (Ref. 55, p. 1).

Source Number: U-1B

Name of source: Vermillion Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 2)

The Vermillion mine is located in a large gentle swale high on the north side of California Gulch near the southwestern flank of Houghton Mountain (Ref. 14, p. 71). The Vermillion waste rock pile consists of waste rock from the Vermillion mining activities 5,100 cubic yards (CY). The waste pile is located in a wetland area immediately below perennial springs. There was a large iron-stained kill zone extending for over 500 ft below the waste pile. (Ref. 14. pp. 71-73). Although sampling data for this source was generated in the late 1990's, because metals do not degrade and the piles have not been removed, contaminants are still present in the source.

Source Number: U-2A

Name of Source: Frisco/Bagley Tunnel Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 2)

The Frisco/Bagley Tunnel adit is located approximately 1/2 mile west of Animas Forks on the north side of California Gulch. A 4-wheel dive access road passes through the mine area (Ref. 14, p.78). This source consists of a safeguarded, draining mine adit (Ref. 14, Figure 28). The Frisco/Bagley Tunnel is located at an elevation of 11,440 ft, and is believed to be on the Gorilla patented mining claim. The mine is located at latitude N37°55'54.4', longitude W107°34'53.2' (Ref. 14, pp. 75). During a 1997/98 site investigation, approximately half of the adit discharge was conveyed across the waste rock pile by HDPE pipe. The other half was flowing out of the adit and ponding on the waste rock pile, then flowing through the mill structure to the stream. During that investigation, the HDPE pipe was partially filled with iron sludge, reducing its capacity. The flow measured at this source varied between 58 and 75 gpm of pH 5.3 to 6.4 water. The Bagley Tunnel adit discharge produced approximately 4.5 to 9 pounds of metals per day, dominated by zinc and manganese. The Bagley adit discharge produced approximately 2.5 to 3 pound of zinc per day. There was a measurable increase of 10 to 12 pounds of zinc per day in California Gulch below the Bagley Mine measured during a 1997/98 investigation. (Refs. 14, pp. 5, 77, 79; 55, p.2) The adit discharge appears to flow partially over the waste pile for approximately 342 ft and then over soil for approximately 250 ft directly into the West Fork Animas River (California Gulch) (Ref. 14, p. 77; 55, p. 2).

<u>Source Number</u>: U-2B

<u>Name of Source</u>: Frisco/Bagley Tunnel Waste Rock Pile

<u>Source Type</u>: Pile

<u>Description</u> and <u>Location</u> of Source: (Figure 2)

The Frisco/Bagley Tunnel waste rock pile is located approximately 1/2 mile west of Animas Forks on the north side of California Gulch (Ref. 14, p.78). The Frisco/Bagley Tunnel is located at an elevation of 11,440 ft, and is believed to be on the Gorilla patented mining claim. The mine is located at latitude N37°55'54.4', longitude W107°34'53.2' (Ref. 14, pp. 75). The Frisco/Bagley Tunnel waste rock pile source consists of two piles separated by the 4-wheel drive access road. Combined quantity of the waste piles is approximately 20,500 CY. Because these two piles are composed of the same types of waste, have the same containment values, affect the same targets, are the same source type, and are found in the same watershed, they are being addressed as one combined source for HRS scoring purposes. The waste rock piles are comprised of a northern main pile and southern pile by the former mill: these are dominantly country rock from the crosscut adit, but do contain some waste that is pyritic, with sphalerite and some galena and chalcopyrite. The southern pile appears to be more mineralized than the main, northern pile. The southern pile at this mine is located approximately 150 yards southeast of the main pile in a small valley on public lands and/or the Gorilla claim. A dam was constructed to impound the waste, which are kept continually wet by seepage from a wetland above them. There is a large vegetation kill zone below the mine area. The volume of the southern pile is estimated to be 1,500 CY. (Ref. 14, pp. 75-78). Although sampling data for this source was generated in the late 1990’s, because metals do not degrade and the piles have not been removed, contaminants are still present in the source.

<u>Source Number</u>: U-3A

<u>Name of Source</u>: Columbus Mine Adit Discharge

<u>Source Type</u>: Other (adit)

Description and Location of Source: (Figure 2)

The Columbus Mine adit is located across the stream in California Gulch from Animas Forks at an elevation of 11,240 ft. This mine is believed to be on the Dakota and Valkyre patented mining claims. The adit source crosscuts northwards to ore bodies located along the Animas River upstream of California Gulch. The mine is located at latitude N37°55'59.7", longitude W107°34'14.7"(Ref. 14, p.80). The adit discharge flow was measured at 1.5 to approximately 6 gpm and had a pH of 2.9 & 3.3 during a 1997/98 site investigation (Ref. 14, p. 82). The adit discharge exits the adit and quickly infiltrates into the pile, flows south for approximately 310 ft before emerging below it and entering California Gulch. There were a series of seeps below both levels of the waste rock pile that may be from the adit discharge (Refs. 14, pp. 80-82; 55, p. 3). During a 1997/98 site investigation, the adit discharge produced about 23 to 32% of the dissolved zinc, 20 to 39% of the dissolved copper and 11 to 19% of the dissolved aluminum load from adit discharges in the Upper Animas River. Overall, the adit discharge produces approximately 6 to 12 pounds of hazardous metals per day (Ref. 14, p. 82).

Source Number: U-3B

Name of Source: Columbus Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 2)

The Columbus Mine waste rock pile is located across the stream in California Gulch from Animas (Ref. 14, p.80). The waste rock pile source at the Columbus Mine is on two levels. Because these two levels are composed of the same types of waste, have the same containment values, affect the same targets, are the same source type, and are found in the same watershed they are addressed as one combined source for HRS scoring purposes. The access road to the mine adit crosses the flat portion between the levels. The pile contains approximately 24,000 CY of fine to coarse sulfide waste containing pyrite and sphalerite, and some calcopyrite and galena. Runoff from the waste rock pile flows directly into California Gulch/West Fork Animas River (Refs. 14, p. 81; 55, p.3). Much of the runoff water is channeled by access roads. The leachate analysis showed that the waste was high in copper and zinc during the 1997/98 site investigation (Ref. 14, pp. 5, 80-82). Although sampling data for this source was generated in the late 1990's, because metals do not degrade and the piles have not been removed, contaminants are still present in the source.

Source Number: U-4A

Name of Source: Tom Moore Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 2)

The Tom Moore Mine adit is located approximately 1 mile north of Eureka at an elevation of 10,360 ft. Access to this mine is by a road from the Silver Wing Mine. This mine is believed to be on the Byron patented mining claim. The mine is located at latitude N37°53'59.0", longitude W107°33'31.9" (Ref. 14,

p. 97). The flow from this mine has been measured between 36 and 50 gpm of pH 7.3-7.6 water during a 1997/98 site investigation (Ref. 14, p. 98). The adit discharge was producing approximately 0.6 to 0.7 pounds of metals per day and discharges in a southwest direction adjacent to the waste rock pile for approximately 180 ft directly to the Upper Animas River (Ref. 14, pp. 12, 97, 98; 55, p. 4).

Source Number: U-4B

Name of Source: Tom Moore Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 2)

The Tom Moore Mine is located approximately 1 mile north of Eureka (Ref. 14, p. 97). The waste rock pile source at the Tom Moore Mine is located immediately adjacent to the Animas River. The pile contains approximately 4,000 CY of waste rock containing. Manganese staining is prevalent over the surface of the pile. Where avalanches have carried debris onto the pile, sparse vegetation is growing. (Ref. 14, p. 97). This area is subject to snow avalanches. When avalanches occur at this location, this increases the leaching of hazardous metals from the waste rock pile (Ref. 14, p. 97). Although sampling data for this source was generated in the late 1990's, because metals do not degrade and the piles have not been removed, contaminants are still present in the source.

Source Number: U-5B

Name of Source: Kittimack Tailings Waste Pile

Source Type: Pile

Description and Location of Source: (Figure 2)

The Kittimack mill tailings waste pile source is located adjacent to the county road near the confluence of the Animas River and Maggie Gulch. The mill tailings pile is at an elevation of approximately 9,740 ft. The tailings piles are believed to be on the French Placer claim. The main tailings pile is located near latitude N37°51 '32.2", longitude W107°34'14.1" (Ref. 15, p. 128; 55, p. 5).
Although sampling data for this source was generated in the late 1990's, because metals do not degrade and the piles have not been removed, contaminants are still present in the source.

Source Number: U-6A

Name of Source: Amy Tunnel of Aspen Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 2)

The Amy Tunnel of Aspen Mine adit discharge source of the Aspen Mine is located south of the Animas River on the slopes of Kendall Mountain at an elevation of approximately 9,760 ft. This source is believed to be on the Aspen Group claims. The mine is located at latitude N37°49'16.2" longitude W107°37'49.8" (Ref. 15, p. 141). The tunnel adit was found to drain between 190 to 325 gpm of pH 7.0+ water over the waste pile and into a series of beaver ponds that drain into the Animas River during a 1997/98 site investigation (Ref. 15, p. 143). The adit drainage flows northwest for approximately 1,503 ft (Ref. 55, p.6). During high-flow, the measured dissolved zinc and iron loading from this mine was about four times that found during low-flow (Ref. 15, pp. 20, 143).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE – UPPER ANIMAS RIVER

Source No.	Source Name	Units	Hazardous Substances Associated with a Source *Associated Sample ID in Italics*					Reference
			Al	**Cd**	**Cu**	**Mn**	**Zn**	
1A	Vermillion Mine Adit Discharge aq.	µg/L	3,079 *DM-17*	211 *DM-17*	1,303 *DM-17*	7,288 *DM-17*	51,660 *DM-17*	14, pp. 121, 123, 125, 127
1B	Vermillion Mine Waste Rock Pile so.	ppb	2,300 *#6*	84 *#6*	590 *#6*	1,400 *#6*	18,000 *#6*	14, p. 150-151
2A	Frisco/ Bagley Mine Adit Discharge aq.	µg/L	135 *DM-19*	11.2 *DM-19*	N/A *DM-19*	7,603 *DM-19*	3,669 *DM-19*	14, pp. 121, 123, 125, 127
2B	Frisco/ Bagley Mine Waste Rock Pile so.	ppb	76 *#10*	8 *#10*	38 *#10*	1,000 *#10*	2,100 *#10*	14, p. 150-151
3A	Columbus Mine Adit Discharge aq.	µg/L	18,870 *DM-20*	1,037 *DM-20*	7,707 *DM-20*	13,610 *DM-20*	247,800 *DM-20*	14, pp. 121, 123, 125, 127
3B	Columbus Mine Waste Rock Pile so.	ppb	440 *#13*	54 *#13*	660 *#13*	1.8 *#13*	10,000 *#13*	14, p. 150-151
4A	Tom Moore Mine Adit Discharge aq.	µg/L	N/A *DM-22*	2.0 *DM-22*	N/A *DM-22*	537 *DM-22*	845 *DM-22*	14, pp. 121, 123, 125, 127
4B	Tom Moore Mine Waste Rock Pile so.	ppb	12,000 *#33*	270 *#33*	760 *#33*	34,000 *#33*	58,000 *#33*	14, p. 150-151
5B	Kittimack Tailings Waste Pile so.	ppb	415.9 *#13*	12.6 *#13*	1101.6 *#13*	339.6 *#13*	2,370.2 *#13*	15, pp. 228-232
6A	Amy Tunnel of Aspen Mine Adit Discharge aq.	µg/L	N/A *DM64*	5.5 *DM64*	18.8 *DM64*	14.5 *DM64*	1,574,000 *DM64*	15, pp. 187, 190, 193, 199

Notes:	µg/L	micrograms per liter
	aq.	Aqueous sample, dissolved metals
	N/A	Not Associated with the source
	ppb	parts per billion
	so.	Passive aqueous extract of a solid sample

Source Number: U-1A

Name of Source: Vermillion Mine Adit Discharge

Source Samples:

During a September 1997 sampling event performed by Colorado DMG, flow measurements were taken at the same time that the water quality samples were collected. Water quality sampling and flow measurements were taken by continually moving up the watershed during the day. Raw depth and width integrated samples were taken in the stream. The dissolved metals samples were collected by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml sample bottle. After sampling, the samples were placed in coolers, and iced. All sampling activities were completed at the sampling location. During the sampling, pH, electrical conductivity and temperature were measured at the sampling location (Ref. 14, pp. 11, 14).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	**Evidence**		**References**
	Sample No.	**Dissolved Concentration (µg/L)**	
Aluminum	DM-17	3,079	14, pp. 121, 123, 125, 127
Cadmium		211	
Copper		1,303	
Manganese		7,288	
Zinc		51,660	

Notes: µg/L micrograms per liter

Source Sample Information

The source samples listed above were analyzed by the by the EPA Region 8 lab in Golden, Colorado (Ref. 31, pp. 1, 20).

Source Number: U-1B

Name of Source: Vermillion Mine Waste Rock Pile

Source Samples:

For the Vermillion Mine source pile, during a Colorado DMG August 1998 sampling event, a composite sample from multiple locations was subjected to a passive water extraction in the field, and this aqueous extract was analyzed by the laboratory (Ref. 14, pp. 11, 13, 16).

Waste rock and soil outcropping samples were collected from a minimum of ten and maximum of twenty locations at each source. Acid-washed plastic 100 ml beakers were used to remove the top two inches of material. The sub-samples from each source were composited in a l-gallon re-closeable plastic bag. The composited samples were thoroughly mixed in the field by inverting the bag numerous times. After mixing, 150 ml of sample was removed and placed in a 1 liter plastic beaker along with 300 ml of deionized water. The wetted sample was then vigorously mixed for 15 seconds, plastic wrap was placed over the top, then left to settle for 90 minutes. Ninety minutes was the amount of time it took for the clay fraction to settle to the bottom of the beaker (Ref. 14, p. 16).

After 90 minutes, the liquid was filtered through very fine grade soil filters (approximately 2 micron). A portion of the liquid was then used to measure the total acidity, pH, and specific conductance. The remaining liquid was acidified with nitric acid for lab analysis (Ref. 14, p. 16).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Concentration (ppb)	
Aluminum	Site #6	2,300	14, pp. 150-151
Cadmium		84	
Copper		590	
Manganese		1,400	
Zinc		18,000	

Notes: ppb parts per billion

Source Sample Information

The source samples listed above were analyzed by the by the EPA Region 8 lab in Golden, Colorado (Ref. 14, pp. 150-151).

Source Number: U-2A

Name of Source: Frisco/Bagley Tunnel Adit Discharge

Source Samples:

During a September 1997 sampling event (performed by Colorado DMG) for the Frisco/Bagley Tunnel adit discharge, flow measurements were taken at the same time that the water quality samples were collected. Water quality sampling and flow measurements that were taken by continually moving up the watershed during the day. Raw depth and width integrated samples were taken in the stream. The dissolved metals samples were collected by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml sample bottle. After sampling, the samples were placed in coolers, and iced. All sampling activities were completed at the sampling site. During the sampling, pH, electrical conductivity and temperature were measured at the site (Ref. 14, pp. 11, 14).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	DM-19	135	14, pp. 121, 123, 125, 127
Cadmium		11.2	
Manganese		7,603	
Zinc		3,669	

Notes: ug/L micrograms per liter

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 31, pp. 1, 19).

Source Number: U-2B

Name of Source: Frisco/Bagley Tunnel Waste Rock Pile

Source Samples:

For the Frisco/Bagley Tunnel source pile, during a Colorado DMG August 1998 sampling event, a composite sample from multiple locations was subjected to a passive water extraction in the field, and this aqueous extract was analyzed by the laboratory.

Waste rock and soil outcropping samples were collected from a minimum of ten and maximum of twenty locations at each source. Acid-washed plastic 100 ml beakers were used to remove the top two inches of material (Ref. 14, p.16). The sub-samples from each source were composited in a l-gallon re-closeable plastic bag. The composited samples were thoroughly mixed in the field by inverting the bag numerous times. After mixing, 150 ml of sample was removed and placed in a 1 liter plastic beaker along with 300 ml of deionized water. The wetted sample was then vigorously mixed for 15 seconds, plastic wrap was placed over the top, then left to settle for 90 minutes. Ninety minutes was the amount of time it took for the clay fraction to settle to the bottom of the beaker (Ref. 14, p. 16).

After 90 minutes, the liquid was filtered through very fine grade soil filters (approximately 2 micron). A portion of the liquid was then used to measure the total acidity, pH, and specific conductance. The remaining liquid was acidified with nitric acid for lab analysis (Ref. 14, p. 16)

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Concentration (ppb)	
Aluminum	Site #10	76	14, pp. 150-151
Cadmium		8	
Copper		38	
Manganese		1,000	
Zinc		2,100	

Notes: ppb parts per billion

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 14, pp. 150-151).

Source Number: U-3A

Name of Source: Columbus Mine Adit Discharge

Source Samples:

During a September 1997 sampling event (performed by Colorado DMG) for the Columbus mine adit discharge, flow measurements were taken at the same time that the water quality samples were collected. Water quality sampling and flow measurements that were taken by continually moving up the watershed during the day. Raw depth and width integrated samples were taken in the stream. The dissolved metals samples were collected by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml sample bottle. After sampling, the samples were placed in coolers, and iced. All sampling activities were completed at the sampling site. During the sampling, pH, electrical conductivity and temperature were measured at the site (Ref. 14, pp. 11, 14).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	DM-20	18,870	14, pp. 121, 123, 125, 127
Cadmium		1,037	

Copper		7,707	
Manganese		13,610	
Zinc		247,800	

Notes: µg/L mircograms per liter

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 31, pp. 1, 19).

Source Number: U-3B

Name of Source: Columbus Mine Waste Rock Pile

Source Samples:

For the Columbus Mine source pile, during a Colorado DMG August 1998 sampling even, a composite sample from multiple locations was subjected to a passive water extraction in the field, and this aqueous extract was analyzed by the laboratory.

Waste rock and soil outcropping samples were collected from a minimum of ten and maximum of twenty locations at each source. Acid-washed plastic 100 ml beakers were used to remove the top two inches of material. The sub-samples from each source were composited in a l-gallon re-closeable plastic bag. The composited samples were thoroughly mixed in the field by inverting the bag numerous times. After mixing, 150 ml of sample was removed and placed in a 1 liter plastic beaker along with 300 ml of deionized water. The wetted sample was then vigorously mixed for 15 seconds, plastic wrap was placed over the top, then left to settle for 90 minutes. Ninety minutes was the amount of time it took for the clay fraction to settle to the bottom of the beaker (Ref. 14, p. 16).

After 90 minutes, the liquid was filtered through very fine grade soil filters (approximately 2 micron). A portion of the liquid was then used to measure the total acidity, pH, and specific conductance. The remaining liquid was acidified with nitric acid for lab analysis (Ref. 14, p. 16)

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Concentration (ppb)	
Aluminum	Site #13	440	14, pp. 150-151
Cadmium		54	
Copper		660	
Manganese		1.8	

Hazardous Substance	Evidence		References
	Sample No.	Concentration (ppb)	
Zinc		10,000	

Notes: ppb parts per billion

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 14, pp. 150-151).

Source Number: U-4A

Name of Source: Tom Moore Mine Adit Discharge

Source Samples:

During a September 1997 sampling event (performed by Colorado DMG) for the Tom Moore mine adit discharge, flow measurements were taken at the same time that the water quality samples were collected. Water quality sampling and flow measurements that were taken by continually moving up the watershed during the day. Raw depth and width integrated samples were taken in the stream. The dissolved metals samples were collected by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml sample bottle. After sampling, the samples were placed in coolers, and iced. All sampling activities were completed at the sampling site. During the sampling, pH, electrical conductivity and temperature were measured at the site (Ref. 14, pp. 11, 14).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Concentration (µg/L)	
Cadmium	DM-22	2.0	14, pp. 121, 123, 125, 127
Manganese		537	
Zinc		845	

Notes: µg/L micrograms per liter

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 31, pp. 1, 20).

Source Number: U-4B

Name of Source: Tom Moore Mine Waste Rock Pile

Source Samples:

For the Tom Moore Mine source pile, during a Colorado DMG August 1998 sampling event, a composite sample from multiple locations was subjected to a passive water extraction in the field, and this aqueous extract was analyzed by the laboratory.

Waste rock and soil outcropping samples were collected from a minimum of ten and maximum of twenty locations at each source. Acid-washed plastic 100 ml beakers were used to remove the top two inches of material (Ref. 14, p. 16). The sub-samples from each source were composited in a l-gallon re-closeable plastic bag. The composited samples were thoroughly mixed in the field by inverting the bag numerous times. After mixing, 150 ml of sample was removed and placed in a 1 liter plastic beaker along with 300 ml of deionized water. The wetted sample was then vigorously mixed for 15 seconds, plastic wrap was placed over the top, then left to settle for 90 minutes. Ninety minutes was the amount of time it took for the clay fraction to settle to the bottom of the beaker (Ref. 14, p. 16).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

<table>
<tr><th rowspan="2">Hazardous Substance</th><th colspan="2">Evidence</th><th rowspan="2">References</th></tr>
<tr><th>Sample No.</th><th>Concentration (ppb)</th></tr>
<tr><td>Aluminum</td><td rowspan="3">Site #33</td><td>12,000</td><td rowspan="5">14, pp. 150-151</td></tr>
<tr><td>Cadmium</td><td>270</td></tr>
<tr><td>Copper</td><td>760</td></tr>
<tr><td>Manganese</td><td rowspan="2">Site #33</td><td>34,000</td></tr>
<tr><td>Zinc</td><td>58,000</td></tr>
</table>

Notes: ppb parts per billion

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 14, pp. 150-151).

Source Number: U-5B

Name of Source: Kittimack Tailings Waste Pile

Source Samples:

For the Kittimack Tailings waste pile, during a Colorado DMG August 1998 sampling event, a composite sample from multiple locations was subjected to a passive water extraction in the field, and this aqueous extract was analyzed by the laboratory.

Waste rock and soil outcropping samples were collected from a minimum of ten and maximum of twenty locations at each source. Acid-washed plastic 100 ml beakers were used to remove the top two inches of material. The sub-samples from each source were composited in a l-gallon re-closeable plastic bag. The composited samples were thoroughly mixed in the field by inverting the bag numerous times. After mixing, 150 ml of sample was removed and placed in a 1 liter plastic beaker along with 300 ml of deionized water. The wetted sample was then vigorously mixed for 15 seconds, plastic wrap was placed over the top, then left to settle for 90 minutes. Ninety minutes was the amount of time it took for the clay fraction to settle to the bottom of the beaker (Ref. 15, p. 24).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Concentration (ppb)	
Aluminum	Site #13	415.9	15, pp. 228-232
Cadmium		12.6	
Copper		1101.6	
Manganese		339.6	
Zinc		2370.2	

Notes: ppb parts per billion

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 15, pp. 16; 228-232).

Source Number: U-6A

Name of Source: Amy Tunnel of Aspen Mine Adit Discharge

Source Samples:

During a June 1999 sampling event (performed by Colorado DMG) for the Amy Tunnel of Aspen Mine adit discharge, flow measurements were taken at the same time that the water quality samples were collected. Water quality sampling and flow measurements that were taken by continually moving up the watershed during the day. Water samples were collected by representatives of various government agencies. Raw depth and width integrated samples were taken in the stream. The dissolved metals samples were collected by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml sample bottle. After sampling, the samples were placed in coolers, and iced. All sampling activities were completed at the sampling site. During the sampling, pH, electrical conductivity and temperature were measured at the site (Ref. 15, p.17).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Cadmium	DM-64	5.5	15, pp. 187, 190, 193, 196, 199
Copper		18.8	
Manganese		14.5	
Zinc		1,574,000	

Notes: µg/L   micrograms per liter

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Refs. 15, pp. 16-17; 31, pp. 1, 20).

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY – UPPER ANIMAS RIVER

Source No.	Source Name	Source Type	Surface Water Containment Description*	Containment Value	Reference
U-1A	Vermillion Mine Adit Discharge	Other (adit)	Observed discharging to gulch	10	14, pp. 71-75; 55, p. 1
U-1B	Vermillion Mine Waste Rock Pile	Pile	Visibly in contact with wetlands on creek	10	14, pp. 71-75
U-2A	Frisco/Bagley Tunnel Adit Discharge	Other (adit)	Observed discharging to gulch	10	14, pp. 75-79; 55, p.2
U-2B	Frisco/Bagley Tunnel Waste Rock Pile	Pile	Placed in a historic wetland on the gulch	10	14, p. 75-79; 55, p. 2
U-3A	Columbus Mine Adit Discharge	Other (adit)	Observed discharging to pile then gulch	10	14, pp. 81-83; 55, p. 3
U-3B	Columbus Mine Waste Rock Pile	Pile	Runoff flows directly into the gulch	10	14, pp. 81-83; 55, p. 3
U-4A	Tom Moore Mine Adit Discharge	Other (adit)	Observed discharging to river	10	14, pp. 97-98; 55, p. 4
U-4B	Tom Moore Mine Waste Rock Pile	Pile	Directly in contact with the Animas River	10	14, pp. 97-98; 55, p. 4
U-5B	Kittimack Tailings Waste Pile	Pile	No liner, run on/off controls	10	15, p. 129
U-6A	Amy Tunnel of Aspen Mine Adit Discharge	Other (adit)	Observed discharging to river	10	15, p. 143; 55, p. 6

* Only Overland Flow containment has been evaluated.

2.4.2 HAZARDOUS WASTE QUANTITY – UPPER ANIMAS RIVER

Note: the total hazardous constituent quantity for all Sources could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the sources is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.1). There are insufficient historical and current data (manifests, Potentially Responsible Party (PRP) records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the sources to calculate the total hazardous constituent quantity with reasonable confidence. As such, all source evaluations will begin with Tier B.

Source No.	Waste Description[1]	Source Type	Tier	Calculations	HWQ Assigned Value	Reference
U-1A	Vermillion Mine Adit Discharge, 8 gpm	Other (adit)	B	42,048,000 lbs./year /5,000 = 8,409.6	8,409.6	14, p. 72
U-1B	Vermillion Mine Waste Rock Pile, 5,100 CY	Pile	C[2]	5,100 CY/2.5 = 2,040	2,040	14, p. 72
U-2A	Frisco/Bagley Tunnel Adit Discharge, 58 gpm	Other (adit)	B	835,200 lbs./day /5,000 = 167.0	167.0	14, p. 79
U-2B	Frisco/Bagley Tunnel Waste Rock Pile, 20,500 CY	Pile	C[2]	20,500 CY/2.5 = 8,200	8,200	14, p. 78
U-3A	Columbus Mine Adit Discharge, 1.5 gpm	Other (adit)	B	21,600 lbs./day /5,000 = 4.32	4.32	14, p. 82
U-3B	Columbus Mine Waste Rock Pile, 24,000 CY	Pile	C[2]	24,000 CY/2.5 = 9,600	9,600	14, p. 81
U-4A	Tom Moore Mine Adit Discharge, 36 gpm	Other (adit)	B	518,400 lbs./day /5,000 = 103.68	103.68	14, p. 98
U-4B	Tom Moore Mine Waste Rock Pile, 4,000 CY	Pile	C[2]	4,000 CY/2.5 = 1,600	1,600	14, p. 97
U-5B	Kittimack Tailings Waste Pile, 23,000 CY	Pile	C[2]	23,000 CY/2.5= 9,200	9,200	15, p. 68
U-6A	Amy Tunnel of Aspen Mine Adit Discharge, 190 gpm	Other (adit)	B	2,736,000 lbs./day /5,000 = 547.2	547.2	15, p. 143

Notes: gpm gallons per minute
lbs. pounds
CY cubic yards
HWQ Hazardous Wastestream Quantity

[1] If a range of adit discharge rates were provided in the reference, the lowest discharge rate was used to calculate the hazardous wastestream quantity.

[2] The total hazardous wastestream quantity for Sources U-1B, U-2B, U-3B, U-4B and U-5B could not be adequately determined according to the HRS requirements; that is, the total mass of all hazardous wastestreams and CERCLA pollutants and contaminants in the source is not known and cannot be estimated with reasonable confidence [Ref. 1, pp. 51591 (Section 2.4.2.1.2)].There are insufficient historical and current data (manifests, PRP records, State records, permits, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous wastestream and CERCLA pollutants and contaminants in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the total hazardous wastestream quantity for Sources U-1B, U-2B, U-3B, U-4B and U-5B with reasonable confidence.

2.4.2.1.3 Hazardous Wastestream Quantity (Tier B) (Ref. 1, p. 51591)

Description – U-1A: Vermillion Mine Adit Discharge

The hazardous wastestream quantity for the Vermillion Mine adit discharge (Source U-1A) was estimated based on the flow from the adit that contains dissolved metals for aluminum, cadmium, copper, manganese, and zinc collected over one day. Because the adit discharge is perennial, the daily value for the lowest recorded flow rate was multiplied by 365 days [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 14, p. 72]. 42,048,000/5,000 = 8,409.6

8 g/m x 1440 m/d = 11,520 gallons/day
11,520 g/d x 10 lbs./gallon = 115,200 lbs./day
115,200 lbs./day x 365 days/year = 42,048,000 lbs./year
42,048,000 lbs./year /5,000 = 8,409.6

Sum (pounds): 42,048,000
Sum of Wastestream Quantity/5,000 (Table 2-5): 8,409.6

2.4.2.1.3 Volume (Tier C) (Ref. 1, p. 51591)

Description – U-1B: Vermillion Mine Waste Rock Pile

The pile at the Vermillion Mine (Source U-1B) is estimated to contain about 5,100 CY. The waste rock is highly acid forming. The waste pile is located in a wetland area immediately below perennial springs. (Ref. 14. pp. 71-73).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to 5,100 CY / 2.5 = 2,040

Volume Assigned Value (V): 2,040

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B) (Ref. 1, p. 51591)

Description – U-2A: Frisco/Bagley Tunnel Adit Discharge

The hazardous wastestream quantity for the Frisco/Bagley Tunnel adit discharge (Source U-2A) was estimated based on the flow from the adit that contains dissolved metals for aluminum, cadmium, copper, manganese, and zinc collected over one day, and calculated to be 835,200 lbs./day [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 14, p. 79]. 835,200/5,000 = 167.04

58 g/m x 1440 m/d = 83,520 gallons/day
83,520 g/d x 10 lbs./gallon = 835,200 lbs./day
835,200 lbs./day /5,000 = 167.04

Sum (pounds): 835,200
Sum of Wastestream Quantity/5,000 (Table 2-5): 167.04

Hazardous Wastestream Quantity Assigned Value (W): 167.04

2.4.2.1.3 Volume (Tier C) (Ref. 1, p. 51591)

Description – U-2B: Frisco/Bagley Tunnel Waste Rock Pile

The waste rock at the Frisco/Bagley Tunnel_consists of two piles (Source U-2B). Combined quantity of the waste piles is approximately 20,500 CY. (Ref. 14, pp. 75-78).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to 20,500 CY / 2.5 = 8,200

Volume Assigned Value (V): 8,200

2.4.2.1.3 Hazardous Wastestream Quantity (Tier B) (Ref. 1, p. 51591)

Description – U-3A: Columbus Mine Adit Discharge

The hazardous wastestream quantity for the Columbus Mine adit discharge (Source U-3A) was estimated based on the flow from the adit that contains dissolved metals for aluminum, cadmium, copper, manganese, and zinc collected over one day, and calculated to be 21,600 lbs./day [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 14, p. 82]. 21,600/5,000 = 4.32

1.5 g/m x 1440 m/d = 2,160 gallons/day
2,160 g/d x 10 lbs./gallon = 21,600 lbs./day
21,600 lbs./day /5,000 = 4.32

Sum (pounds): 21,600
Sum of Wastestream Quantity/5,000 (Table 2-5): 4.32

Hazardous Wastestream Quantity Assigned Value (W): 4.32

2.4.2.1.3 Volume (Tier C) (Ref. 1, p. 51591)

Description – U-3B: Columbus Mine Waste Rock Pile

The waste rock at the Columbus Mine (Source U-3B) is on two levels. The pile contains approximately

24,000 CY of fine to coarse sulfide waste. Runoff from the waste rock pile flows directly into California Gulch. Much of the runoff water is channeled by access roads. The leachate analysis shows that the waste contains copper and zinc (Ref. 14, pp. 81).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to 24,000 CY / 2.5 = 9,600

Volume Assigned Value (V): 9,600

2.4.2.1.3 Hazardous Wastestream Quantity (Tier B) (Ref. 1, p. 51591)

Description – U-4A: Tom Moore Mine Adit Discharge

The hazardous wastestream quantity for the Tom Moore Mine adit discharge (Source U-4A) was estimated based on the flow from the adit that contains dissolved metals for aluminum, cadmium, copper, manganese, and zinc collected over one day, and calculated to be 518,400 lbs./day [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 14, p. 98]. 518,400/5,000 = 103.68

36 g/m x 1440 m/d = 51,840 gallons/day
51,840 g/d x 10 lbs./gallon = 518,400 lbs./day
518,400 lbs./day /5,000 = 103.68

Sum (pounds): 518,400
Sum of Wastestream Quantity/5,000 (Table 2-5): 103.68

2.4.2.1.3 Volume (Tier C) (Ref. 1, p. 51591)

Description – U-4B: Tom Moore Mine Waste Rock Pile

The waste rock pile (Source U-4B) is located immediately adjacent to the Animas River. The pile contains approximately 4,000 CY of waste rock. Manganese staining is prevalent over the surface of the pile. (Ref. 14, pp. 97, 98).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to 4,000 CY / 2.5 = 1,600

Volume Assigned Value (V): 1,600

2.4.2.1.3 Volume (Tier C) (Ref. 1, p. 51591)

Description – U-5B: Kittimack Tailings Waste Pile

The mill tailings pile (Source U-5B) covers an area of approximately 7 acres. The mill tailings cover the valley to a maximum depth of about 6 ft. Some of the tailings have been eroded toward the Animas by wind and water. Where rocks are exposed, there is considerable manganese staining. The pile contains approximately 23,000 CY of sandy mill tailings. The mill tailings contain leachable copper and lead, and moderately high in zinc. (Ref. 15, p. 129).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to 23,000 CY / 2.5 = 9,200

Volume Assigned Value (V): 9,200

2.4.2.1.3 Hazardous Wastestream Quantity (Tier B) (Ref. 1, p. 51591)

Description – U-6A: Amy Tunnel of Aspen Mine Adit Discharge

The hazardous wastestream quantity for the Amy Tunnel of Aspen Mine adit discharge (Source U-6A) was estimated based on the flow from the adit that contains dissolved metals for aluminum, cadmium, copper, manganese, and zinc collected over one day, and calculated to be 2,736,000 lbs./day [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 15, pp. 141-143]. 518,400/5,000 = 103.68

190 g/m x 1440 m/d = 273,600 gallons/day
273,600 g/d x 10 lbs./gallon = 2,736,000 lbs./day
2,736,000 lbs./day /5,000 = 547.2

Sum (pounds): 2,736,000
Sum of Wastestream Quantity/5,000 (Table 2-5): 547.2

SUMMARY OF UPPER ANIMAS RIVER SOURCE DESCRIPTIONS

Source No.	Mine	Source Hazardous Waste Quantity Value	Mine Total	Source Hazardous Constituent Quantity Complete? (Y/N)	Containment Factor Value to Pathway – Surface Water (SW) – Overland/flood
U-1A	Vermillion Mine	8,409.6	10,449.6	N	10
U-1B		2,040		N	10
U-2A	Frisco/Bagley Tunnel	167.04	8,367.04	N	10
U-2B		8,200		N	10
U-3A	Columbus Mine	4.32	9,604.32	N	10
U-3B		9,600		N	10
U-4A	Tom Moore Mine	103.68	1,703.68	N	10
U-4B		1,600		N	10
U-5B	Kittimack Tailings	9,200	9,200	N	10
U-6A	Amy Tunnel of the Aspen Mine	547.2	547.2	N	10

Description of Other Possible Mines and Mine Related Sources

Given the interconnected nature of the ore bodies and general geology of the study area, these possible mining related sources listed below may also be releasing hazardous substances to the Upper Animas drainage and will be further evaluated during further investigation of this site.

Feature	Description (Reference)
London Mine	Water quality impacts from the London Mine occur from the adit discharges and the waste rock pile. The measured flow from the main adit (DM-7) varies from about 1 to 1.5 gpm. The measured flow from adits DM-5 and DM-6 vary from 0.15 to 6.5 gpm and 0.15 to 3.6 gpm, respectively. The adit discharge from the main adit does come in contact with the westernmost lobe of the waste pile. Drainage from the main mine adit produces more metals than either of the other two draining adits. In aggregate, compared to all the adit discharges in the Upper Animas River, these adit discharges have been estimated to produce 0.2 to 0.34% of the dissolved hazardous metals. The adit discharges produce approximately 0.1 to 0.25 pound of dissolved metals per day. Zinc is the principal dissolved metal in these drainages. The waste rock has been found to be generally high in lead and zinc (Ref. 14, p. 49).
Red Cloud Mine & Boston Mine Complex (Dewitt Mine)	This complex is located on the north side of Burrows Creek along the northwest side of Houghton Mountain above the trans-basin diversion ditch. There are four capped shafts and one collapsed adit at this mine complex. The shafts are located adjacent to the access road through upper Burrows Creek. Elevations range from 12,020 ft to 12,240 ft. The collar of the main shaft is at an elevation of 12,110 ft. The workings are situated on the Boston Mine, Dewitt Mine, Burrows No.2, Red Cloud Mine, and Deposite patented claims. The Boston mine is 650 ft northeast of the Red Cloud Mine main shaft on the same vein structure. This mine consists of a tunnel 200 ft long. The waste piles, in general, have high concentrations of iron, lead and zinc. There are vegetation kill zones below all the waste rock piles in this area. (Ref. 14, pp. 54-56)
Ben Butler Mine	The Ben Butler mine is located north of the London Mine near the hilltop, approximately 1,200 ft west of Denver Hill at an elevation of 12,200 ft. The waste rock at this mine consists of an estimated 400 to 600 CY of fine clayey to gravelly-sized quartz-sulfide waste, all mine from the same ore bodies as part of the historical Ben Butler operations. A 200-yard long vegetation kill zone extends downslope from the waste dump and becomes a drainage channel from the disturbed location into Burrows Creek. The waste rock at this mine exhibited elevated concentrations of aluminum, cadmium, iron and zinc (Ref. 14, pp 50, 51).
Mountain Queen Mine	The Mountain Queen Mine is situated in the headwaters of California Gulch. The Mountain Queen Mine consists of a shaft near the top of California Pass at an elevation of 12,790 ft and a draining mine adit east of the shaft at an elevation of 12,375 ft. This source is believed to be on the Mountain Queen Mine, Eclipse, Agitator, Fairchild, and Animas Belle patented mining claim. There is a water quality impact from the Mountain Queen shaft associated with hazardous metals leaching from the waste pile (Ref. 14, p. 60, 61). A sample collected from the Mountain Queen adit (A19A) in 2015 indicates the presence of hazardous substances, including aluminum, arsenic, cadmium, lead, manganese, and zinc. (Ref 32, pp. 26, 69; 41, p. 8)

Feature	Description (Reference)
Sunbank Group Mine	Sampling of the Sunbank Group Mine's Comet adit discharge (A21A), indicates concentrations of total and dissolved hazardous metals are discharging into Placer Gulch and hazardous metal loading is taking place, but characterization of the area has yet to be performed. Further investigation is required, considering the hazardous metals loading associated with this mine and mines in the study area. (Refs. 18, pp. 51, 52, 53; 32, pp. 26, 30, 53, 69; 48)
Clipper Mine	This small waste rock pile has had a profound effect on the surrounding area. A large kill zone extends for approximately 250 ft below the waste pile. The waste pile has an approximate volume of 1,100 cubic yards. The leachate analysis shows that this waste is acid forming with high quantities of leachable metals. The waste rock contains pyrite, chalcopyrite, sphalerite and galena. Water quality impacts from this mine are from leaching of the waste rock. Because of the close proximity of the stream to this source, there is likely some direct input of hazardous metals during spring snowmelt. Compared to all the waste piles sampled in the Animas River below Eureka, this waste had high acidity, copper and zinc concentrations in the leachate (Ref. 15, pp. 46-48)
Silver Wing Mine	The drainage from the mine adit and leaching and runoff from the waste rock pile have an impact on the Animas River water quality. The waste rock pile is considered to be a source of hazardous metals for most of the year. The mine drains approximately 10 to 19 gpm of pH 6.5 to 6.8 water. CDPHE data shows that the flow has reached as high as 28 gpm. According to one study, the adit discharge produced 1.6-2.9% of the dissolved hazardous metals. The adit discharge produced 39 to 44% of the dissolved copper from adit discharges in the Upper Animas River (Ref. 14, p. 96) A sample collected from the Silver Wing mine adit in 2015 (A29) indicated the presence of hazardous metals, including aluminum, cadmium, manganese, and zinc. (Refs. 18, pp. 51, 52, 53; 32, pp. 19, 26, 63, 68; 40, p. 74; 41, p. 13)
Sunnyside Mine	The Sunnyside Mine is located in the headwaters of Eureka Gulch at 37°54'01.2" N, 107°36'42.1" W. This was the largest mining operation in the area, and operated from 1873 through 1991. (Ref. 15, p. 37-38) The mine was temporarily closed in 1978 when Lake Emma breached the mine workings below and drained through the workings to Cement Creek via the American Tunnel. (Ref. 6a, p. 36) The mine workings are known to be connected to multiple features within the area, including American Tunnel and Terry Tunnel (Ref 6b, p. 30). The waste rock piles at this location were estimated to be 60,000 cubic yards and leachate analysis from the rock indicated the presence of aluminum (2,355 ppb), cadmium (134 ppb), copper (605 ppb), manganese (4 ppb), lead (2,182 ppb) and zinc (39,095 ppb). (Ref 15, p. 38) Remediation efforts have taken place within this general area over time.
Sunnyside Mine Pool Study Area	A pool of underground mine water has built up behind the American Tunnel bulkhead to an elevation of approximately 11,800 ft above mean sea level. The drainage from the American Tunnel is comprised of the water from the Sunnyside Mine Pool. (Ref. 59, pp. 1-2) This mine pool has impacted several mine workings in both Cement Creek and the Upper Animas River area, including the American Tunnel, the Mogul Mine/Grand Mogul Mine, the Red & Bonita, the Gold King Mine, the Terry Tunnel, the Sunnyside Mine, and the Gold Prince. As evidenced in the drainage from the American Tunnel, the Mogul and Grand Mogul Mine the Gold King Mine,

Feature	Description (Reference)
	Terry Tunnel, etc., the Sunnyside Mine Pool is known to contain aluminum, cadmium, manganese, zinc. (Ref. 4, p. 18, 29, 60)
Senator Mine	This mine is located near the townsite of Eureka, immediately northeast of the Eureka mill foundations at an elevation of 10,080 ft. It is believed to be on the Senator patented mining claim. The waste pile contains approximately 4,000 CY of fine clayey fault gouge and coarse wall rock. The principal water quality impact from this mine appears to be the adit discharge. The adit discharge contains approximately 29 to 40 pounds of hazardous metals per day. According to one study, compared to all the adit discharges in the Upper Animas River, this adit discharge produced approximately 37-54% of the dissolved hazardous metals. (Ref. 14, pp. 98-101).
Ben Franklin Mine	This mine is located immediately below the confluence of the headwaters of Eureka Gulch at an elevation of approximately 11,920 ft. Immediately below the confluence, the stream flows into a stope opening, then exits an adit opening approximately 500 ft below. This source is believed to be on the Ben Franklin claim. The waste rock pile from this mine is located along the stream as it exits the mine adit. A portion of the waste rock has been used to create a levee for the stream channel. This results in direct leaching of the waste rock as water from the stream passes through the pile. Identified water quality impacts from this mine come from the waste rock from mining operations. During one study period, low-flow, approximately 1/4 pound of zinc was added to Eureka Gulch from this mine. During the same study period, high-flow, approximately 2.5 pound of zinc, and 0.5 pounds of copper drained into Eureka Gulch from this mine (Ref. 15, pp. 51-53). A sample collected in 2015 at the Ben Franklin (DM32) indicates the presence of aluminum, cadmium, copper, lead, manganese, and zinc. (Refs. 18, p, 51; 32, pp. 27, 67; 41, p. 16)
Eureka Fluvial Tailings	Eureka Fluvial Tailings are located downstream of the former Eureka Mill. Sampling by various organizations of the Eureka fluvial tailings, which are located downstream of the former Eureka Mill, indicates that sediments and soils are high in hazardous metals and may be contributing to loading, based on historic and recent sampling events. Sampling of surficial materials by EPA in 2015 indicates the presence of aluminum, cadmium, copper, mercury, manganese, lead, and zinc. (Ref. 32, pp. 8, 12, 25, 49, 56, 73, 75, 76).
Forest Queen Mine	The Forest Queen Mine is located on the Animas River near Minnie Gulch, and is known to contain cadmium, iron, and zinc (Ref 6c, p. 20). A bio-reactor has been installed with unknown success. (Ref. 15, p. 66). A sample collected in 2015 from the Forest Queen adit (A41) indicates the presence of aluminum, arsenic, cadmium, copper, manganese, lead and zinc. (Refs. 18, p. 51; 32, pp. 26, 66)
Pride of the West Mine	This mine is located on the east side of Cunningham Gulch at an elevation of 10,280 ft. This source is believed to be on the Trail patented mining claim. The Pride of the West Mine has been projected to be the largest source of zinc and cadmium in Cunningham Gulch. During high-flow, the mine drainage from this mine has been projected to account for approximately 18% of the zinc above the confluence of Cunningham Gulch with the Animas River. During low-flow, the mine drainage has been projected to account for approximately 67% of the zinc in Cunningham Gulch above the confluence with the Animas River (Ref. 15, pp. 80, 83).

Feature	Description (Reference)
Mayflower Tailings	Mayflower tailings is comprised of four mill tailings repositories (Ref. 6b, pp. 43, 36). Leachate testing from mill tailings in the area indicate high concentrations of cadmium, copper, lead, and zinc (Ref. 6c, p. 9). Additionally, the Mayflower Mill used mercury for gold recovery (Ref. 6f, p. 15). Up until 1935, prior to the retention of mill tailings, approximately 8.6 million short tons of mill tailings entered the Animas River and its tributaries (Ref. 6a, p. 37). Collapses of the tailings repositories have resulted in tailings being released into the Animas River (Ref. 6f, p, 38).
Howardsville Colo Goldfields Tailings	The Howardsville Colo Goldfields Tailings piles are located immediately north and east of the town of Howardsville at an elevation of approximately 9,680 ft. A portion of the tailings pile is currently part of a permitted milling operation. The tailings piles are believed to be on the Howardsville Placer claim. The mill tailings pile covers an area of approximately 15-20 acres. There was a measured increase in dissolved zinc loading of almost 30 pounds per day during low-flow near the mine (Ref. 15, pp. 134, 135).
Little Nation Mine	The Transformer Level of the Little Nation Mine is located south of the Animas River approximately 200 yards south of the Cunningham Gulch/ Animas River confluence. The adit of the mine is at an elevation of approximately 10,091 ft. This source is believed to be on the Royal Charter claim. The mine drainage from this mine has been projected to be a source of zinc loading to the Animas River below Eureka. The mine drainage flows over the waste rock pile into a small wetland area. The mine drains between 60 to 105 gpm of pH 6.6 to 7.0 water (Ref. 15, pp. 135, 136).
Terry Tunnel	Primary access to the Sunnyside Mine during its latter years of operation was via the American and Terry Tunnels. The Terry Tunnel has been bulkheaded since then, but is below the top of the Sunnyside mine pool. (Ref. 59) The Sunnyside Mine pool is known to contain aluminum, cadmium manganese and zinc as evidenced by the surficial expression of the mine pool at the American Tunnel. (Ref 4, p. 18, 29, 60)
Aspen Mine	The Aspen Mine is located at LAT. N37°49'16.2", LONG. W107°37'49.8" and developed what may be the northwest extension of the Shenandoah-Dives vein system. The workings drifted on a N25°W trending structure, on at least 5 adit levels. The lowest level, known as the Amy Tunnel, is driven southeast from the Animas river valley at an elevation of 9,760 feet. The ores of the Aspen Mine consisted of galena, sphalerite, chalcopyrite, and tetrahedrite in pockets and bunches, and even a little native silver in the upper mine levels. The gangue is quartz, with considerable amounts of green fluorite. The waste rock pile contains approximately 20,000 cubic yards of yellow waste rock containing chalcopyrite, pyrite, galena and sphalerite. Leachate results show this waste to be high in cadmium, copper and zinc. There is some flow from the slopes above that runs onto this pile (Ref. 15, pp. 141).

2.2 SOURCE CHARACTERIZATION – CEMENT CREEK

Although there are many possible sources contributing to surface water contamination associated with this site, this portion of the HRS documentation record is focused solely on the Cement Creek drainage, to make discussion easier. In addition, multiple sources were identified in the Cement Creek drainage (Figure 3). Each source is detailed in the tables below to include an assigned source number, source name, type, description, location as well as hazardous substances associated with the source, hazardous substances available to a pathway and hazardous waste quantities. A complete source identification for each source in the Cement Creek drainage follows the tables below:

Source No.	Source Name and Description	Source Type	Location (Figure 3)	Reference
C-1A	Grand Mogul Mine Adit Discharge. The Grand Mogul Mine has been observed to have one flowing adit.	Other (adit)	Upper Cement Creek (Ross Basin) latitude N37°54'31 .3" longitude W107°37'41 .9" elevation: 11,800 ft.	Refs. 5, pp. 6, 15; 3, pp. 7-10; 2, pp. 56
C-1B	Grand Mogul Mine Waste Rock Pile. The Grand Mogul Mine contains three discrete waste rock (valueless rock that must be fractured and removed in order to gain access to or upgrade ore) piles all composed of similar waste rock.	Pile		Refs. 3, pp. 7-13; 2, pp. 56-61
C-2A	Mogul Mine Adit Discharge. The Mogul Mine has been observed to have one flowing adit.	Other (adit)	Upper Cement Creek (Ross Basin) latitude N37°54'41.2" longitude W107°38' 19.4" elevation: 11,42 ft	2, pp. 68-69; 4, p. 28
C-2B	Mogul Mine Waste Rock Pile. The Mogul Mine contains one two tiered waste rock pile.	Pile		2, pp. 68-71; 4, pp. 27, 28
C-3A	Red and Bonita Mine Adit Discharge. The Red and Bonita Mine has been observed to have one collapsed, flowing adit.	Other (adit)	Upper Cement Creek (Ross Basin) latitude N37°53' 51.3" longitude W 107°38' 34.9" elevation: 10,948 ft	4, p. 28; 2, pp. 79-81; 11, pp. 8,10
C-3B	Red and Bonita Mine Waste Rock Pile. The Red and Bonita Mine has one waste rock pile.	Pile		4, p. 28; 2, pp. 79-81; 11, pp. 8-9
C-4A	Gold King Mine Adit Discharge. The Gold King Mine has been	Other	Upper Cement Creek (Ross	4, p.28

Source No.	Source Name and Description	Source Type	Location (Figure 3)	Reference
	observed to have one flowing adit.	(adit)	Basin)	
C-4B	Gold King Mine Waste Rock Pile. The Gold King Mine has one waste rock pile named The Upper Gold King Mine waste rock pile.	Pile	latitude 37.89493519 longitude -107.6384931 elevation: 11,800 ft	4, p.28; 6e; 48
C-5A	American Tunnel Adit Discharge. The American Tunnel (a passage that goes under the ground, through a hill or mountain, etc.) has been observed to have one flowing adit.	Other (adit)	Upper Cement Creek (Ross Basin) latitude N37°53'39.98" longitude W107°38'25.53" elevation: 11,471 ft	5, p. 7; 8, p. 1, 3; 10, p. 1
C-6A	Natalie/Occidental (Silver Ledge) Mine Adit Discharge. The Natalie/Occidental (also known as [a.k.a.] Silver Ledge, hereafter referred to as Natalie/Occidental Mine) Mine has been observed to have one draining adit (lower).	Other (adit)	South Fork of Cement Creek latitude N37°52'39.1" longitude W107°38'38.6" elevation: 11,000 ft	Ref. 2, p. 94
C-6B	Natalie/Occidental (Silver Ledge) Mine Waste Rock Pile. The Natalie/Occidental Mine has one waste rock pile.	Pile		Ref. 2, pp. 95
C-7A	Henrietta Mine Adit Discharge. The Henrietta Mine has been observed to have one seasonally flowing adit.	Other (adit)	Prospect Gulch latitude N37°53'31.8" longitude W107°40'58.1". elevation: 11,360 ft	Ref. 2, p. 105, 110
C-7B	Henrietta Mine Waste Rock Pile. The Henrietta Mine has one waste pile which consists of a large compound dump, located at the adits of the 700 and 800 levels.	Pile		Ref. 2, p. 107
C-8A	Lark Mine Adit Discharge. The Lark Mine is now collapsed, but the adit has been observed to still drain a small amount of water.	Other (adit)	Prospect Gulch latitude N37°53'35.9" longitude W107°40'49.6" elevation: 11,320 ft	Ref. 2, p. 111, 113

Source No.	Source Name and Description	Source Type	Location (Figure 3)	Reference
C-9A	Grand Mogul Mine Seep Discharge. The Grand Mogul Mine has been observed to have one flowing seep.	Other (adit)	Prospect Gulch latitude N37°53'28.6" longitude W107°40'43.4" elevation: 11,200 ft.	Ref. 2, pp. 113-115

2.2.1 SOURCE IDENTIFICATION - CEMENT CREEK

Source Number: C-1A

Name of Source: Grand Mogul Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 3)

The Grand Mogul mine is located in Ross Basin about 1/2 mile above the Mogul Mine main adit near the base of the north basin wall at an elevation of 11,800 ft. The mine is located at latitude N37°54'31.3", longitude W107°37'41.9". There is no surface discharge from the collapsed adit, but there is discharge from the toe of the waste rock pile. (Ref. 2, p. 56, 57) Flow from beneath the Grand Mogul Mine waste rock travels westward over soil approximately 653 ft before entering upper Cement Creek. The overland flow path is heavily stained with iron oxides. The flow of the drainage beneath mine waste rock pile three was estimated by the EPA contractor to be 12 gallons per minute (gpm) in June of 2010 (Refs. 5, pp. 6, 15; 3, pp. 7-10; 2, p. 56; 55, p. 7).

Source Number: C-1B

Name of Source: Grand Mogul Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 3)

This Grand Mogul mine is located in Ross Basin about 1/2 mile above the Mogul Mine main adit near the base of the north basin wall (Ref. 2, p. 69). Three adjacent piles of mine waste from the workings of the Grand Mogul Mine are located on the north side of Cement Creek (Refs. 3, p. 8; 55, p. 7). The three mine waste piles are specifically identified as the east, west, and center piles. The three mine waste piles are addressed as one combined source for HRS scoring purposes based upon sharing similar characteristics which include proximity to the mine, a common pile morphology, similarity of mineralogy (abundant sphalerite and galena) and weathering characteristics of the mine waste rock, similar lack of any engineered contaminants, similar lack of containment features (no liners, covers, run-on and runoff controls), similar location along the north bank of Cement Creek (adjacent to one another) and within the same drainage, and similar target populations along Cement Creek, (Refs. 4, pp. 27, 28, 118-123; 5, pp. 6, 15; 3, pp. 7-13; 2, pp. 56-61). The volume of all the mine waste rock at the Grand Mogul Mine was estimated in 2010 using a DGPS to total 26,521.1 CY (Ref. 3, p. 13).

Mine Waste Rock Pile 1 (West Pile or "Lower Waste Pile") is the smallest of the three waste rock piles, is flat lying with a maximum estimated thickness of 15 ft. The material found in the pile consists of mineralized waste bedrock and sulfide bearing vein derived quartz. Grain size in the mine waste rock piles ranges from silty to coarse sand lip to cobbles approximately 12 inches in diameter. A small spring was emanating from the base Waste Rock Pile 1 with an estimated discharge of 1 gallon per minute (gpm) in early summer of 2010 (Ref. 3, P. 10).

Mine Waste Rock Pile 2 (Center Pile or "Grand Mogul Stope Complex") consists of two large lobes of mineralized mine waste rock. The maximum thickness of the two main waste rock pile lobes is estimated to be 25 ft. Grain size of the material in the two lobes consists of silty to coarse sand with waste rock cobbles up to 12 inches in diameter (Ref. 3, p.-11).

Mine Waste Rock Pile 3 (East Pile) is the largest of the three mine waste rock piles. The material in the mine waste rock pile is mineralized bedrock cobbles with grain sizes ranging between fine sand and pea gravel-sized waste rock to larger cobble sized rocks. A spring has been observed flowing from beneath the toe of the Mine Waste Rock Pile (Ref. 3, p. 11).

Source Number: C-2A

Name of Source: Mogul Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 3)

The adit discharge from the Mogul Mine is located on the east side of upper Cement Creek just below the Ross Basin at latitude N37°54'41.2", longitude W107°38' 19.4" (Refs. 2, p. 68-69). The Flow from the adit in the late 1990s was estimated to be between 10 to 30 gallons per minute (Ref. 2, p. 69). The Colorado Division of Minerals and Geology in their 1998 report stated that the Mogul Mine at low-flow was the largest loader of dissolved copper, lead, cadmium, and zinc of all the mine drainages in Cement Creek (Ref. 2, p. 71). A June 2010 EPA investigation reported that the adit flowed at an average rate of 0.1365 cubic feet per second (cfs) or approximately 61 gallons per minute (gpm) (Ref. 4, p 28). A Parshall flume has been installed to monitor drainage from the adit and flow from the adit has been channelized into a polyfiber lined ditch across the top of the main mine waste rock pile and partway down the south side to the creek (Refs. 3, p. 8; 4, p. 28). The adit discharge flows in a southwestern direction across the waste rock pile for approximately 347 ft and continues to flow over soil for approximately 1,092 ft (Ref. 55, p. 8). No engineered run-on control structures or evidence of a liner or cover other than the polyfiber lined ditch which controls the adit flow across part of the waste rock pile were observed (Ref. 12, p.2).

Source Number: C-2B

Name of Source: Mogul Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 3)

The Mogul Mine waste rock pile is a two tiered waste rock pile . Grain sizes of the material range from silty to coarse-grained sand including cobbles and boulders up to 20 inches in diameter. The mine waste rock pile is estimated to be approximately at its maximum 30 ft thick. Because these two piles are composed of the same types of waste, have the same containment values, affect the same targets, are the same source type, and are found in the same watershed they are addressed as one combined source for HRS scoring purposes (Ref. 3, p. 9).

The major mining activity at the Mogul Mine occurred between 1900 and 1907 on ore bodies in the Ross Basin Fault and the branching Grand Mogul Vein (Ref. 2, p. 69). The mine waste rock dump was surveyed by the Colorado DMG and estimated to contain 25,000 CY of fine to coarse sulphide mine waste (Ref. 2. p. 69). The ore from the mine was reported to be high in pyrite and sphalerite which was difficult to profitably mill. (Ref. 2, pp. 71).

Source Number: C-3A

Name of Source: Red and Bonita Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 3)

The Red and Bonita Mine adit discharge is located at latitude N37°53' 51.3", longitude W107°38' 34.9" on the east side of Cement Creek just upstream of the confluence with North Fork at an elevation of 10,948 ft (Refs. 2, p. 80). The mine was driven eastward into the mountainside to veins in the Bonita Fault and the tunnels are estimated to be several thousand ft long, however the mine adit has collapsed (Ref. 2, p. 80; 11, p. 6). The flow rate from the collapsed adit at the Red and Bonita Mine ranges from a low recorded in April 2010 of 0.4 cfs (24 cubic ft per minute) to a high in May 2009 of 0.749 cfs (approximately 45cubic ft per minute). The adit discharges perennially into Cement creek (Ref. 11, p. 8). The adit discharge flows west for approximately 203 ft, is directed south for approximately 266 ft, and then continues to flow west for approximately 475 ft where it enters Cement Creek (Ref. 55, p. 9).

Source Number: C-3B

Name of Source: Red and Bonita Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 3)

The Red and Bonita Mine is on the east side of Cement Creek just upstream of the confluence with North Fork (Refs. 2, p. 80). The volume of mine waste rock at the Red and Bonita Mines was estimated by the Colorado DMG in their 1998 report to be approximately 6,000 CY consisting largely of coarse, pyritized, and altered country rock (Ref. 2, p. 80). Site work conducted by the EPA in the summer of 2010 included the conducting a Differential Global Positing System (DGPS) survey of the mine waste rock pile which recorded a volume of 3, 160 CY for the lower tier of the waste pile, which appears to contain most of the waste rock in the pile (Ref. 4, p. 28).

Three samples of the mine waste rock pile were collected from the Red and Bonita Mine waste rock pile in June 2010 (Ref. 4, p. 28).

Source Number: C-4A

Name of Source: Gold King Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 3)

The Gold King Mine adit is located at the top of the mine waste rock pile on the north side of North Fork (Ref., 48). The adit discharge is directed into a segmented plastic culvert that flows to the east across the top of the pile to a point near the eastern edge of the waste rock. At this point, the discharge exits the culvert and cascades down the waste rock at the eastern edge of the pile, and into the North Fork of Cement Creek which flows to the west near the base of the pile (Ref. 12, p.2). The adit coordinates are latitude 37.894592285, longitude -107.63902282715 (Ref. 6e). The adit discharge flows east for approximately 94 ft, south for approximately 123 ft and west for approximately 790 ft before flowing into Cement Creek (Ref. 55, p.10).

Source Number: C-4B

Name of Source: Gold King Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 3)

The Upper Gold King Mine waste rock pile, is a single pile located on the north side of the North Fork at latitude 37.89493519 and longitude -107.6384931 (sample location UASOO15) (Ref. 5, p. 11; 6e).

The Gold King Mine is located on the north side of the North Fork of Cement Creek at an altitude of approximately 11,400 ft. The mine consists of a single large mine waste rock pile that is being actively eroded by the North Fork of Cement Creek (Refs. 5, pp. 7, 11; 12, p. 2).

The area if the mine waste rock pile at the Gold King Mine was calculated using data collected with a geographic positioning system (GPS) and is calculated to be 142,097 square ft (ft^2) (Ref. 9, p. 2). A channel for the east adit discharge has been constructed across the top of the mine waste rock pile and a rock berm, that is breached, has been constructed of mine waste rock at the base of a part of the mine waste rock pile between the eastern part of the mine waste rock pile and the North Fork of Cement Creek but no other run-on, run-off, liner, or other engineered containment features were noted at the Gold King Mine (Ref. 12, pp. 4-5). The North Fork of Cement Creek was observed actively eroding the mine waste rock pile (Ref. 5, p. 18).

Source Number: C-5A

Name of Source: American Tunnel Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 3)

The American Tunnel adit discharges into Cement Creek from the east approximately 1.4 miles above the confluence with North Fork. The American Tunnel is approximately 2 miles long and travels to the east to the lower level of the Sunnyside Mine. In 1959 Standard Metals Corporation purchased the Sunnyside

Mine on the east side of Bonita Peak. The American Tunnel was constructed from the Sunnyside Mine to Gladstone (Ref. 8. p. 3). Ore was hauled out of the lower levels of the Sunnyside Mine at the American Tunnel adit to the railroad into Silverton (Refs. 8, p. 4). The adit discharge flows northwest for approximately 397 ft before flowing into Cement Creek. Adit discharge from the American Tunnel has been treated in the past, but is not being treated currently (Ref. 55, p. 11).

On June 4, 1978 the water from Lake Emma which was above the Sunnyside Mine broke through into the Sunnyside Mine and flooded the mine. The entire volume of the lake water exited the mine through the American Tunnel and flowed down Cement Creek in a flood of water 8 to 10 ft high (Ref. 8, p. 3). The mine workings were destroyed and filled with sediment which took almost two years to cleanup (Ref. 8, p. 3). The Sunnyside Mine eventually reopened, but closed permanently in 1991 (Ref. 8, p. 3).

Source Number: C-6A

Name of Source: Natalie/Occidental (Silver Ledge) Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 3)

The Natalie/Occidental mine is located one mile southeast of Gladstone on the north side of the South Fork of Cement Creek, directly across from the Big Colorado Mine. The mine is located at latitude N37°52'39.1", longitude W107°38'38.6". The adit elevation is 11,000 ft. This mine is believed to be on the Silver Ledge Millsite claim. The adit drainage was sampled at station SO-13 and shown on Figures 6 and 30 of the Cement Creek Feasibility study (Ref. 2, pp. 18, 19, 92, 94).

The lower adit was draining up to 700 gpm of metals-laden water during an October 1996 and June 1997 sampling events (Ref. 2, p. 94). This discharge was sufficient to wash out the collapses that had occurred near the adit. The mine drainage flowed across the dump before entering the creek during the 1996/97 sampling events (Ref. 2, p. 94). The adit discharge flows southwest over soil for approximately 111 ft and over or adjacent to waste rock for approximately 127 ft before entering Cement Creek (Ref. 55, p. 12). This adit is shown with a stream flowing out of it on a 1935 USGS topographic base map (Ref. 2, pp. 94).

Source Number: C-6B

Name of Source: Natalie/Occidental (Silver Ledge) Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 3)

The Natalie/Occidental (Silver Ledge) Mine is located one mile southeast of Gladstone on the north side of the South Fork of Cement Creek, directly across from the Big Colorado Mine (Ref. 2, p. 94). The Natalie/Occidental Mine waste rock pile is spread out along the creek banks. The South Fork of Cement Creek ran through the toe of this waste material for over 270 ft. during 1996/97 sampling events (Ref. 2, p. 95). Much of the original wastes have been eroded by the creek. Survey work indicates there are approximately 6,800 CY of waste rock. The dump contains a lot of clayey and sandy quartz-pyrite sulphide vein waste mixed with altered country rock. (Ref. 2, p. 95). Although sampling data for this source was generated in the late 1990's, because metals do not degrade and the piles have not been removed, contaminants are still present in the source.

Source Number: C-7A

Name of Source: Henrietta Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 3)

The Henrietta Mine is located on the south side of Prospect Gulch a. There are adits into at least six levels of this mine. One Henrietta adit, which was the main entrance to the mine, is located at latitude N37°53'31.8", longitude W107°40'58.1". The main adit is seasonal and only flows in the spring. The drainage from the mine infiltrated quickly into a drainage ditch and passed through the waste rock. (Ref. 2, pp. 105-110). The Henrietta 7 adit discharge flows northeast approximately 539 ft before reaching Cement Creek. (Ref.55, p. 13). The locations of some of the adits are shown on Figure 32 of the 1998 Cement Creek Feasibility Study (Ref. 2, pp. 106).

Source Number: C-7B

Name of Source: Henrietta Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 3)

The Henrietta Mine is located on the south side of Prospect Gulch and is accessible from County Rd. 35 (Ref. 2, p. 105). A large compound waste pile is located at the adits of the 700 and 800 levels. Prospect Gulch divides the pile into two parts. Most of the pile lies on the south side of Prospect Gulch below the 700 level adit (denoted here as the 'south pile'). A smaller part of the dump lies to the north of Prospect Gulch (denoted here as the 'north pile'). Because these two piles are composed of the same types of waste, have the same containment values, affect the same targets, are the same source type, and are found in the same watershed they are addressed as one combined source for HRS scoring purposes. The entire pile was surveyed and is estimated to contain approximately 30,000 CY of waste materials. The pile is made up of at least three different ages of materials from the two adits, as indicated by relative weathering and oxidation of the different parts of the pile. Older materials are located near the creek level. Newer waste rock dating from the last operations in the 1970's has been placed on the upper east side of the pile (Ref. 2, pp. 106-107).

Waste rock materials are highly pyritic, and include some small areas of base-metal and possibly silver ores. (Ref. 2, pp. 107).

The south pile is located immediately north of the Henrietta 7 Mine adit at Latitude N37° 53' 31.8" Long. W107° 40' 58.1". There are three distinct lobes to this waste pile. The lower lobe is principally coarse material on the surface. The middle lobe is finer textured on the surface with abundant secondary sulfides. The upper lobe is fine-textured, with one area containing low grade lead-zinc ore. Waste rock sample #3 is a composite sample taken in 11 locations at the south pile. The northwest portion of this pile is directly in contact with the stream near the 800 level adit. The drainage from the mine apparently infiltrates quickly into a drainage ditch and passes through the waste rock. A spring located on the west side of the pile appears to partially flow through the pile (Ref. 2, pp. 108).

Two of these piles are steep, and are being eroded by the creek. Some sections appear to be over steepened by erosion at the toe, and subject to mass failure into the creek (Ref. 2, pp. 108). Although sampling data for this source was generated in the late 1990’s, because metals do not degrade and the piles have not been removed, contaminants are still present in the source.

Source Number: C-8A

Name of Source: Lark Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 3)

The Lark Mine is located on the north side of Prospect Gulch, 1.5 miles up County Rd. 35 from Cement Creek. It is north of the north waste pile at the Henrietta Mine at an elevation of 11,320 ft. The adit is at latitude N37°53'35.9", longitude W107°40'49.6". The Lark Mine adit is believed to be on an unpatented claim. The adit drainage flows southeast over waste rock and soil for approximately 990 ft before entering Cement Creek (Ref. 55, p. 14). The mine drainage was sampled at station SO-2 during high-flow. This sampling location is shown on Figures 4 and 32 of the Cement Creek Feasibility Study (Ref. 2, pp. 13, 19, 106, 111).

The Lark Mine adit was driven northwards under Red Mountain No.3 to explore steeply-dipping veins and disseminated mineralization within the highly altered Red Mountain structural block. The adit is estimated to have penetrated the near vertical to steeply north-dipping bounding fault of this structure within 300 ft. from the adit. There are many other prospect pits and adits, and even some modern drill holes higher up the slopes on the Lark Mine property, however, it is believed these operations never progressed much beyond an exploration effort. There appears to have been at least two other older adits developed during past operations at this mine, both of which are now totally collapsed and are difficult to locate (Ref. 2, pp. 111).

The newest adit was constructed through a long section of loose, unconsolidated scree and colluvium which mantles the lower foot slopes of Red Mountain No.3. The adit was open and was grated by DMG in the late 1980's. Although now collapsed, the adit still drains a small amount of water, which quickly seeps into the colluvium and scree. (Ref. 2, p. 111).

Source Number: C-9A

Name of Source: Joe and Johns Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 3)

The Joe and Johns Mine adit is located 1.5 miles from Cement Creek adjacent to the Prospect Gulch road (County Rd. 35). The adit is at an elevation of 11,200 ft. at latitude N37°53'28.6", longitude W107°40'43.4". It is east-southeast of the Lark Mine. (Ref. 2, pp. 13, 19, 113-114).

An adit was driven north into the valley wall to explore a steeply-dipping vein system striking almost due north. The adit is thought to have penetrated the near vertical to steeply north-dipping bounding fault of the Red Mountain block about 600 ft. from the adit. (Ref. 2, p. 114).

The collapsed adit drained an average of 2 to 15 gpm of metals-contaminated water (Ref. 2, pp. 114). The adit drains in a southern direction over soil and waste rock for approximately 920 ft (Ref.55, p. 15).

2.2.2 *HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE – CEMENT CREEK*

Source No.	Source Name	Units	Hazardous Substances Associated with a Source *Associated sample ID in italics*					Reference
			Al	Cd	Cu	Mn	Zn	
C-1A	Grand Mogul Mine Adit Discharge aq.	µg/L	13,200 *UASW059*	105 *UASW059*	4,690 *UASW059*	8,740 *UASW059*	24,900 *UASW059*	4, pp. 23, 27, 60
C-1B	Grand Mogul Mine Waste Rock Pile ss.	mg/kg	N/A *UASO010*	40 J *UASO010*	4,600 J+ *UASO010*	3,280 *UASO011*	10,400 J *UASO010*	4, pp. 24, 27, 62
C-2A	Mogul Mine Adit Discharge aq.	µg/L	3,300 *UAAD004*	50.9 *UAAD004*	20.9 *UAAD004*	29,100 *UAAD004*	32,700 *UAAD004*	4, pp. 18, 28, 60
C-2B	Mogul Mine Waste Rock Pile ss.	mg/kg	N/A *UASO013*	9 J *UASO013*	285 J+ *UASO013*	5,570 *UASO014*	2,580 J *UASO013*	4, pp. 17, 21, 27, 28, 62
C-3A	Red and Bonita Mine Adit Discharge aq.	µg/L	4,210 *CC03C*	28.0 *CC03C*	17.0 *CC03C*	34,300 *CC03C*	15,900 *CC03C*	26, p. 20
C-3B	Red and Bonita Mine Waste Rock Pile ss.	mg/kg	N/A *UASO05*	35.4 J *UASO05*	286 J+ *UASO05*	630 *UASO04*	11,300 J *UASO05*	4, pp. 28, 62
C-4A	Gold King Mine Adit Discharge aq.	µg/L	18,300 *UAADO02*	53 *UAADO02*	4,210 *UAADO02*	27,800 *UAADO02*	18,100 *UAADO02*	4, pp. 18, 28, 60
C-4B	Gold King Mine Waste Rock Pile ss.	mg/kg	N/A *UASO016*	1.4 *UASO016*	67.2 *UASO015*	171 *UASO016*	399 *UASO016*	5, pp. 11, 12
C-5A	American Tunnel Adit Discharge aq.	µg/L	4,990 *UAADO01*	2.02 *UAADO01*	N/A *UAADO01*	41,700 *UAADO01*	18,100 *UAADO01*	4, pp. 18, 29, 60

Source No.	Source Name	Units	Hazardous Substances Associated with a Source *Associated sample ID in italics*					Reference
			Al	**Cd**	**Cu**	**Mn**	**Zn**	
C-6A	Natalie/Occidental (Silver Ledge) Mine Adit Discharge aq.	µg/L	2,877 *SO-13*	7 *SO-13*	114 *SO-13*	2,424 *SO-13*	1,641 *SO-13*	2, p. 168, 170, 172
C-6B	Natalie/Occidental Mine (Silver Ledge) Waste Rock Pile so.	ppb	11,100 *Site #20*	9.5 *Site #20*	372 *Site #20*	380 *Site #20*	1,260 *Site #20*	2, pp. 185, 187, 189
C-7A	Henrietta Mine Adit Discharge aq.	µg/L	2,238 *SO-04*	16 *SO-04*	170 *SO-04*	106 *SO-04*	3,136 *SO-04*	2, pp. 168, 170, 172
C-7B	Henrietta Mine Waste Rock Pile so.	ppb	37,200 *Site #10*	127 *Site #10*	18,300 *Site #10*	2,840 *Site #10*	19,400 *Site #3*	2, pp. 185, 187, 189
C-8A	Lark Mine Adit Discharge aq.	µg/L	3,532 *SO-02*	242 *SO-02*	12,020 *SO-02*	164 *SO-02*	55,110 *SO-02*	2, p. 168, 170, 172
C-9A	Joe and Johns Mine Adit Discharge aq.	µg/L	8,439 *SO-06*	63 *SO-06*	1,121 *SO-06*	130 *SO-06*	12,080 *SO-06*	2, p. 168, 170, 172

Notes: µg/L micrograms per liter
aq. Aqueous sample, dissolved metals
J The associated value is an estimated quantity, although the presence of the substance is not in doubt.
J+ The associated value is an estimated quantity and may be biased high, although the presence of the substance is not in doubt.
mg/kg milligrams per kilogram
N/A Not Applicable
ppb parts per billion
ss. Solid sample
so. Passive aqueous extract of a solid sample

Source Number: C-1A

Name of Source: Grand Mogul Mine Adit Discharge

Source Samples:

EPA personnel measured field parameters, including pH, temperature, and electrical conductivity of each sample. Field instrumentation was calibrated daily, and all calibration and field data were recorded in the field logbook. All adit water samples were collected for total and dissolved TAL metals. Dissolved metal water samples were drawn through a 0.45 µm filter using a peristaltic pump with disposable dedicated Tygon tubing. The water samples were preserved with nitric acid to a pH <2 and stored on ice (Ref. 4, pp. 20, 21).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	**Dissolved Concentration (µg/L)**	
Aluminum	UASW059	13,200	4, pp. 21, 23, 27, 60
Cadmium		105	
Copper		4,690	
Manganese		8,740	
Zinc		24,900	

Notes: µg/L micrograms per liter

Source Sample Information

Adit water samples were filtered in the field and delivered for dissolved TAL metals analysis to the EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples were analyzed for both total and dissolved TAL metals by EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples for dissolved metals analysis were also filtered in the field. (Ref. 4, p. 21).

Source Number: C-1B

Name of Source: Grand Mogul Mine Waste Rock Pile

Source Samples:

EPA personnel used disposable plastic scoops for source sample collection. All source samples were collected as biased grab samples from the 6- to l2-inch depth interval, where possible. The 6 to l2-inch depth interval was chosen because it is below the oxidized layer, but near the surface where exposure to water flow occurs (Ref. 4, p. 20).

Hazardous Substance	Evidence		References
	Sample No.	Concentration (mg/kg)	
Cadmium	UASO010	40 J	4, pp. 17, 27, 62
	UASO011	0.7 J	
Copper	UASO009	47.1 J+	
	UASO010	4,600 J+	
	UASO011	33.1 J+	
Manganese	UASO009	1,620	4, pp. 17, 27, 62
	UASO010	177	
	UASO011	3,280	
Zinc	UASO009	187 J	
	UASO010	10,400 J	
	UASO011	210 J	

Notes (Ref. 4, p. 62):

mg/kg milligrams per kilogram

J The associated value is an estimated quantity, although the presence of the substance is not in doubt.

J+ The associated value is an estimated quantity and may be biased high, although the presence of the substance is not in doubt.

Source Sample Information

Source soil samples were analyzed through the CLP for TAL total metals and PCBs. (Ref. 4, p.21).

Source Number: C-2A

Name of Source: Mogul Mine Adit Discharge

Source Samples:

EPA personnel measured field parameters, including pH, temperature, and electrical conductivity of each sample. Field instrumentation was calibrated daily, and all calibration and field data were recorded in the field logbook. All adit water samples were collected for total and dissolved TAL metals. Dissolved metal water samples were drawn through a 0.45 µm filter using a peristaltic pump with disposable dedicated Tygon tubing. The water samples were preserved with nitric acid to a pH <2 and stored on ice (Ref. 4, pp. 20, 21)

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	UAA004	3,300	4, pp. 18, 28, 60
Cadmium		50.9	
Copper		20.9	
Manganese		29,100	
Zinc		32,700	

Notes: µg/L micrograms per liter

Source Sample Information

Surface water samples were filtered in the field and delivered for dissolved TAL metals analysis to the EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples were analyzed for both total and dissolved TAL metals by EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples for dissolved metals analysis were also filtered in the field. (Ref. 4, p. 21)

The adit discharge from Mogul Mine passes through a wetland area, where it enters Cement Creek (Ref. 4, p. 28). Mogul Mine has a flumed adit, which has had flow rates recorded between 0.095 cfs in July 2010 and 0.178 cfs in July 2009. Metals observed in the mine discharge (UAAD004, Table 2) include aluminum, arsenic, beryllium, cadmium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, sodium, and zinc (Ref. 4, p. 28).

Source Number: C-2B

Name of Source: Mogul Mine Waste Rock Pile

Source Samples:

EPA personnel used disposable plastic scoops for source sample collection. All source samples were collected as biased grab samples from the 6- to l2-inch depth interval, where possible. The 6 to l2-inch depth interval was chosen because it is below the oxidized layer, but near the surface where exposure to water flow occurs (Ref. 4, p. 20).

Hazardous Substance	Evidence		References
	Sample No.	Concentration (mg/kg)	
Cadmium	UASO013	9 J	4, pp. 17, 21, 27, 28, 62
	UASO014	3.7 J	
Copper	UASO012	63.1 J+	

	UASO013	285 J+	
	UASO014	162 J+	
Manganese	UASO012	135	
	UASO013	433	
	UASO014	5,570	
Zinc	UASO012	140 J	
	UASO013	2,580 J	
	UASO014	498 J	

Notes (Ref. 4, p. 62):

mg/kg milligrams per kilogram

J The associated value is an estimated quantity, although the presence of the substance is not in doubt.

J+ The associated value is an estimated quantity and may be biased high, although the presence of the substance is not in doubt.

Source Sample Information

Source soil samples were analyzed through the CLP for TAL total metals and PCBs. (Ref. 4, p.21).

Source Number: C-3A

Name of Source: Red and Bonita Mine Adit Discharge

Source Samples:

ESAT personnel measured field parameters, including pH, temperature, and electrical conductivity of each sample. Field instrumentation was calibrated daily, and all calibration and field data were recorded in the field logbook. All adit water samples were collected for total and dissolved TAL metals. Dissolved metal water samples were drawn through a 0.45 µm filter using a peristaltic pump with disposable dedicated Tygon tubing. The water samples were preserved with nitric acid to a pH <2 and stored on ice (Ref. 26, pp. 20)

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	**Evidence**		**References**
	Sample No.	**Dissolved Concentration (µg/L)**	
Aluminum	CC03C	4,210	26, p. 20
Cadmium		28	

Manganese		34,300	
Zinc		15,900	

Notes: µg/L micrograms per liter

Source Sample Information

Surface water samples were filtered in the field and delivered for dissolved TAL metals analysis to the EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples were analyzed for both total and dissolved TAL metals by EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples for dissolved metals analysis were also filtered in the field. (Ref. 26, p. 20)

Source Number: C-3B

Name of Source: Red and Bonita Mine Waste Rock Pile

Source Samples:

EPA personnel used disposable plastic scoops for source sample collection. All source samples were collected as biased grab samples from the 6- to l2-inch depth interval, where possible. The 6- to l2-inch depth interval was chosen because it is below the oxidized layer, but near the surface where exposure to water flow occurs (Ref. 4, p. 20).

Only the following are evaluated based on their associated toxicities:

Hazardous Substance	**Evidence**		**References**
	Sample No.	**Concentration (mg/kg)**	
Cadmium	UASO003	0.63 J	4, pp. 28, 62
	UASO005	35.4 J	
Copper	UASO003	195 J+	
	UASO004	104 J+	
	UASO005	286 J+	
Manganese	UASO003	452	
	UASO004	630	
	UASO005	136	
Zinc	UASO003	167 J	
	UASO004	265 J	
	UASO005	11,300 J	

Notes (Ref. 6, p. 42):
mg/kg milligrams per kilogram

J	The associated value is an estimated quantity, although the presence of the substance is not in doubt.
J+	The associated value is an estimated quantity and may be biased high, although the presence of the substance is not in doubt.

Source Sample Information

Source soil samples were analyzed through the CLP for TAL total metals and PCBs. (Ref. 4, p.21).

Source Number: C-4A

Name of Source: Gold King Mine Adit Discharge

Source Samples:

EPA personnel measured field parameters, including pH, temperature, and electrical conductivity of each sample. Field instrumentation was calibrated daily, and all calibration and field data were recorded in the field logbook. All adit water samples were collected for total and dissolved TAL metals. Dissolved metal water samples were drawn through a 0.45 µm filter using a peristaltic pump with disposable dedicated Tygon tubing. The water samples were preserved with nitric acid to a pH <2 and stored on ice (Ref. 4, pp. 20, 21)

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	UAADO02	18,300	4, pp. 18, 28, 60
Cadmium		53	
Copper		4,210	
Manganese		27,800	
Zinc		18,600	

Notes: µg/L micrograms per liter

Source Sample Information

Surface water samples were filtered in the field and delivered for dissolved TAL metals analysis to the EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples were analyzed for both total and dissolved TAL metals by EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples for dissolved metals analysis were also filtered in the field. (Ref. 4, p. 21)

Source Number: C-4B

Name of Source: Gold King Mine Waste Rock Pile

Source Samples:

EPA personnel used disposable plastic scoops for source sample collection. All source samples were collected as biased grab samples from the 6- to l2-inch depth interval, where possible. The 6- to l2-inch depth interval was chosen because it is below the oxidized layer, but near the surface where exposure to water flow occurs (Ref. 5, p. 4).

Only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Concentration (mg/kg)	
Cadmium	UASO15	0.35 J	5, pp. 4, 11-12
	UASO16	1.4	
	UASO18	0.83	
Copper	UASO15	47.5	
	UASO16	67.2	
	UASO17	84.2	
	UASO18	192	
Manganese	UASO15	69.6	
	UASO16	171	
	UASO17	91.2	
	UASO18	49	
Zinc	UASO15	45	
	UASO16	399	
	UASO17	89.3	
	UASO18	186	

Notes (Ref. 5, p. 12):
mg/kg milligrams per kilogram

J The associated value is an estimated quantity, although the presence of the substance is not in doubt.

Source Sample Information

Source soil samples were analyzed through the CLP for TAL total metals and PCBs. (Ref. 5, p. 5).

Source Number: C-5A

Name of Source: American Tunnel Adit Discharge

Source Samples:

EPA personnel measured field parameters, including pH, temperature, and electrical conductivity of each sample. Field instrumentation was calibrated daily, and all calibration and field data were recorded in the field logbook. All adit water samples were collected for total and dissolved TAL metals. Dissolved metal water samples were drawn through a 0.45 µm filter using a peristaltic pump with disposable dedicated Tygon tubing. The water samples were preserved with nitric acid to a pH <2 and stored on ice (Ref. 4, pp. 20, 21)

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	UAADO01	4,990	4, pp.18, 29, 60
Cadmium		2.02	
Manganese		41,700	
Zinc		18,100	

Notes: µg/L micrograms per liter

Source Sample Information

Surface water samples were filtered in the field and delivered for dissolved TAL metals analysis to the EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples were analyzed for both total and dissolved TAL metals by EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples for dissolved metals analysis were also filtered in the field. (Ref. 4, p. 21).

Source Number: C-6A

Name of Source: Natalie/Occidental (Silver Ledge) Mine Adit Discharge

Source Samples:

Water quality samples were collected during a Colorado DMG sampling event by teams comprised of individuals from various government agencies. Raw depth-integrated samples were taken in the stream. The dissolved metals samples were taken by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml. sampling bottle. After sampling, the samples were placed in coolers, and the anion samples were iced. All sampling activities were completed at the sampling site. During the June 1997 sampling, pH and electrical conductivities were measured from a raw water sample collected at the stream sites, and measurements were taken directly from the flow for the mine drainage samples (Ref. 2, pp. 11, 17).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	**Dissolved Concentration (µg/L)**	
Aluminum	SO-13	2877	2, p. 168, 170, 171
Cadmium		7	
Copper		114	
Manganese		2424	
Zinc		1641	

Notes: µg/L mircrograms per liter

Source Sample Information

The source samples listed above were collected during the June 1997 DMG sampling event and analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 31, pp. 1, 6).

Source Number: C-6B

Name of Source: Natalie/Occidental (Silver Ledge) Mine Waste Rock Pile

Source Samples:

For the Natalie/Occidental Mine Pile, during a Colorado DMG 1996 investigation, a composite sample from multiple locations was subjected to a passive water extraction in the field, and this aqueous extract was analyzed by the laboratory.

Waste rock and soil outcropping samples were collected from a minimum of ten and maximum of twenty locations at each source. Acid-washed plastic 100 ml beakers were used to remove the top two inches of material. The sub-samples from each source were composited in a l-gallon re-closeable plastic bag. The composited samples were thoroughly mixed in the field by inverting the bag numerous times. After mixing, 150 ml of sample was removed and placed in a 1 liter plastic beaker along with 300 ml of deionized water. The wetted sample was then vigorously mixed for 15 seconds, plastic wrap was placed over the top, then left to settle for 90 minutes. Ninety minutes was the amount of time it took for the clay fraction to settle to the bottom of the beaker (Ref. 2, p. 17).

After 90 minutes, the liquid was filtered through very fine grade soil filters (approximately 2 microns). A portion of the liquid was used to measure the total alkalinity, pH, specific conductance, and sulfates. The remaining liquid was acidified with nitric acid for lab analysis (Ref. 2, p. 21).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Concentration (ppb)	
Cadmium	Site #20	9.5	2, p. 185; 31, p.1
Copper		372	2, p. 187; 31, p.1
Manganese		380	
Zinc		1,260	2, p. 189; 31, p.1

Notes: ppb parts per billion

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 2, pp. 185, 187, 189; 31, pp. 1).

Source Number: C-7A

Name of Source: Henrietta Mine Adit Discharge

Source Samples:

Water quality samples were collected during a Colorado DMG sampling event by teams comprised of individuals from various government agencies. Raw depth-integrated samples were taken in the stream. The dissolved metals samples were taken by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml. sampling bottle. After sampling, the samples were placed in coolers, and the anion samples were iced. All sampling activities were completed at the sampling site. During an October 1996 and February 1997 sampling, the pH and electrical conductivities were taken in-stream at the sampling site. During a June 1997 sampling, pH and electrical conductivities were measured from a raw water sample collected at the stream sites, and measurements were taken directly from the flow for the mine drainage samples (Ref. 2, pp. 11, 17).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	SO-04	2238	2, 168, 170, 172
Cadmium		16	
Copper		170	
Manganese		106	
Zinc		3136	

Notes: µg/L micrograms per liter

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 31, pp. 1, 7).

Source Number: C-7B

Name of Source: Henrietta Mine Waste Rock Pile

Source Samples:

Waste rock samples were collected at 44 different locations in Cement Creek in August 1996. The investigation was conducted to provide information on waste rock piles sufficient to allow the Animas River Stakeholders Group to prioritize mines for reclamation, using the limited funds available. Samples were collected from 40 waste rock locations and four soil/outcrop sample locations in the Cement Creek watershed (Ref. 2, pp. 17, 18).

A 2:1, by volume, extract was collected in the field. The extract was analyzed for field parameters, then a portion was analyzed in the laboratory for heavy metals (Ref. 2, pp. 17, 18).

Acid-washed plastic 100 ml. beakers were used to remove the top two inches of material. The sub-samples from each source were composited in a 1-gallon recloseable plastic bag. The composited samples were thoroughly mixed in the field by inverting the bag numerous times. After mixing, 150 ml. of sample was removed and placed in a 1 liter plastic beaker along with 300 ml. of deionized water. The wetted sample was then vigorously mixed for 15 seconds, and plastic wrap was placed over the top. The sample was left to settle for 90 minutes, which is the amount of time it takes for the clay fraction to settle to the bottom of the beaker (Ref. 2, pp. 17, 18).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Concentration (ppb)	
Cadmium	Site #2	7.8	2, p. 185; 31, p.1 2, p. 187; 31, p.1
	Site #3	97.7	
	Site #10	127	
Copper	Site #2	198	2, p. 189; 31, p.1 2, p. 185; 31, p.1 2, p. 187; 31, p.1 2, p. 185; 31, p.1
	Site #3	3,070	
	Site #10	18,300	
Manganese	Site #2	0.16	
	Site #3	0.63	
	Site #10	2,840	
Zinc	Site #2	1,730	2, p. 187; 31, p.1
	Site #3	19,700	
	Site #10	19,400	

Notes: ppb parts per billion

Source Sample Information

The source samples listed above were collected during a June 1997 DMG sampling event and analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 2, pp. 185, 187, 189; 31, pp. 1).

Source Number: C-8A

Name of Source: Lark Mine Adit Discharge

Source Samples:

Water quality samples were collected during a Colorado DMG sampling event by teams comprised of individuals from various government agencies. Raw depth-integrated samples were taken in the stream. The dissolved metals samples were taken by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml. sampling bottle. After sampling, the samples were placed in coolers, and the anion samples were iced. All sampling activities were completed at the sampling site. During the October 1996 and February 1997 sampling, the pH and electrical conductivities were taken in-stream at the sampling site. During a June 1997 sampling, pH and electrical conductivities were measured from a raw water sample collected at the stream sites, and measurements were taken directly from the flow for the mine drainage samples (Ref. 2, pp. 11, 17).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	SO-2	3532	2, p. 168, 170, 172
Cadmium		242	
Copper		12020	
Manganese		164	
Zinc		55110	

Notes: µg/L micrograms per liter

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 31, pp. 1, 7).

Source Number: C-9A

Name of Source: Joe and Johns Mine Adit Discharge

Source Samples:

Water quality samples were collected during a Colorado DMG sampling event by teams comprised of individuals from various government agencies. Raw depth-integrated samples were taken in the stream. The total recoverable metals samples were then transferred directly to pre-cleaned pre-acidified 250 ml. sample bottles; anion samples were transferred to pre-cleaned neutral 250 ml. sample bottles; and dissolved metals samples were taken by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml. sampling bottle. After sampling, the samples were placed in coolers, and the anion samples were iced. All sampling activities were completed at the sampling site. During the October 1996 and February 1997 sampling, the pH and electrical conductivities were taken in-stream at the sampling site. During a June 1997 sampling, pH and electrical conductivities were measured from a raw water sample collected at the stream sites, and measurements were taken directly from the flow for the mine drainage samples (Ref. 2, pp. 11, 12).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	SO-06	8439	2, p. 168, 170, 172
Cadmium		63	

Copper		1121	
Manganese		130	
Zinc		12080	

Notes: µg/L micrograms per liter

Source Sample Information

The source samples listed above were analyzed by the EPA Region 8 lab in Golden, Colorado (Ref. 31, pp. 1, 6).

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY – CEMENT CREEK

Source No.	Source Name	Source Type	Surface Water Containment Description*	Containment Value	Reference
C-1A	Grand Mogul Mine Adit Discharge	Other (adit)	Observed discharging to Cement Creek	10	Refs. 5, pp. 6, 15; 3, pp. 7-10; 2, p. 56; 55, p. 7; 12, pp. 1, 3
C-1B	Grand Mogul Mine Waste Rock Pile	Pile	No liner or run on/off controls	10	3, pp. 10-12; 12, pp. 2, 3
C-2A	Mogul Mine Adit Discharge	Other (adit)	Observed discharging to Cement Creek	10	3, 9; 12, pp. 1, 3; 55, p. 8
C-2B	Mogul Mine Waste Rock Pile	Pile	No liner or run on/off controls	10	3, p. 9-10; 12, pp. 2, 3
C-3A	Red and Bonita Mine Adit Discharge	Other (adit)	Observed discharging to Cement Creek	10	12, p. 1, 4; 55, p. 9
C-3B	Red and Bonita Mine Waste Rock Pile	Pile	No liner or run on/off controls	10	12, pp. 1, 2, 4
C-4A	Gold King Mine Adit Discharge	Other (adit)	Observed discharging to Cement Creek	10	12, pp. 2, 4, 5; 55, p. 10
C-4B	Gold King Mine Waste Rock Pile	Pile	No liner or run on/off controls	10	5, pp. 18; 12, pp. 2-5
C-5A	American Tunnel Adit Discharge	Other (adit)	Observed discharging to Cement Creek	10	5, p. 7; 55, p. 11
C-6A	Natalie/Occidental (Silver Ledge) Mine Adit Discharge	Other (adit)	Observed discharging to Cement Creek	10	2, pp. 92, 94; 55, p. 12
C-6B	Natalie/Occidental (Silver Ledge) Mine Waste Rock Pile	Pile	Visibly in contact with creek	10	2, pp. 92, 95; 55, p. 12
C-7A	Henrietta Mine Adit Discharge	Other (adit)	Observed discharging to Prospect Gulch	10	2, pp. 106-107, 110
C-7B	Henrietta Mine Waste Rock Pile	Pile	No liner or run on/off controls. Visibly in contact with creek	10	2, pp. 106, 109, 110; 55, p. 13

C-8A	Lark Mine Adit Discharge	Other (adit)	Observed discharging to Prospect Gulch	10	2, p. 111, 113; 55, p. 14
C-9A	Joe and Johns Mine Adit Discharge	Other (adit)	Observed discharging to Prospect Gulch	10	2, pp. 33, 114-115; 55, p. 15

* Only Overland Flow containment has been evaluated.

2.4.2 HAZARDOUS WASTE QUANTITY – CEMENT CREEK

Note: the total hazardous constituent quantity for all Sources could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the sources is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.1). There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in most of the sources and the associated releases from said source. Therefore, there is insufficient information to evaluate the associated releases from the sources to calculate the total hazardous constituent quantity with reasonable confidence, except in Sources C-1A, C-2A, C-3A, C-4A and C-5A.

Source No.	Waste Description[1,2]	Source Type	Tier	Calculations	HWQ Assigned Value	Reference
C-1A	Grand Mogul Mine Adit Discharge, 39.5 lbs./day, 10 days	Other (adit)	A[2;3]	38.17 lbs.	38.17	33, pp. 1, 3
C-1B	Grand Mogul Mine Piles, 26,521 CY	Pile	C[4]	26,521 CY/2.5 = 10,608.4	10,608.4	3, pp. 11- 13
C-2A	Mogul Mine Adit Discharge, 76 lbs./day, 21 days	Other (adit)	A[2;3]	1,008.5 lbs.	1,008.5	33, pp. 1,5
C-2B	Mogul Mine Pile, 41,374.7 CY	Pile	C[4]	41,374.7 CY/2.5 = 16,549.9	16,549.9	3, pp. 9, 10, 13
C-3A	Red and Bonita Mine Adit Discharge, 198 lbs./day, 23 days	Other (adit)	A[2;3]	4,253.5 lbs.	4,253.5	33, pp. 1, 7
C-3B	Red and Bonita Mine Pile, 3,160 CY	Pile	C[4]	3,160 CY/2.5 = 1,264	1,264	11, p. 9
C-4A	Gold King Mine Adit Discharge, 210 lbs./day, 21 days	Other (adit)	A[2;3]	4,836.1 lbs.	4,836.1	33, pp. 1, 9
C-4B	Gold King Mine Pile, 142,096 ft^2	Pile	D[4; 5]	142.096 ft^2/13 =	10,930.4	9, p. 2, 3

Source No.	Waste Description[1,2]	Source Type	Tier	Calculations	HWQ Assigned Value	Reference
				10,930.4		
C-5A	American Tunnel Discharge 162 lbs./day, 20 days	Other (adit)	A[2; 3]	2,568.4 lbs	2,568.4	33, pp. 1, 12
C-6A	Natalie/Occidental (Silver Ledge) Mine Adit Discharge, 0.89 cfs	Other (adit)	B	5,696,000 lbs./day /5,000 = 1,139.2	1,139.2	2, p. 148
C-6B	Natalie/Occidental (Silver Ledge) Mine Pile, 6,800 CY	Pile	C[4]	6,800 CY/2.5 = 2,720	2,720	2, p. 95
C-7A	Henrietta Mine Adit Discharge, 0.101 cfs	Other (adit)	B	646,400 lbs./day /5,000 = 129.28	129.28	2, p. 168
C-7B	Henrietta Mine Pile, 30,000 CY	Pile	C[4]	30,000 CY/2.5 = 12,000	12,000	2, pp, 107, 108
C-8A	Lark Mine Adit Discharge, 0.012 cfs	Other (adit)	B	76,800 lbs./day /5,000 = 15.36	15.36	2, p. 168
C-9A	Joe and Johns Mine Adit Discharge, 0.034 cfs	Other (adit)	B	217,600 lbs./day /5,000 = 43.52	43.52	2, p. 168

Notes:
- cfs cubic feet per second
- CY cubic yards
- ft^2 square ft
- lbs. pounds
- HWQ Hazardous Wastestream Quantity

1 If a range of adit discharge rates were provided in the reference, the lowest discharge rate was used to calculate the hazardous wastestream quantity.

2 The adit discharge values reported in lbs./day were calculated by summing the Dissolved Metal Loads (pounds/day) for each analyte and for all samples collected for the sample location as provided in Reference 33.

[3] The Tier A estimates are incomplete estimates, as they do not account for the full amount of discharge over time.

[4] The total hazardous wastestream quantity for Sources C-1B, C-2B, C-3B, C-4B, C-6B and C-7B could not be adequately determined according to the HRS requirements; that is, the total mass of all hazardous wastestreams and CERCLA pollutants and contaminants in the source is not known and cannot be estimated with reasonable confidence [Ref. 1, pp. 51591 (Section 2.4.2.1.2)]. There are insufficient historical and current data (manifests, PRP records, State records, permits, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous wastestream and CERCLA pollutants and contaminants in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the total hazardous wastestream quantity for Sources C-1B, C-2B, C-3B, C-6B and C-7B with reasonable confidence.

[5] The volume measure of this source could not be determined. The volume area measure for this source was assigned a value of 0.

2.4.2.1.2 Hazardous Constituent Quantity (Tier A) (Ref. 1, p. 51591)

Description C-1A: Grand Mogul Mine Adit Discharge

The hazardous constituent quantity for the Grand Mogul Mine adit discharge (Source C-1A) was estimated based on the dissolved metals loading for aluminum, cadmium, copper, manganese, and zinc collected over 10 days, and summed to be 38.17 lbs. [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 33, pp. 1, 3]. The adit discharge values reported in lbs./day were calculated by summing the Dissolved Metal Loads (pounds/day) for each analyte and for all samples collected for the sample location (Ref. 33, pp.3). It should be noted that the constituent quantity is calculated only for the five contaminants listed above: There are additional dissolved metals not included in this calculation and this is only a partial Tier A estimation.

Sum (pounds): 38.17
Sum of Constituent Quantity (Table 2-5): 38.17

Hazardous Wastestream Quantity Assigned Value (W): 38.17

2.4.2.1.3 Volume (Tier C) (Ref. 1, p. 51591)

Description C-1B: Grand Mogul Mine Waste Rock Piles

The volume of three piles of mine waste rock (Source C-1B) found on the north side of Cement Creek at the workings of the Grand Mogul Mine were estimated using data gathered during a June/July 2010 site work conducted by the EPA. This data was analyzed in a Geographic Information System (GIS). The volume estimate of the mine waste rock was accomplished by identifying the thickest part of each lobe of mine waste rock and estimating the thickness of that area. The boundary of the waste rock piles were also surveyed using the GPS to provide area estimates and a base footprint for each waste pile. The GPS measurements were converted to a 3-D surface, a convex hull, in a GIS. A GIS was then used to summarize the interior volume of the convex hull, and to determine the 3-D surface area (Ref. 3, p. 12, 13).

The sum of the volume of the three mine waste rock piles at the Grand Mogul Mine are:
(845 CY) + (6,925.9 CY) + (18,750.2 CY) = 26,521 CY

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to 26, 521 CY / 2.5 = 10,608.4

Volume Assigned Value (V): 10,608.4

2.4.2.1.2 Hazardous Constituent Quantity (Tier A) (Ref. 1, p. 51591)

Description C-2A: Mogul Mine Adit Discharge

The hazardous constituent quantity for the Mogul Mine adit discharge (Source C-2A) was estimated based on the dissolved metals loading for aluminum, cadmium, copper, manganese, and zinc collected over 21 days, and summed to be 1008.5 lbs. [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 33, pp. 1, 5]. The adit discharge values reported in lbs./day were calculated by summing the Dissolved Metal Loads (pounds/day) for each analyte and for all samples collected for the sample location Ref. 33, pp.5). It should be noted that the constituent quantity is calculated only for the five contaminants listed above: There are additional dissolved metals not included in this calculation and this is only a partial Tier A estimation.

Sum (pounds): 1,008.5
Sum of Constituent Quantity (Table 2-5): 1,008.5

Hazardous Constituent Quantity Assigned Value (W): 1,008.5

2.4.2.1.3 Volume (Tier C) (Ref. 1, p. 51591)

Description C-2B: Mogul Mine Waste Rock Pile

The volume of the pile of mine waste rock found at the workings of the Mogul Mine (Source C-2B) were estimated using data gathered during a June/July 2010 site work conducted by the EPA. This data was analyzed in a Geographic Information System (GIS). The volume estimate of the mine waste rock was accomplished by identifying the thickest part of the mine waste rock and estimating the thickness. The boundary of the waste rock pile was also surveyed using the GPS to provide an area estimate and a base footprint for the mine waste rock pile. The GPS measurements were converted to a 3-D surface, a convex hull, in a GIS. A GIS was then used to summarize the interior volume of the convex hull, and to determine the 3-D surface area (Ref. 1, Table 2-5; 3, p. 9, 12, 13).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to 41,374.7 CY / 2.5 = 16,549.9

Volume Assigned Value (V): 16,549.9

2.4.2.1.2 Hazardous Constituent Quantity (Tier A) (Ref. 1, p. 51591)

Description C-3A: Red and Bonita Mine Adit Discharge

The hazardous constituent quantity for the Red and Bonita Mine adit discharge (Source C-3A) was estimated based on the dissolved metals loading for aluminum, cadmium, copper, manganese, and zinc collected over 23 days, and summed to be 4,253.5 lbs. [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 33, pp. 1, 7]. The adit discharge values reported in lbs./day were calculated by summing the Dissolved Metal Loads (pounds/day) for each analyte and for all samples collected for the sample location Ref. 33, pp.1, 7). It should be noted that the constituent quantity is calculated only for the five contaminants listed above: There are additional dissolved metals not included in this calculation and this is only a partial Tier A estimation.

Sum (pounds): 4,253.5
Sum of Constituent Quantity (Table 2-5): 4,253.5

Hazardous Wastestream Quantity Assigned Value (W): 4,253.5

2.4.2.1.3 Volume (Tier C) (Ref. 1, p. 51591)

Description C-3B: Red and Bonita Mine Waste Rock Pile

The volume of the pile of mine waste rock found at the workings of the Red and Bonita Mine (Source C-3B) were estimated using data gathered during a June/July 2010 site work conducted by the EPA. This data was analyzed in a Geographic Information System (GIS). The volume estimate of the mine waste rock was accomplished by identifying the thickest part of the mine waste rock and estimating the thickness. The boundary of the waste rock pile was also surveyed using the GPS to provide an area estimate and a base footprint for the mine waste rock pile. The GPS measurements were converted to a 3-D surface, a convex hull, in a GIS. A GIS was then used to summarize the interior volume of the convex hull, and to determine the 3-D surface area (Ref. 1, Table 2-5; 11, p. 9).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to 3,160 CY / 2.5 = 1,264

Volume Assigned Value (V): 1,264

2.4.2.1.2 Hazardous Constituent Quantity (Tier A) (Ref. 1, p. 51591)

Description C-4A: Gold King Mine Adit Discharge

The hazardous constituent quantity for the Gold King Mine adit discharge (Source C-4A) was estimated based on the dissolved metals loading for aluminum, cadmium, copper, manganese, and zinc collected over 21 days, and summed to be 4,836.1 lbs. [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 33, pp. 1, 9]. The adit discharge values reported in lbs./day were calculated by summing the Dissolved Metal Loads (pounds/day) for each analyte and for all samples collected for the sample location (Ref. 33, pp.9). It should be noted that the constituent quantity is calculated only for the five contaminants listed above: There are additional dissolved metals not included in this calculation and this is only a partial Tier A estimation.

Sum (pounds): 4,836.1
Sum of Constituent Quantity (Table 2-5): 4,836.1

Hazardous Constituent Quantity Assigned Value (W): 4,836.1

2.4.2.1.4 Area (Tier D) (Ref. 1, p. 51591)

Description C-4B: Gold King Mine Waste Rock Pile

The area of the mine waste rock pile found at the Upper Gold King Mine (Source C-4B) were calculated using data collected during an August 25, 2011 site work conducted by EPA. A professional grade GPS system was used to trace a line along the upper (northern) side of the mine waste rock pile and along the greater extent of the downhill (southern) side of the waste rock pile bordered by the North Fork. The eastern and western sides of the mine waste rock pile are too steep and treacherous to be walked so they were not measured in the field. A boundary line was drawn on the map from the eastern end of the upper/northern boundary line to the eastern end of the lower/southern line of the waste rock pile. This line closely matches the distribution of mine waste rock observed on the ground in August 2011. Another line was drawn from the western end of the upper boundary line to the western end of the southern boundary line. This western boundary did not include a substantial amount of mine waste rock west of the boundary that could not be accessed because of the steepness of the terrain. The data points defining the partial outline of the area of mine waste rock were imported into ESRI ARC Info Work Station 10.0 and a polygon shape file was created. The polygon was projected in the GCS North American Datum 1983 and an area calculated). The area of mine waste rock is calculated to be 142,096 ft^2 (Ref 9, pp. 2, 3; 1, Table 2-5)

Since the equation for assigning value (Ref. 1, Table 2-5) is the area divided by 13, the HWQ value is equal to 142,096 ft^2 / 13 = 10,930.4

Area Assigned Value (A): 10,930.4

2.4.2.1.2 Hazardous Constituent Quantity (Tier A) (Ref. 1, p. 51591)

Description C-5A: American Tunnel Adit Discharge

The hazardous constituent quantity for the American Tunnel adit discharge (Source C-4A) was estimated based on the dissolved metals loading for aluminum, cadmium, copper, manganese, and zinc collected over 28 days, and summed to be 2,568.4 lbs. [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 33, pp. 1, 12]. The adit discharge values reported in lbs./day were calculated by summing the Dissolved Metal Loads (pounds/day) for each analyte and for all samples collected for the sample location (Ref. 33, pp.12). It should be noted that the constituent quantity is calculated only for the five contaminants listed above: There are additional dissolved metals not included in this calculation and this is only a partial Tier A estimation.

Sum (pounds): 2,568.4
Sum of Constituent Quantity (Table 2-5): 2,568.4

Hazardous Constituent Quantity Assigned Value (W): 2,568.4

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B) (Ref. 1, p. 51591)

Description C-6A: Natalie/Occidental (Silver Ledge) Mine Adit Discharge

The hazardous wastestream quantity for the Natalie/Occidental Mine adit discharge (Source C-6A) was calculated based on the dissolved metals for aluminum, cadmium, copper, manganese, and zinc collected in one day, and calculated to be 569,600 lbs./day [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 2, p. 148]. 5,696,000/5,000 = 1,139.2

0.89 cfs x 86,400 s/d = 76,896 cf/day
76,896 cf/day / 27 cf/yd^3 = 2,848 CY/day
2,848 CY/day x 2,000 lbs./CY = 5,696,000 lbs./day
5,696,000 lbs./day /5,000 = 1,139.2

Sum (pounds): 5,696,000
Sum of Wastestream Quantity/5,000 (Table 2-5): 1,139.2

Hazardous Wastestream Quantity Assigned Value (W): 1,139.2

2.4.2.1.3 **Volume (Tier C)** (Ref. 1, p. 51591)

Description C-6B: Natalie/Occidental (Silver Ledge) Mine Waste Rock Pile

The Natalie/Occidental Mine dump (Source C-6B) is quite large, and spread out along the creek banks. Because the adit is only 35 ft. above creek level, it forced the miners to spread material out over a larger area, and dump materials directly into the stream. The South Fork of Cement Creek runs through the toe of this waste material for over 270 ft. Much of the original wastes have been eroded by the creek. Survey work indicates there are approximately 6,800 CY of waste rock. The dump contains a lot of clayey and sandy quartz-pyrite sulphide vein waste mixed with altered country rock. Minerals found include pyrite, quartz and occasional sphalerite (Ref. 1, Table 2-5; 2, p. 95).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to 6,800 CY / 2.5 = 2,720

Volume Assigned Value (V): 2,720

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B) (Ref. 1, p. 51591)

Description C-7A: Henrietta Mine Adit Discharge

The hazardous wastestream quantity for the Henrietta Mine adit discharge (Source C-7A) was estimated based on the dissolved metals for aluminum, cadmium, copper, manganese, and zinc collected in one day, and calculated to be 646,400 lbs./day [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 2, p. 168]. 646,400/5,000 = 129.28

0.101 cfs x 86,400 s/d = 8,726.4 cf/day
8,726.4 cf/day / 27 cf/yd^3 = 323.2 CY/day
323.2 CY/day x 2,000 lbs./CY = 646,400 lbs./day
646,400 lbs./day /5,000 = 129.28

Sum (pounds): 646,400
Sum of Wastestream Quantity/5,000 (Table 2-5): 129.28

Hazardous Wastestream Quantity Assigned Value (W): 129.28

2.4.2.1.3 **Volume (Tier C)** (Ref. 1, p. 51591)

Description C-7B: Henrietta Mine Waste Rock Pile

A large compound waste pile is located at the adits of the 700 and 800 levels (Source C-7B). Prospect Gulch divides the pile into two parts. Most of the pile lies on the south side of Prospect Gulch below the 700 level adit (denoted here as the 'south pile'). A smaller part of the dump lies to the north of Prospect Gulch (denoted here as the 'north pile'). The entire pile was surveyed and is estimated to contain approximately 30,000 CY of waste materials. The pile is made up of at least three different ages of materials from the two adits, as indicated by relative weathering and oxidation of the different parts of the pile. Older materials are located near the creek level. Newer waste rock dating from the last operations in the 1970's have been placed on the upper east side of the pile. (Ref. 1, Table 2-5; 2, pp. 106, 107).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to30,000 CY / 2.5 = 12,000

Volume Assigned Value (V): 12,000

2.4.2.1.3 Volume (Tier C) (Ref. 1, p. 51591)

Description C-8A: Lark Mine Adit Discharge

The hazardous wastestream quantity for the Lark Mine adit discharge (Source C-8A) was estimated based on the dissolved metals for aluminum, cadmium, copper, manganese, and zinc collected over one day, and calculated to be 76,800 lbs. [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 2, p. 168]. 76,800/5,000 = 15.36

0.012 cfs x 86,400 s/d = 1,036.8 cf/day
1,036 cf/day / 27 cf/yd^3 = 38.4 CY/day
38.4 CY/day x 2,000 lbs./CY = 76,800 lbs./day
76,800 lbs./day /5,000 = 15.36

Sum (pounds): 76,800
Sum of Wastestream Quantity/5,000 (Table 2-5): 15.36

Hazardous Wastestream Quantity Assigned Value (W): 15.36

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B) (Ref. 1, p. 51591)

Description C-9A: Joe and Johns Mine Adit Discharge

The hazardous wastestream quantity for the Joe and Johns Mine adit discharge (Source C-9A) was estimated based on the dissolved metals for aluminum, cadmium, copper, manganese, and zinc collected over one day, and calculated to be 217,600 lbs. [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 2, p. 168]. 76,800/5,000 = 43.52

0.034 cfs x 86,400 s/d = 2,937.6 cf/day
2,937.6 cf/day / 27 cf/yd^3 = 108.8 CY/day
108.8 CY/day x 2,000 lbs./CY = 217,600 lbs./day
217,600 lbs./day /5,000 = 43.52

Sum (pounds): 217,600
Sum of Wastestream Quantity/5,000 (Table 2-5): 43.52

Hazardous Wastestream Quantity Assigned Value (W): 43.52

SUMMARY OF CEMENT CREEK SOURCE DESCRIPTIONS

Source No.	Mine	Source Hazardous Waste Quantity Value	Mine Total	Source Hazardous Constituent Quantity Complete? (Y/N)	Containment Factor Value to Pathway
					Surface Water (SW)
					Overland/flood
C-1A	Grand Mogul Mine	38.17	10,646.57	N	10
C-1B		10,608.4		N	10
C-2A	Mogul Mine	1,008.5	17,558.4	N	10
C-2B		16,549.9		N	10
C-3A	Red and Bonita Mine	4,253.5	5,517.5	N	10
C-3B		1,264		N	10
C-4A	Gold King Mine	4,836.1	15,766.5	N	10
C-4B		10,930.4		N	10
C-5A	American Tunnel	2,568.4	2,568.4	N	10
C-6A	Natalie/ Occidental Mine	1,139.2	3,859.2	N	10
C-6B		2,720		N	10
C-7A	Henrietta Mine	129.28	12,129.28	N	10
C-7B		12,000		N	10
C-8A	Lark Mine	15.36	15.36	N	10
C-9A	Joe and Johns Mine	43.52	43.52	N	10

Other Possible Mines and Mine Related Sources

Given the interconnected nature of the ore bodies and general geology of the study area, these possible mining related sources listed below may also be releasing hazardous substances to the Cement Creek drainage and will be further evaluated during further investigation of this site.

Feature	Description (Reference)
Sunnyside Mine Pool	A pool of underground mine water has built up behind the American Tunnel bulkhead to an elevation of approximately 11,800 ft above mean sea level. The drainage from the American Tunnel is comprised of the water from the Sunnyside Mine Pool. (Ref. 59, pp. 1-2) This mine pool has impacted several mine workings in both Cement Creek and the Upper Animas River area, including the American Tunnel, the Mogul Mine/Grand Mogul Mine, the Red & Bonita, the Gold King Mine, the Terry Tunnel, the Sunnyside Mine, and the Gold Prince. As evidenced in the drainage from the American Tunnel, the Mogul and Grand Mogul Mine the Gold King Mine, Terry Tunnel, etc., the Sunnyside Mine Pool is known to contain aluminum, cadmium, manganese, zinc. (Ref. 4, p. 18, 29, 60)
Abandoned Mines adjacent to Prospect Gulch located between the Galena Queen Mine and the Henrietta Mine	There are several mines with draining adits and waste rocks piles located between the Galen Queen Mine and the Henrietta Mine, which lie adjacent to Prospect Gulch, a drainage to Cement Creek. Sampling indicates that the principal zinc addition at low-flow and high-flow in the headwaters of Prospect Gulch occurs at the Hercules and Galena Queen Mines. Water quality below the Galena Queen Mine is affected and the stream passes over and through a portion of the waste rock of the Galena Queen Mine. This results in a 2-3 order of magnitude increase in zinc concentrations. The zinc loading attributable to this small area has been projected to be approximately 0.2 lb/day of zinc per day during low-flow and 5 lb/day of zinc per day during high-flow periods. There is also a vegetation kill zone located downgradient of the Hercules Mine waste rock piles (Ref. 2, pp. 23, 29-33, 40).The mines in this area, including Galena Queen, ISP, Hercules, Henrietta, Joe and Johns, Lark, may be contributing to additional hazardous metals loading from the drainage to Cement Creek based on their contributions to Prospect Gulch as described above.
Yukon Tunnel (Gold Hub)	This mine is at an elevation of 10,080 ft. at latitude N37°51'3.6", longitude W107°40'31.5". It lies on the east side of lower Cement Creek along State Route 110 about 21/2 miles upstream from Silverton. Access is via an old bridge across Cement Creek. The adit at this mine appears to be a crosscut driven east beneath Storm Peak to explore mineralized veins. Little is known about the workings, other than that they are extensive, based on the size of the dump and mining infrastructure at the mine. The adit is intact, but flooded to a depth of 2 ft., discouraging access. Water flows out of the adit in a pipe to a ditch constructed on the top of the dump, then drains back into the adit, where a sump has been constructed just inside. This sump collects the mine water, then runs it underground in a pipe, to a discharge point in Illinois Gulch adjacent to the mine. Discharge from this adit was measured at about 550 gpm (Ref. 2, p. 131). At low-flow, the mine drainage produces about 7% of the dissolved metals from draining mines in Cement Creek, and about 1 % during high-flow. At low-flow, the dissolved metals amount to about

	171b/day including 0.6 pounds of zinc and 7 pounds of iron per day. At high-flow, the mine drainage produces about 7 pounds of dissolved metals, including 1 pound of zinc and 2 pounds of iron per day (Ref. 2, p. 134).
Wynona (a.k.a. Evelyne) Mine Adit	The Wynona (a.k.a Evelyne) Mine is located on an unpatented claim on the west side of Dry Gulch approximately 100 yards above where County Rd. 35 crosses the stream channel of Dry Gulch. The mine is at an elevation of 10,600 ft. at latitude N37°53'03.3", longitude W107°39'17.9". An ad it was driven west into the hillside approximately 100 ft. above Dry Gulch. The mine adit drains approximately 2-60 gpm of iron-rich water. At low-flow, the adit was found to drain approximately 2 gpm. This flow increased to about 60 gpm during high-flow. At high-flow, the metals loading from the adit was found to be about 0.6 pound of zinc and 0.2 pound of copper per day. (Ref. 2, p. 123-124)
Mammoth Tunnel	The Mammoth Tunnel is located on the west side of Cement Creek near the mouth of Georgia Gulch. The road to the Kansas City Mines crosses this location. The Mammoth Tunnel is at an elevation of 10,400 ft. at latitude N37°52'42.3", longitude W107°40'10.7". The tunnel is believed to be on the Dooley claim. An adit was driven west into the hillside approximately 100 ft. above Cement Creek. The mine adit drains approximately 20-30 gpm of iron-rich water (Ref. 2, p. 124). At low-flow, this mine was found to contribute the second highest dissolved metal load of all the draining mines (approximately 11 %). including about 15% of the iron and 16% of the nickel to Cement Creek. At high-flow, this mine was found to contribute the third highest dissolved metal load (approximately 4.5 lbs./day) in the Cement Creek area (Ref. 2, p. 125).
Anglo Saxon Mine Adit	The Anglo Saxon Mine is adjacent to State Route 110 on the west side of lower Cement Creek about 3 miles upstream from Silverton. This mine consists of two adits, a main adit and the Porcupine Gulch adit. The main adit is located at latitude N37°51'25.5", longitude W107°40'40.5" at an elevation of 10,080 ft. This mine includes two adits driven northwest, which prospected quartz-sulphide veins. The main adit is collapsed at the surface, but discharged about 40-60 gpm of hazardous metals-laden water during a 1996/97 sampling event. The discharge flowed across a partly eroded dump, then cascaded down to the road, flowing under it in a culvert to a constructed settling pond, before continuing to Cement Creek. The second adit is about 500 ft. up Porcupine Gulch on the north side, 200 ft. higher than the main adit in elevation. This adit has been buried by talus and colluvium. A spring was issuing from the collapsed adit, discharging 40-55 gpm. One study projected that most of the water in Porcupine Gulch during low-flow periods is discharge from this mine adit (Ref. 2, pp. 127, 128).

Other areas in the drainage area may also qualify as sources; however, sampling to date does not document association of hazardous substances with these areas.

2.2 SOURCE CHARACTERIZATION – MINERAL CREEK

Although there are many possible sources contributing to surface water contamination associated with this site, this portion of the HRS documentation record is focused solely on the Mineral Creek drainage, to make discussion easier. In addition, multiple sources were identified in the Mineral Creek drainage (Figure 4). Each source is detailed in the tables below to include an assigned source number, source name, type, description, location as well as hazardous substances associated with the source, hazardous substances available to a pathway and hazardous waste quantities. A complete source identification for each source in the Mineral Creek drainage follows the tables below:

Source No.	Source Name and Description	Source Type	Location (Figure 4)	Reference
M-1A	Koehler Tunnel Adit Pool. The Koehler Tunnel (a passage that goes under the ground, through a hill or mountain, etc.) has been observed to have one leaking bulkheaded adit (a horizontal passage leading into a mine for the purposes of access or drainage). The bulkhead was installed in 2003. . The adit drains across soil and flows directly into Mineral Creek.	Other (adit)	Upper Mineral Creek latitude 37.89531 longitude 107.71101 elevation: 11,160 ft	Ref. 6b, p. 29 52, p.1; 39, p. 3-8.
M-2A	Brooklyn Mine Adit Discharge. Brooklyn Mine has been observed to have one flowing adit. The drainage has since been diverted from flowing over the associated mine waste pile and flows directly into Mineral Creek.	Other (adit)	Browns Gulch latitude 37.86083 longitude 107.71468 elevation: 11,310	Refs. 13, pp. 32; 6b, pp. 31, 44; 6c, p. 26; 55, p. 17
M-2B	Brooklyn Mine Waste Rock Pile. Brooklyn Mine contains one waste rock pile.	Pile		Refs. 13, p. 32; 6c, pp. 26; 48; 55, p. 17.
M-3A	Paradise Mine Adit Discharge. Paradise Mine contains four collapsed adits. Although there are four adits at the Paradise Mine, only the adit that is has been observed to be discharging the greatest amount of contaminated water is being evaluated as a source.	Other (adit)	Middle Fork latitude 37.84263 longitude 107.76407 elevation: 10,638 ft	Refs. 13, pp. 47-48; 6b, pp. 31, 46.
M-3B	Paradise Mine Waste Rock Pile. The Paradise Mine waste pile is associated with Paradise Mine Adit 1 (P1) and is referred to as “White Death” (Ref. 13, p. 47).	Pile		Refs. 13, p. 49; 6b, p. 46; 6c, pp. 30–31; 48; 55, p. 18.
M-4A	Bandora Mine Adit Discharge. Bandora Mine has been observed to have four flowing adits. The four flowing mine adits are addressed as one combined source for HRS scoring purposes because all four adits drain the same mine operations and/or ore body.	Other (adit)	South Fork latitude 37.78699 longitude 107.80130	Refs. 13, p. 52; 6b, pp. 35, 44; 48; 55, p. 19.

M-4B	Bandora Mine Waste Rock Piles. Bandora Mine contains two main waste piles. The two main waste rock piles associated with Bandora Mine are addressed as one combined source for HRS scoring purposes because the waste piles are from the same mine operations and/or ore body .	Pile	elevation: 10,813 ft	Refs. 13, p. 50, 55; 6b, p. 44; 48; 55, p. 19.

2.2.1 SOURCE IDENTIFICATION – MINERAL CREEK

Source Number: M-1A

Name of Source: Koehler Tunnel Adit Pool

Source Type: Other (adit)

Description and Location of Source: (Figure 4)

The Koehler Tunnel mine is located east of Mineral Creek at latitude 37.89531, longitude -107.71101 (Ref. 6b, p. 29). The area is characterized by rugged, steep, high alpine terrain at timber line (Ref. 13, p. 9). A small tributary to Mineral Creek and natural pond are located on the disturbed mine area (Ref. 13, p. 9). The mines lie at the very headwaters of Mineral Creek watershed (Ref. 13, p. 9).

Koehler Tunnel was collapsed at the adit and covered by talus rock fall until 1996 when Sunnyside Gold Corporation crews excavated and re-opened the tunnel (Refs. 13, p. 14; 52, p.1). The Koehler Tunnel bulkhead was installed by Gold King Mines Corporation in 2003 as part of their reclamation requirements with the State of Colorado to offset environmental damages at Sunnyside permitted mining operations (Ref. 52, p.1). The existing bulkhead has been effective in improving in-stream water quality in Mineral Creek, but additional hydrologic controls will result in further reductions of heavy metals loading (Ref. 52, p.1). The bulkhead is leaking at an approximate 7 gallons per minute of pH 3 water with high metals concentrations and flows into Mineral Creek (Ref. 52, p.1; 39, pp. 4–7). The adit drainage flows northwest over soil approximately 188 ft before flowing into Mineral Creek (Ref. 55, p. 16). There is also an estimated 80,000 cubic feet (ft^3) of pooled water in the tunnel behind the bulkhead (Ref. 51, p. 1).

Source Number: M-2A

Name of Source: Brooklyn Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 4)

Brooklyn Mine adit is located on the east side of Mineral Creek at latitude 37.86083, longitude -107.71468 (Ref. 6b, p. 31). Brooklyn Mine is located along a steep walled portion of Brown's Gulch at an elevation of approximately 11,400 ft (Ref. 13, p. 31). The adit discharge flows over soil adjacent to waste rock. The discharge flows east for approximately 319 ft, west for approximately 520 ft, and south for approximately 621 ft (Ref. 55, p. 17). The mine is situated on a privately owned patented lode mining claim (Ref. 13, p. 31-32).

There is one flowing adit (Ref. 6b, p. 44) discharging 0.045–0.08 cfs (Ref. 6b, p. 51). Water drains from the adit at about 10–20 gpm (Ref. 6c, p. 26). Measured pH values range from 3.2 to 4.8(Ref. 6c, p. 26). The drainage historically flowed 50 ft before cascading down the side of a mine waste pile (Ref. 13, p. 33-34). Iron, copper, and zinc are the most significant contaminants; zinc, at about 150 times the aquatic life standard, is possibly most problematic (Ref. 6c, p. 26). Currently, the adit drainage flow path has since been diverted to no longer flow over the associated waste rock pile and then flows directly into Mineral Creek (Refs. 13, pp. 32-33; 39, pp. 1–2; 55, p. 17).

Source Number: M-2B

Name of Source: Brooklyn Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 4)

The Brooklyn Mine waste pile of sulfidic waste rock is located near a flowing adit (Ref. 13, p. 32; 6c, p. 26). The Brooklyn Mine is located on the east side of Mineral Creek at latitude 37.86083, longitude -107.71468 (Ref. 6b, p. 31). Brooklyn Mine is located along a steep walled portion of Brown's Gulch at an elevation of approximately 11,400 ft (Ref. 13, p. 31). The mine is situated on a privately owned patented lode mining claim (Ref. 13, p. 31). This mined area has evidently been worked by several operators over the years (Ref. 6c, p. 26).

The tailings behave like the mine waste and release large amounts of metal and acid (Ref. 6c, p. 26). Although sampling data for this source was generated in the late 1990's, because metals do not degrade and the piles have not been removed, contaminants are still present in the source.

Source Number: M-3A

Name of Source: Paradise Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 4)

Paradise Mine is located on Mineral Creek in the Middle Fork portion at its confluence with Crystal Lake tributary (Ref. 13, p. 45) at latitude 37.84263, longitude -107.76407 (Ref. 6b, p. 31). Elevation of the mine is 10,640 ft (Ref. 13, p. 45). The mine is at creek level below uniform, steep mountain slopes, in an avalanche zone with at least four chutes (Ref. 13, p. 45, 49; 39, pp. 8–9).

Paradise Mine has four collapsed flowing adits (Ref. 13, p. 47; 6b, p. 46). It is reported that there is one adit (P1), which is the predominate source of contaminated water, that discharged approximately 400 gpm (Ref. 6c, p. 30; 13, p. 47-48). The adit drainage flows over the associated waste piles northeast for approximately 150 ft and directly into the creek (Refs. 39, pp. 8–9; 55, p. 18). The other three collapsed adits reported a discharge of: 1) relatively small flow of water, 2) 30 gpm, and 3) 80 gpm (Ref. 13, p. 49). Based on the limited access and small size of the dump at Paradise Mine, these mines probably had little production (Ref. 13, p. 49). The P1 adit is probably not more than a few hundred ft in length (Ref. 13, p. 49). According to the 1997 Feasibility Report, the Paradise Mine contributes approximately 1% of the zinc from mining sources in the Mineral Creek watershed (Ref. 13, p. 48).

Although there are four adits at the Paradise Mine, only the adit that is discharging the greatest amount (P1) of contaminated water is evaluated as a source.

Source Number: M-3B

Name of Source: Paradise Mine Waste Rock Pile

Source Type: Pile

Description and Location of Source: (Figure 4)

The Paradise Mine is located on the Middle Fork portion of Mineral Creek at its confluence with Crystal Lake tributary (Ref. 13, p. 45) at latitude 37.84263, longitude -107.76407 (Ref. 6b, p. 31). Elevation of the mine is 10,640 ft (Ref. 13, p. 45). The mine is at creek level below uniform, steep mountain slopes, in an avalanche zone with at least four chutes (Ref. 13, p. 45, 49).

Paradise Mine waste pile is associated with Paradise Mine Adit 1 (P1) and is referred to as "White Death" (Ref. 13, p. 49). A heavy white, chalky basaluminite precipitate covers most of the less than 700 CY of material in the pile (Refs. 13, pp. 48-49; 6c, pp. 30-31). The adit drainage flows over the associated waste pile and is in direct contact with the creek (Ref. 39, pp. 8–9). Sulphide minerals were found on the pile (Ref. 13, p. 48). Leach tests were made on three samples from the Paradise Mine waste pile and one sample from the smaller pile to the west (Ref. 6c, p. 31). One sample of red iron floc on the Paradise mine waste dump showed high acid generation but low metal release (Ref. 6c, p. 31). A sample of the white aluminum-rich precipitate showed moderate acid generation and low metal release (Ref. 6c, p. 31). Although sampling data for this source was generated in the late 1990's, because metals do not degrade and the piles have not been removed, contaminants are still present in the source.

Source Number: M-4A

Name of Source: Bandora Mine Adit Discharge

Source Type: Other (adit)

Description and Location of Source: (Figure 4)

Bandora Mine is located west of Mineral Creek along the South Fork (Ref. 13, p. 52, 53) at latitude 37.78699, longitude -107.80130 (Ref. 6b, p. 35) at an elevation range between 10,690 ft to 11,000 ft (Ref. 13, p. 52). The mine is situated on a uniform, south-facing, steep mountain slope in a forested sub-alpine terrain just below timberline (Ref. 13, p. 52).

Bandora Mine has four flowing adits (Ref. 6b, p. 44). These adits had a discharge rate between 0.045–0.22 cfs (Ref. 6b, p. 53) or a median flow volume of 45 gpm (Ref. 6c, p. 27) into the creek (Ref. 13, p. 52). The lower most main adit is discharging drainage, which flows around the main mine dump in a southeastern direction for approximately 920 ft, and on to the creek (Refs. 13, p. 52; 55, p. 19). The adit drainage has since been rerouted and diverted from flowing over the associated waste piles (Refs. 39, pp. 12-13; 55, p. 19). The Bandora mine zinc from mine drainage sources (Ref. 13, p. 52). The adit drainage flows directly into South Fork Mineral Creek (Refs. 39, p. 10–12; 55, p. 19).

The four actively flowing mine adits are evaluated as one source because all four adits drain the same mine operations and/or ore body and therefore, can be combined into one source for the purpose of this HRS documentation record.

Source Number: M-4B

Name of Source: Bandora Mine Waste Rock Piles

Source Type: Pile

Description and Location of Source: (Figure 4)

Bandora Mine is located west of Mineral Creek along the South Fork (Ref. 13, p. 52) at latitude 37.78699, longitude -107.80130 (Ref. 6b, p. 35) at an elevation range between 10,690 ft to 11,000 ft (Ref. 13, p. 52). The mine is situated on a uniform, south-facing, steep mountain slope in a forested sub-alpine terrain just below timberline (Ref. 13, p. 52).

Bandora Mine waste pile contains an estimated 5,500 CY of mine waste (Ref. 6b, p. 44). There are a confirmed two waste piles associate with Bandora Mine adits with a volume of 3,500 CY, and 2,000 CY (Ref. 13, p. 55). Some of the historic waste piles have been washed away (Ref. 13, p. 55). Leach tests were made on three samples from the Bandora mine waste pile; one of the leachate solutions carried the lead (Ref. 6c, p. 27). The adit drainage has since been rerouted and diverted from flowing over the associated waste piles (Refs. 39, p. 13; 55, p. 19).

The two waste rock piles associated with Bandora Mine are addressed as one combined source for HRS scoring purposes because the waste piles are from the same mine operations and/or ore body. Although sampling data for this source was generated in the late 1990's, because metals do not degrade and the piles have not been removed, contaminants are still present in the source.

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE – MINERAL CREEK

Source No.	Source Name	Unit	Hazardous Substances Associated with a Source[1] *Associated sample ID in italics*					See Page
			Al	**Cd**	**Cu**	**Mn**	**Zn**	
M-1A	Koehler Tunnel Adit Pool aq.	µg/L	71,400 *MS81*	780 *MS81*	98,600 *MS81*	23,700 *MS81*	228,000 *MS81*	Ref. 6b, p. 50; 6d, p. 7.
M-2A	Brooklyn Mine Adit Discharge aq.	µg/L	5,500 *NAW819*	38 *216/4193-1.306*	810 *216/4193-1.306*	9,400 *NAW589*	7,300 *216/4193-1.306*	Ref. 6b, pp. 48, 51; 6d, pp. 2, 8, 9.
M-2B	Brooklyn Mine Waste Rock Pile so.	µg/L	6,900 *NAD817*	30 *NAD817*	1,300 *NAD588*	9,100 *NAD817*	5,400 *NAD817*	6d, pp. 15–16.
M-3A	Paradise Mine Adit Discharge aq.	µg/L	27,000 *NAW870*	0.4 *NAW870*	13 *MS77*	6,600 *NAW520*	660 *NAW520*	Ref. 6b, p. 52; 6d, pp. 7, 8, 10, 11.
M-3B	Paradise Mine Waste Rock Pile so.	µg/L	14,000 *NADW520*	0.09 *NAD520*	6 *NAD520*	280 *NAF521*	20 *NAF521*	6d, pp. 14, 16–18.
M-4A	Bandora Mine Adit Discharges aq.	µg/L	320 *MS4-712*	88 *235/4185-1.3000*	143 *MS4-799*	8,230 *MS4-365*	17,400 *MS4-799*	Ref. 6b, pp. 49; 6d, pp. 2, 3, 5, 6.
M-4B	Bandora Mine Waste Rock Pile so.	µg/L	7.9 *NAD399*	110 *NAD399*	1,800 *NAD399*	7,400 *NAD399*	16,000 *NAD399*	6d, pp. 12.

Notes: µg/L micrograms per liter
aq. Aqueous sample, disolved metals
so. Passive aqueous extract of solid sample
1 Value presented is the maximum concentration recorded on provided data sets

Source Number: M-1A

Name of Source: Koehler Tunnel Adit Discharge

Source Samples:

Adit water samples were analyzed for dissolved metals and were filtered by the laboratory using a 0.45 micron filter (Ref. 6d, p. 7). Samples were collected during low flow periods, on 8/18/98 and 9/25/95 (Ref. 6b, p. 50).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		Reference
	Sample No.	Dissolved Concentration (μg/L)	
Aluminum	MS81 NAW580	71,400 51,000	6b, p. 50; 6d, p. 7.
Cadmium	MS81 NAW580	780 450	
Copper	MS81 NAW580	98,600 40,000	
Manganese	MS81 NAW580	23,700 19,000	
Zinc	MS81 NAW580	228,000 120,000	

Notes: μg/L micrograms per liter

Source Sample Information

The adit was observed discharging at a rate of 0.02–0.15 cfs (Ref. 6b, p. 50) into Mineral Creek (Ref. 39, pp. 3, 7).

Source Number: M-2A

Name of Source: Brooklyn Mine Adit Discharge

Source Samples:

Adit water samples were analyzed for dissolved metals and were filtered using a 0.45 micron filter (Ref. 6d, pp. 2, 6, 7, 8, 9). Samples were collected during low flow periods, on 7/18/1995, 8/13/98, 8/18/98, 7/18/99 and 9/1/99 (Ref. 6b, pp. 48, 51).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	261/4193-1.306	2,300	6b, pp. 48, 51; 6d, pp. 2, 6, 7, 8, 9, 10.
	NAW508	810	
	NAW589	4,200	
	MS8	2,250	
	NAW817	3,700; 2,400	
	NAW819	5,500; 4,200	
Cadmium	261/4193-1.306	38	
	NAW508	14	
	NAW589	27	
	MS8	18	
	NAW817	23; 21	
	NAW819	30; 26	
Copper	261/4193-1.306	810	
	NAW508	99	
	NAW589	380	
	MS8	338	
	NAW817	280	
	NAW819	430	
Manganese	NAW508	8,100	
	NAW589	9,400	
	MS8	6,750	
	NAW817	5,800; 4,100	
	NAW819	6,400; 5,100	

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Zinc	261/4193-1.306	7,300	
	NAW508	5,300	
	NAW589	6,500	
	MS8	556	
	NAW817	5,900; 4,400	
	NAW819	6,500; 5,300	

Notes: µg/L micrograms per liter

Source Sample Information

There is one flowing adit discharging 0.045–0.08 cfs (Ref. 6b, pp. 44, 51). Composition of the water at the adit mouth appears to be variable over time (Ref. 6c, p. 26). Measured pH values range from 3.2 to 4.8 (Ref. 6c, p. 26). Historically, the drainage flowed 50 ft before cascading down the side of a mine waste pile (Ref. 13, pp. 33-34). Currently, the adit drainage has been diverted from flowing over the waste pile and then enters Mineral Creek (Refs. 13, pp. 33-34; 39, pp. 1–2; 55, p. 17).
For samples NAW817 and NAW819: the first value was analyzed using ICP-AES methodology and second value was analyzed using ICP-MS methodology (copper is only analyzed with IPC-MS) (Ref. 6d, p. 9-10). Samples NAW508 and NAW589 were analyzed using IPC-MS. All other samples were analyzed using IPC-AES methods, except cadmium for sample 261/4193-1.306, which was analyzed using graphite furnace atomic absorption spectrometry (GFAAS) (Ref. 6d, pp. 2, 6, 7, 8).

Source Number: M-2B

Name of Source: Brooklyn Mine Waste Rock Pile

Source Samples:

Hazardous Substance	Evidence			References
	Sample No.	DL (µg/L)	Concentration (µg/L)	
Aluminum	NAD588 NAD817 NAD818 NAT501	Not Reported	5,200 6,900 4,400 6,400	Ref. 6d,pp. 15-16, 18.
Cadmium	NAD588 NAD817 NAD818 NAT501	Not Reported	18 30 10 15	

Hazardous Substance	Evidence			References
	Sample No.	DL (µg/L)	Concentration (µg/L)	
Copper	NAD588 NAD817 NAD818 NAT501	Not Reported	1,300 1,100 750 550	
Manganese	NAD588 NAD817 NAD818 NAT501	Not Reported	2,200 9,100 780 380	
Zinc	NAD588 NAD817 NAD818 NAT501	Not Reported	3,500 5,400 2,100 2,000	

Notes: µg/L micrograms per liter

Source Sample Information

Brooklyn Mine waste pile of sulfidic waste rock is located near the flowing adit (Ref. 13, pp. 31-34; 6c, p. 26). According to a USGS study, leach tests on three waste-dump samples showed consistent results: very high acid generation and moderate to high metal release (Ref. 6c, p. 26).

Samples NAD588, NAD817, NAD818, and NAT501 were analyzed using Passive Leach & ICP-MS methodology from sediments collected from the Brooklyn mine waste (Ref. 6d, pp. 15, 16, 18).

Source Number: M-3A

Name of Source: Paradise Mine Adit Discharge

Source Samples:

Adit water samples were analyzed for dissolved metals and were filtered using a 0.45 micron filter (Ref. 6d, pp. 4, 7, 8, 10, 11). Samples were collected during low flow periods on 9/28/95, 8/14/98, 8/14/98, 8/27/98, and 9/6/1999 (Refs. 6b, p. 52; 6d, p. 10).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	MS77 NAW520 NAW521	8,600 22,000 19,000	6b, p. 52; 6d, pp. 4, 7, 8, 10, 11.

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
	MS34 NAW870 NAW869	21,200 27,000; 18,000 23,000; 18,000	
Cadmium	NAW520 NAW521 MS34 NAW870 NAW869	0.31 0.7 2 0.4 0.2	
Copper	MS77 NAW520 NAW521 MS34 NAW870 NAW869	13 1.4 3 4 3 3	
Manganese	MS77 NAW520 NAW521 MS34 NAW870 NAW869	5,100 6,600 6,400 5,920 5,100; 3,800 4,800; 3,800	
Zinc	MS77 NAW520 NAW521 MS34 NAW870 NAW869	530 660 640 620 570; 440 530; 420	

Notes: µg/L micrograms per liter

Source Sample Information

Paradise Mine has four collapsed flowing adits (Ref. 13, p. 46; 6b, p. 47). It is reported that there is one adit (P1), which is the predominate source of contaminated water, that discharges approximately 400 gpm across the associated mine dump (Refs. 6c, p. 30; 13, pp. 47-48). The other three collapsed adits reported a discharge: 1) a relatively small flow of water, 2) 30 gpm, and 3) 80 gpm (Ref. 13, p. 49). Although there are four adits at the Paradise Mine, only the adit that is discharging the greatest amount (P1) of contaminated water is evaluated in the determination of waste quantity.

For sample NAW869 and 870: the first value was analyzed using ICP-AES methodology and second value was analyzed using ICP-MS methodology (copper is only analyzed with IPC-MS) (Ref. 6d, p. 10-11). All other samples were analyzed using IPC-MS methods, except for samples MS77 and MS34, which were analyzed using IPC-AES (Ref. 6d, pp. 4, 6, 7–8). All samples were collected as adit/tunnel mine drainage (Ref. 6d, pp. 4, 6, 7–8, 10-11).

Source Number: M-3B

Name of source: Paradise Mine Waste Rock Pile

Source Samples:

Hazardous Substance	Evidence		
	Sample No.	**Concentration (µg/L)**	**References**
Aluminum	NAD520 NADW520 NAF520 NAF521	150; 210; 400 14,000 2,200 9,600	Ref. 6d, pp. 12–14, 16–18.
Cadmium	NAD520 NAF520 NAF521	0.04; 0.06; 0.09 0.07 0.07	
Copper	NAD520 NADW520 NAF520 NAF521	4; 5; 6 2 1 2	
Manganese	NAD520 NADW520 NAF520 NAF521	11; 13; 18 110 110 280	
Zinc	NAD520 NADW520 NAF520 NAF521	4; 7; 9 20 9 20	

Notes: µg/L micrograms per liter

Source Sample Information

The Paradise Mine waste pile is associated with Paradise Mine Adit 1 (P1) (Ref. 13, p. 49). A heavy white, chalky basaluminite precipitate covers a significant amount of the less than 700 CY of material in the pile (Refs. 13, pp. 48, 49; 6c, pp. 30-31). Sulphide minerals were found on the pile(Ref. 13, p. 48). Leach tests were made on three samples from the Paradise Mine waste pile and one sample from the smaller pile to the west (Ref. 6c, p. 31). The tests of dump waste showed acid generation and metal release (Ref. 6c, p. 31). One sample of red iron floc on the Paradise mine waste dump showed high acid generation but low metal release (Ref. 6c, p. 31). A sample of the white aluminum-rich precipitate showed moderate acid generation and low metal release (Ref. 6c, p. 31).

All samples were analyzed using Passive Leach & ICP-MS methodology (Ref. 6d, pp. 12–14, 16–18). There were three analytical values for samples NAD520 (Ref. 6d, pp. 12-14). The sediment sample consisted of low pyrite, high iron-oxide and white crust; mostly red and brown fine iron-oxide soil;

mostly white crust on iron-oxide soil (Ref. 6d, pp. 12-14). The remaining samples were soil samples (Ref. 6d, pp. 16–18). All samples detailed above were collected the same day (i.e., 08/14/1998) (Ref. 6d, pp. 12–14, 16–18).

Source Number: M-4A

Name of Source: Bandora Mine Adit Discharge

Source Samples:

Adit water samples were analyzed for dissolved metals and were filtered by the laboratory using a 0.45 micron filter (Ref. 6d, pp. 2-9, 11). Samples were collected during low flow periods on 7/19/95, 9/9/97, 8/23/98, 10/13/98, 9/9/99 (Ref. 6b, p. 49, 53).

Although the samples were analyzed for the full TAL metals complement, only the following are evaluated based on their associated toxicities:

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
Aluminum	235/4185-1.3000 NAW399 NAW648 NAW887 NAW649 MS4-365 MS4-631 MS4-712 MS4-755 MS4-799	25 4.7 24 19; 36 17 86 55 320 94 232	6b, pp. 49, 53; 6d, pp. 2-11.
Cadmium	235/4185-1.3000 NAW399 NAW648 NAW887 NAW649 NAW647 MS4-365 MS4-446 MS4-631 MS4-649 MS4-712 MS4-755 MS4-799	88 65 51 80; 67 39 0.51 55.1 54.6 42.9 39.9 60.7 65.4 77.8	
Copper	235/4185-1.3000 NAW399 NAW648	140 35 63	

Hazardous Substance	Evidence		References
	Sample No.	Dissolved Concentration (µg/L)	
	NAW887 NAW649 MS4-365 MS4-446 MS4-631 MS4-649 MS4-712 MS4-799 MS4-755	120 2 55 79 39 30 72 121 143	
Manganese	NAW399 NAW648 NAW887 NAW649 NAW647 MS4-365 MS4-446 MS4-631 MS4-649 MS4-712 MS4-755 MS4-799	3,200 6,800 7,200; 6,500 6,100 1,600 8,230 6,680 5,780 5,720 7,610 7,030 8,120	
Zinc	235/4185-1.3000 NAW399 NAW648 NAW887 NAW649 NAW647 MS4-365 MS4-446 MS4-631 MS4-649 MS4-712 MS4-755 MS4-799	16,000 8,300 12,000 16,000; 15,000 8,000 450 15,700 13,100 10,500 10,100 15,400 14,400 17,400	

Notes: µg/L micrograms per liter

Source Sample Information

The Bandora Mine adits drain over the associated waste piles and have a discharge rate between 0.045–0.22 cfs (Ref. 6b, pp. 44, 53) into the creek (Ref. 13, p. 52). The lower most main adit is discharging drainage, which flows around the main mine dump, and on to the creek (Ref. 13, p. 52; 39, pp. 11, 13). The four actively flowing mine adits are addressed as one combined source for HRS scoring purposes because all four adits drain the same mine operations and/or ore body.

Samples preceded with “MS4-” were collected on separate dates from the same sample location over time (Ref. 6d, pp. 3, 4–5, 6). These samples are differentiated by using the nomenclature “Sample Site Number” (i.e. MS4-) and then “Sample Name” (Ref. 6d, pp. 3, 4–5, 6).

For sample NAW887: the first value was analyzed using ICP-AES methodology and second value was analyzed using ICP-MS methodology (copper is only analyzed with IPC-MS) (Ref. 6d, pp. 11). All NAWXXX samples were analyzed using ICP-MS methods. All other samples were analyzed using IPC-AES methods, except cadmium for sample 235/4185-1.3000, which was analyzed using GFAAS. All samples were collected as adit/tunnel mine drainage. (Ref. 6d, pp. 2-7, 9, 11)

Source Number: M-4B

Name of Source: Bandora Mine Waste Rock Pile

Source Samples:

Hazardous Substance	Evidence		References
	Sample No.	Concentration (µg/L)	
Aluminum	NAD399	3; 7.9; 4.4	Ref. 6d, pp. 12, 15.
Cadmium	NAD399 NAD648 NAD650	110; 45; 100 94 14	
Copper	NAD399 NAD648 NAD650	10; 1,800 150 690	
Manganese	NAD399 NAD648 NAD650	3,700; 1,200; 7,400 6,300 550	
Zinc	NAD399 NAD648 NAD650	9,900; 3,400; 16,000 15,000 2,600	

Notes: µg/L micrograms per liter

Source Sample Information

Bandora Mine waste pile contains an estimate 5,500 CY of mine waste (Ref. 6b, p. 44). There are a confirmed two waste piles associate with Bandora Mine adits with a volume of 3,500 CY, and 2,000 CY (Ref. 13, p. 55). Leach tests were made on three samples from the Bandora mine waste pile; one of the leachate solutions carried the highest lead concentration of the study (Ref. 6c, p. 27). The two waste rock piles associated with Bandora Mine are addressed as one combined source for HRS scoring purposes because the waste piles are from the same mine operations and/or ore body.

The three analytical values of sample NAD399 were analyzed using EPA-1312Leach & ICP-AES, Passive Leach & ICP-MS methodology, and IPC-AES, respectively (Ref. 6d, p. 12). The remaining samples (i.e., NAD648, and NAD650) were analyzed using Passive Leach & ICP-MS methodology (Ref. 6d, p.15). Samples consisted of solids from the Bandora mine (Ref. 6d, pp. 12, 15).

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY – MINERAL CREEK

Source No.	Source Name	Source Type	Surface Water Containment Description*	Containment Value	Reference
M-1A	Koehler Tunnel Adit Pool	Other (adit)	Observed discharging to creek	10	Ref. 13, pp. 9–10, 14; 39, pp. 3–7; 55, p. 16.
M-2A	Brooklyn Mine Adit Discharge	Other (adit)	Observed discharging to creek	10	Ref. 13, p. 32-34; 6c, p. 26-27; 39, pp. 1–2.
M-2B	Brooklyn Mine Waste Rock Pile	Pile	No liner or run on/off controls. Visibly in contact with creek	10	Ref. 13, p. 32-34; 6c, p. 26; 39, pp. 1–2; 55, p. 17.
M-3A	Paradise Mine Adit Discharge	Other (adit)	Observed discharging to creek	10	Ref. 13, pp. 45, 47, 49; 6c pp. 30–31; 39, pp. 8–9.
M-3B	Paradise Mine Waste Rock Pile	Pile	No liner or run on/off controls. Visibly in contact with creek	10	Ref. 13, pp. 45, 47, 49 ; 6c pp. 30–31; 39, pp. 8–9; 55, p. 18.
M-4A	Bandora Mine Adit Discharge	Other (adit)	Observed discharging to creek	10	Ref. 13, pp. 52–55; 6c, p 27; 39, pp. 11–16.
M-4B	Bandora Mine Waste Rock Pile	Pile	No liner or run on/off controls. Visibly in contact with creek	10	Ref. 13, pp. 53–55; 6c, p 27; 39, p. 10; 55, p. 19.

* Only Overland Flow containment has been evaluated.

2.4.2 HAZARDOUS WASTE QUANTITY – MINERAL CREEK

Note: the total hazardous constituent quantity for all Sources could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the sources is not known and cannot be estimated with reasonable confidence (Ref. 13, Section 2.4.2.1.1). There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the sources to calculate the total hazardous constituent quantity with reasonable confidence. As such, all source evaluations will begin with Tier B.

Source No.	Waste Description[1]	Source Type	Tier	Calculations	HWQ Assigned Value	Reference
M-1A	Koehler Tunnel Adit Pool; 80,000 ft^3	Other (adit)	C[2]	2,962.9 /2.5 = 1,185.1	1,185.1	Ref 51.
M-2A	Brooklyn Mine Adit Discharge; measured flowrate:	Other (adit)	B	-	-	Ref. 6b, pp. 48, 51.
	0.045 cfs (Sample 261/4193-1.306) on 7/18/95			287,712 lbs./day /5,000 = 57.54	57.54	
	0.045 cfs (Sample NAW508) on 8/13/98			287,712 lbs./day /5,000 = 57.54	57.54	
	0.045 cfs (Sample NAW589) on 8/18/98			287,712 lbs./day /5,000 = 57.54	57.54	
	0.08 cfs (Sample MS8) on 7/18/99			511,488 lbs./day /5,000 = 102.3	102.3	
	0.045 cfs (Sample NAW817) on 9/1/99			287,712 lbs./day /5,000 = 57.54	57.54	
	-			-	Total = 332.46	
M-2B	Brooklyn Mine Waste Rock Pile; 15,000 m^2 of disturbed area	Pile	D[2; 3]	161,459 ft^2/13 = 12,419.9	12,419.9	Ref. 6b, p. 44.
M-3A	Paradise Mine Adit Discharge; measured flowrate:	Other (adit)	B	-	-	Ref. 6b, p. 52.
	0.6 cfs (Sample MS77) on 9/28/95			3,836,160 lbs./day /5,000 = 767.23	767.23	
	0.22 cfs (Sample NAW520) on 8/14/98			1,406,592 lbs./day /5,000 = 281.32	281.32	

Source No.	Waste Description[1]	Source Type	Tier	Calculations	HWQ Assigned Value	Reference
	0.009 cfs (Sample MS34) on 8/27/98			57,542.4 lbs./day /5,000 = 11.51	11.51	
	0.45 cfs (Sample NAW870) on 9/6/99			2,877,120 lbs./day /5,000 = 575.42	575.42	
	-			-	Total = 1,635.48	
M-3B	Paradise Mine Waste Rock Pile: 700 CY	Pile	C[2]	700 CY/2.5 = 280	280	Ref. 6b, p. 46.
M-4A	Bandora Mine Adit Discharge; measured flowrates:	Other (adit)	B	-	-	Ref. 13, pp. 53; 6b, pp. 49, 53.
	0.071 cfs (Sample 235/4185-1.3000) on 7/19/95			453,945.6 lbs./day /5,000 = 90.79	90.79	
	0.045 cfs (Sample NAW399) on 9/9/97			287,712 lbs./day /5,000 = 57.54	57.54	
	0.056 cfs (Sample NAW648) on 8/23/98			358,041.6 lbs./day /5,000 = 71.61	71.61	
	0.09 cfs (Sample MS4) 10/13/98			575,424 lbs./day /5,000 = 115.08	115.08	
	0.22 cfs (Sample NAW887) on 9/9/99			1,406,592 lbs./day /5,000 = 281.32	281.32	
	-			-	Total = 616.34	
M-4B	Bandora Mine Waste Rock Pile; 5,500 CY total	Pile	C[2]	5,500 CY/2.5 = 2,200	2,200	Ref. 13, p. 53; 6b, p. 44, 53.

Notes:

( )	Sample name and date	gpm	gallons per minute
cfs	cubic ft per second	HWQ	Hazardous Wastestream Quantity
CY	cubic yards	lbs.	pounds
ft^2	square ft	m^2	square meters
ft^3	cubic ft		

[1] If a range of adit discharge rates were provided in the reference, the lowest discharge rate was used to calculate the hazardous wastestream quantity.

[2] The total hazardous wastestream quantity for Sources M-1A, M-2B, M-3B and M-4B could not be adequately determined according to the HRS requirements; that is, the total mass of all hazardous wastestreams and CERCLA pollutants and contaminants in the source is not known and cannot be estimated with reasonable confidence [Ref. 1, pp. 51591 (Section 2.4.2.1.2)]. There are insufficient historical and current data (manifests, PRP records, State records, permits, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous wastestream and CERCLA pollutants and contaminants in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the total hazardous wastestream quantity for Sources M-1A, M-2B, M-3B and M-4B with reasonable confidence.

[3] The volume measure of this source could not be determined. The volume measure for this source was assigned a value of 0.

2.4.2.1.1 Volume (Tier C)

<u>Description – M-1A: Koehler Tunnel Adit Pool</u>

The volume of the adit pool for Source 1A was calculated based on a conservative estimate of the length and size of the tunnel behind the bulkhead, and the measured pressure at the bulkhead that ultimately obtained a volume estimate of the pool in the mine tunnel. The Adit pool contains dissolved metals of aluminum, cadmium, copper, manganese, and zinc. A volume of 80,000 ft^3 of submerged tunnel was determined in the mine [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 51].

80,000 ft^3 / 27 = 2,962.9 yd^3 (Cubic Yard = CY)
2,962.9 CY / 2.5 = 1,185.1

Volume/2.5 (Table 2-5): 1,185.1

Hazardous Volume Assigned Value (W): 1,185.1

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B)

<u>Description – M-2A: Brooklyn Mine Adit Discharge</u>

The hazardous wastestream quantity for Source 2A was calculated based on the flow from the adit that contains dissolved metals for aluminum, cadmium, copper, manganese, and zinc. The Brooklyn adit contains flow data collected over five days (0.045 cfs, 0.045 cfs, 0.045 cfs, 0.08 cfs, and 0.045 cfs), and the wastestream is calculated to be a total of 1,662,336 pounds over five days [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 6b, pp. 48, 51]. 1,662,336 /5000 = 322.46

0.045 cfs x 0.037 CY/ ft^3 =
0.001665 CY/sec x 2,000 lbs./CY =
3.33 lbs./sec x 86,400 sec/day =
287,712 lbs./day /5,000 = 57.54

0.045 cfs x 0.037 CY/ ft^3 =
0.001665 CY/sec x 2,000 lbs./CY =
3.33 lbs./sec x 86,400 sec/day =
287,712 lbs./day /5,000 = 57.54

0.045 cfs x 0.037 CY/ ft^3 =
0.001665 CY/sec x 2,000 lbs./CY =
3.33 lbs./sec x 86,400 sec/day =
287,712 lbs./day /5,000 = 57.54

0.08 cfs x 0.037 CY/ ft^3 =
0.00296 CY/sec x 2,000 lbs./CY =
5.92 lbs./sec x 86,400 sec/day =
511,488 lbs./day /5,000 = 102.3

0.045 cfs x 0.037 CY/ ft^3 =

0.001665 CY/sec x 2,000 lbs./CY =
3.33 lbs./sec x 86,400 sec/day =
287,712 lbs./day /5,000 = 57.54

Sum (pounds): 1,662,336
Sum of Wastestream Quantity/5,000 (Table 2-5): 332.46
Hazardous Wastestream Quantity Assigned Value (W): 332.46

2.4.2.1.3 Area (Tier D) (Ref. 1, p. 51591)

Description – M-2B: Brooklyn Mine Waste Rock Pile

The size of the disturbed area due to mine workings of the Brooklyn Mine (Source M-2B) was estimated by the US Geological Survey (USGS) using historical documentation (Ref. 6b, p. 44).

Since the area is estimated by the USGS in square meters and the equation for assigning value (Ref. 1, Table 2-5) is in square feet, the following calculation has been applied to estimate the area:
15,000 m^2 * 10.76 ft^2/m^2 = 161,459 ft^2

161,459 ft^2 / 13 = 12,419.9
Volume Assigned Value (V): 12,419.9

2.4.2.1.4 Hazardous Wastestream Quantity (Tier B)

Description – M-3A: Paradise Mine Adit Discharge

The hazardous wastestream quantity for Source 3A was calculated based on the flow from the adit that contains dissolved metals for aluminum, cadmium, copper, manganese, and zinc. The Paradise mine adit data was collected over four days (0.6 cfs, 0.22 cfs, 0.009 cfs, and 0.45 cfs), and is calculated to be a total of 8,177,414.4 lbs. [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 6b, p. 52]. 8,177,414.4 /5000 = 1,635.48

0.6 cfs x 0.037 CY/ ft^3 =
0.0222 CY/sec x 2,000 lbs./CY =
44.4 lbs./sec x 86,400 sec/day =
3,836,160 lbs./day /5,000 = 767.23

0.22 cfs x 0.037 CY/ ft^3 =
0.00814 CY/sec x 2,000 lbs./CY =
16.28 lbs./sec x 86,400 sec/day =
1,406,592 lbs./day /5,000 = 281.32

0.009 cfs x 0.037 CY/ ft^3 =
0.000333 CY/sec x 2,000 lbs./CY =
0.666 lbs./sec x 86,400 sec/day =
57,542.4 lbs./day /5,000 = 11.51

0.45 cfs x 0.037 CY/ ft^3 =
0.01665 CY/sec x 2,000 lbs./CY =

33.3 lbs./sec x 86,400 sec/day =
2,877,120 lbs./day /5,000 = 575.42

Sum (pounds): 8,177,414.4
Sum of Wastestream Quantity/5,000 (Table 2-5): 1,635.48
Hazardous Wastestream Quantity Assigned Value (W): 1,635.48

2.4.2.1.5 **Volume (Tier C)** (Ref. 1, p. 51591)

Description – M-3B: Paradise Mine Waste Rock Pile

The volume of the pile of mine waste rock found at the workings of the Paradise Mine (Source 3B) was estimated by the USGS using historical documentation (Ref. 6b, p. 46).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to
700 CY / 2.5 = 280
Volume Assigned Value (V): 280

2.4.2.1.6 Hazardous Wastestream Quantity (Tier B)

Description – M-4A: Bandora Mine Adit Discharge

The hazardous wastestream quantity for Source 4A was calculated based on the flow from the adit that contains dissolved metals for aluminum, cadmium, copper, manganese, and zinc. The Bandora mine adit data was collected over five days (0.071 cfs, 0.045 cfs, 0.056 cfs, 0.09 cfs, and 0.22 cfs), and is calculated to be a total of 3,081,715.2lbs. [Ref. 1, pp. 51591 (Section 2.4.2.1.2); 13, pp. 53; 6b, pp. 49, 53]. 3,081,715.2/5000 = 616.34

0.071 cfs x 0.037 CY/ ft^3 =
0.002627 CY/sec x 2,000 lbs./CY =
5.254 lbs./sec x 86,400 sec/day =
453,945.6 lbs./day /5,000 = 90.79

0.045 cfs x 0.037 CY/ ft^3 =
0.001665 CY/sec x 2,000 lbs./CY =
3.33 lbs./sec x 86,400 sec/day =
287,712 lbs./day /5,000 = 57.54

0.056 cfs x 0.037 CY/ ft^3 =
0.002072 CY/sec x 2,000 lbs./CY =
4.144 lbs./sec x 86,400 sec/day =
358,041.6 lbs./day /5,000 = 71.61

0.09 cfs x 0.037 CY/ ft^3 =
0.00333 CY/sec x 2,000 lbs./CY =
6.66 lbs./sec x 86,400 sec/day =

575,424 lbs./day /5,000 = 115.08

0.22 cfs x 0.037 CY/ ft^3 =
0.00814 CY/sec x 2,000 lbs./CY =
16.28 lbs./sec x 86,400 sec/day =
1,406,592 lbs./day /5,000 = 281.32

Sum (pounds): 3,081,715.2
Sum of Wastestream Quantity/5,000 (Table 2-5): 616.34
Hazardous Wastestream Quantity Assigned Value (W): 616.34

2.4.2.1.7 **Volume (Tier C)** (Ref. 1, p. 51591)

Description – M-4B: Bandora Mine Waste Rock Pile

The volume of the pile of mine waste rock found at the workings of the Bandora Mine (Source 4B) was estimated by the USGS using historical documentation (Ref. 13, pp. 50, 53; 6b, p. 44).

Since the equation for assigning value (Ref. 1, Table 2-5) is the volume in CY divided by 2.5, the HWQ value is equal to
5,500 CY / 2.5 = 2,200
Volume Assigned Value (V): 2,200

SUMMARY OF MINERAL CREEK SOURCE DESCRIPTIONS

Source No.	Mine	Source Hazardous Waste Quantity Value	Mine Total	Source Hazardous Constituent Quantity Complete? (Y/N)	Available to Pathway (X) Surface Water (SW) Overland/flood
M-1A	Koehler Tunnel	1,185.1	1,185.1	N	10
M-2A	Brooklyn Mine	332.46	12,752.36	N	10
M-2B		12,419.9		N	10
M-3A	Paradise Mine	1,635.48	1,915.48	N	10
M-3B		280		N	10
M-4A	Bandora Mine	616.34	2,816.34	N	10
M-4B		2,200		N	10

Other Possible Mines and Mine Related Sources

Given the interconnected nature of the ore bodies and general geology of the study area, these possible mining related sources listed below may also be releasing hazardous substances to the Mineral Creek drainage and will be further evaluated during further investigation of this site.

Feature	**Description (Reference)**
Silver Ledge Mine	Silver Ledge mine is located along a tributary which feeds into Mineral Creek at latitude 37.88394, longitude 107.72082 (Ref. 6b, p. 29). Silver Ledge mine has a mill with unknown volumes of mine waste materials (Ref. 6b, p. 43). It is unknown how many adits there are, and if they are flowing. An increase in lead concentrations in Mineral Creek has been documented due to flow from the Silver Ledge mine. (Ref. 57, p. 6)
Junction Mine	Junction Mine is located east of Mineral Creek at latitude 37.89627, longitude 107.71050 (Ref. 6b, p. 29). Discharge from this mine, known to be acidic, comingles with discharge from the Koehler tunnel in a small unnamed drainage near the mines. A pH below 3.0 and elevated concentrations of copper, lead, arsenic and zinc are found in Mineral Creek below the comingled drainage. (Ref. 57, p. 2)
Longfellow Mine	Longfellow Mine is located at the very headwaters of Mineral Creek watershed (Ref. 13, p. 9) at latitude 37.89685, longitude 107.71036 (Ref. 6b, p. 29). The area is characterized by rugged, steep, high alpine terrain at timber line (Ref. 13, p. 9). A small tributary to Mineral Creek and natural pond are located on the disturbed mine area (Ref. 13, p. 9). There are two adits associated with Longfellow Mine (Ref. 6b, p. 46). The Longfellow Mine adit is a drift on a sulphide vein and may be associated with the Koehler Tunnel adit (Ref. 13, p. 14). It is unknown if these two adits, 40 ft apart vertically are interconnected via stopes or winzes in this brecca pipe (Ref. 13, p. 14). Longfellow Mine is located relatively close to Koehler Tunnel and Junction Mine (Ref. 13, pp. 9-10; 48), and are often examined and discussed cumulatively in historical documentation (For example see, Ref. 13, p. 9). The Longfellow Mine shaft is sunk on a separate northeast-trending vein which may intersect another breccia pipe ore body a few hundred ft to the northeast of the shaft collar (Ref. 13, p. 14). Longfellow Mine waste pile is estimated to have a volume of 5,500 CY of sulphide ore waste (Ref.13, pp. 9-1115; 6b, p. 46). Analytical data for adit drainage or a waste pile is unavailable, although other mine and adit discharges in the drainage have been characterized as contributing to hazardous metals loading in the Upper Animas. As such, further evaluation is required.

4.0 SURFACE WATER MIGRATION PATHWAY

4.1 OVERLAND/FLOOD MIGRATION COMPONENT

The Bonita Peak Mining District (BPMD) site consists of the release of hazardous substances, mainly metals, due to the operation and abandonment or discontinued operation of hundreds of mines to the upper portion of Animas River; the river's two main tributaries in the Silverton area, Cement Creek and Mineral Creek; and some smaller tributaries to all three streams. The headwaters of all these water bodies are located in the high mountain peaks surrounding Silverton (Ref. 6a, pp. 4, 21-23). This site is delineated based on releases from mining activities in the caldera that have caused contiguous and commingling of contamination of surface water and sediment along each of the three drainages. The site is evaluated according to sources located in all three drainage areas (i.e., the Upper Animas River, Cement Creek, and Mineral Creek drainages) (see Figures 5, 6, 7). Cement Creek and Mineral Creek flow into Animas River at Silverton (see Figures 2 through 7).

Surface water flow in the Upper Animas River watershed follows a typical Rocky Mountain pattern with higher flow in the spring through early summer due to snowmelt and low flow conditions from August through March (Ref. 6a, p.21). Based on the locations of multiple PPEs within all three drainages, the in-water segment for the BPMD site (i.e., perennially flowing streams from PPEs to target distance limits [TDL]) includes portions of West Fork Animas River (aka California Gulch), Animas River, Cement Creek, North Fork Cement Creek, South Fork Cement Creek, Prospect Gulch, Mineral Creek, Browns Gulch, Middle Fork Mineral Creek, and South Fork Mineral Creek (see Section 4.1.1.1 below and Figures 5 through 11). Contamination associated with the site (i.e., observed release by direct observation) is documented within the drainages, and available analytical results suggest that the contamination extends downstream of the mining district (see Section 4.1.2.1.1 below). The peaks and valleys of the mountainous terrain cause variable rates of erosion and sedimentation, and subsequent variability in the levels of contamination throughout the watershed (see below, Sections 4.1.1.1 and 4.1.2.1).

4.1.1.1 Definition of Hazardous Substance Migration Path for Overland/Flood Component

The hazardous substance migration path for the BPMD site consists of overland segments originating at site sources, waste rock piles in direct contact with streams and active adit discharges at multiple PPEs, and the in-water segment within the perennially flowing streams of the watershed (Figures 5 through 11; Ref. 1, Section 4.1.1.1).

<u>Overland Segments and PPEs</u>

As described in Section 2.2, there are multiple sources within each of the three drainages. The overland flow paths from the site sources to PPEs are described below in Table SW-1. As shown in Figures 5 through 7, there are a total of 26 PPEs, including 8 in the Upper Animas River drainage, 12 in the Cement Creek drainage, and 6 in the Mineral Creek drainage. Each PPE is associated with one or more sources at mining sites that are being scored in this HRS documentation record. The most upstream PPE is in West Fork Animas River (a.k.a. California Gulch), at PPE-U-1A associated with the Vermillion Mine Adit Discharge (Source U-1A). The most downstream PPE is in Animas River, at PPE-U-6 associated with the Brooklyn Mine Waste Rock Pile (Source M-2B).

TABLE SW-1. Overland Segments from Sources and Probable Points of Entry					
Source No.	**Source Name**	**Description of Overland Segment**	**Receiving Stream**	**PPE Designation**	**Reference**
U-1A	Vermillion Mine Adit Discharge	The adit discharge (DM 17) flows in a southerly direction for almost 2,200 feet directly into West Fork Animas River; the flow path is through the waste rock pile (Source U-1A) and then in a broad swale.	West Fork Animas River (California Gulch)	PPE-U-1A	Refs. 14, pp. 12, 71-73; 55, p.1
U-1B	Vermillion Mine Waste Rock Pile	The waste rock pile (sample #6) is just below the adit discharge. Runoff from Source U-1B flows in a southerly direction and enters West Fork Animas River about 125 feet downstream of PPE-U-1A.		PPE-U-1B	
U-2A	Frisco/Bagley Tunnel Adit Discharge	The adit discharge (DM 19) flows in a southerly direction for about 580 feet into West Fork Animas River; the flow path is through the waste rock pile (Source U-2B), then through a PVC pipe and over soil.	West Fork Animas River (California Gulch)	PPE-U-2A	Refs. 14, pp. 12, 75-80; 55, p. 2
U-2B	Frisco/Bagley Tunnel Waste Rock Pile	The waste rock pile (sample #10) is in direct contact with West Fork Animas River at PPE-U-2B, about 80 feet downstream of PPE-U-2A.		PPE-U-2B	
U-3A	Columbus Mine Adit Discharge	The adit discharge (DM 20) flows south through the waste rock pile for about 240 feet and enters West Fork Animas River.	West Fork Animas River (California Gulch)	PPE-U-3	Refs. 14, pp. 12, 80-82; 55, p. 3
U-3B	Columbus Mine Waste Rock Pile	Runoff from the waste rock pile (sample #13) flows directly into West Fork Animas River at the same PPE as the adit discharge (Source U-3A).			
U-4A	Tom Moore Mine Adit Discharge	The adit discharge (DM 22) flows southwest for approximately 185 feet directly into Animas River.	Animas River	PPE-U-4	Refs. 14, pp. 12, 97-98; 55, p. 4
U-4B	Tom Moore Mine Waste Rock Pile	The waste rock pile (sample #33) abuts the Animas River and leaches into it at the same PPE as the adit discharge (Source U-4A).			
U-5B	Kittimack Tailings Waste Pile	The tailings (sample #13) cover the valley near the confluence of Animas River and Maggie Gulch. The area becomes saturated in spring, and some of the tailings have been eroded toward Animas River.	Animas River	PPE-U-5	Ref. 15, pp. 26, 128-129; 55, p. 5

TABLE SW-1. Overland Segments from Sources and Probable Points of Entry					
Source No.	**Source Name**	**Description of Overland Segment**	**Receiving Stream**	**PPE Designation**	**Reference**
U-6A	Amy Tunnel of the Aspen Mine Adit Discharge	The adit drainage (DM 64) flows overland northwest for approximately 1,500 feet to Animas River.	Animas River	PPE-U-6	Refs. 15, pp. 20, 141-143; 55, p. 6
C-1A	Grand Mogul Mine Adit Discharge	The adit discharge (UASW059) (Source C-1A) emanates from the waste rock pile (UASO010) (Source C-1B) and travels northwest overland for about 300 feet to Cement Creek, where a rust-colored stain has been observed on stream rocks at the PPE.	Cement Creek	PPE-C-1	Refs. 3, pp. 25, 41-44; 4, pp. 18, 22-24, 27; 5, pp. 6, 15; 12, pp. 1-3; 26, pp. 273-275; 55, p.7
C-1B	Grand Mogul Mine Waste Rock Pile				
C-2A	Mogul Mine Adit Discharge	The adit discharge (UAAD004) follows a ditch southwest across the waste rock pile and soil for about 1,440 feet, where it enters Cement Creek. A portion of the ditch atop the pile is polyfiber-lined.	Cement Creek	PPE-C-2	Refs. 2, p. 18; 3, pp. 9-10, 32, 37; 4, pp. 18, 22-24, 27-28; 12, pp. 1-3; 55; p. 8
C-2B	Mogul Mine Waste Rock Pile	Runoff from the waste rock pile (UASO013) follows the same ditch as the adit discharge (Source C-2A) for about 1,100 feet to the same PPE.			
C-3A	Red and Bonita Mine Adit Discharge	The adit discharge (CC03C) flows west and south across the waste rock pile and down a steep slope for about 950 feet and enters Cement Creek.	Cement Creek	PPE-C-3	Refs. 2, p. 18; 4, pp. 18-19, 27-28; 11, pp. 8-10, 40-41; 12, pp. 1, 2, 4, 5; 55, p. 9
C-3B	Red and Bonita Mine Waste Rock Pile	Runoff from the waste rock pile (UASO005) follows the same path as the adit discharge (Source C-3A) for about 200 feet down a steep slope to the same PPE in Cement Creek.			
C-4A	Gold King Mine Adit Discharge	The adit discharge (UAADO02) flows east, south, and west for about 1,000 feet before flowing into North Fork Cement Creek. Currently, the adit discharge is being treated before being released into the creek.	North Fork Cement Creek	PPE-C-4A	Refs. 2, p. 18; 4, pp. 18-19, 27-28; 5, pp. 18-19; 12, pp. 1-5; 55, p. 10
C-4B	Gold King Mine Waste Rock Pile	The waste rock pile (UASO016) is being actively eroded by North Fork Cement Creek at PPE-U-2B, about 750 feet downstream of PPE-C-4A.		PPE-C-4B	

TABLE SW-1. Overland Segments from Sources and Probable Points of Entry					
Source No.	**Source Name**	**Description of Overland Segment**	**Receiving Stream**	**PPE Designation**	**Reference**
C-5A	American Tunnel Adit Discharge	The adit discharge (UAADO01) flows northwest for about 400 feet before flowing into Cement Creek. Adit discharge from the American Tunnel has been treated in the past, but is not being treated currently.	Cement Creek	PPE-C-5	Refs. 4, pp. 18-19, 27-29; 55, p. 11
C-6A	Natalie/Occidental (Silver Ledge) Mine Adit Discharge	The adit discharge (SO-13) flows southwest over soil and the waste rock pile (Source C-6B) for about 240 feet before entering South Fork Cement Creek.	South Fork Cement Creek	PPE-C-6A	Refs. 2, pp. 18, 92, 94-96; 55, p. 12
C-6B	Natalie/Occidental (Silver Ledge) Mine Waste Rock Pile	South Fork Cement Creek runs through and erodes the toe of the waste rock pile (site #20) at PPE at PPE-C-6B, about 250 feet downstream of PPE-C-6A.		PPE-C-6B	
C-7A	Henrietta Mine Adit Discharge	This adit discharge (SO-04), which only flows in the spring, follows a drainage ditch northeast across the waste rock pile (Source C-7B) for about 539 feet and flows directly into Prospect Gulch.	Prospect Gulch	PPE-C-7A	Refs. 2, pp. 18, 105-111; 55, p.13
C-7B	Henrietta Mine Waste Rock Pile	The pile (site #10) is being eroded at the toe by the stream (Prospect Gulch) at PPE-C-7B, about 50 feet downstream of PPE-C-7A. Some sections over-steepened by erosion appear to be susceptible to mass failure into the stream.		PPE-C-7B	
C-8A	Lark Mine Adit Discharge	The discharge (SO-02) from this collapsed adit flows southeast over waste rock and soil for about 990 feet and enters directly into Prospect Gulch.	Prospect Gulch	PPE-C-8	Refs. 2, pp. 106, 111-113; 55, p. 14
C-9A	Joe & John Adit Discharge	The adit discharge (SO-06) flows south over soil and waste rock for approximately 920 feet and enters directly into Prospect Gulch.	Prospect Gulch	PPE-C-9	Refs. 2, pp. 33, 113-115; 55, p. 15
M-1A	Koehler Tunnel Adit Discharge	The adit drainage (MS81) flows northwest through a pipe and over soil for approximately 190 feet and enters the headwaters of Mineral Creek.	Mineral Creek	PPE-M-1	Refs. 6b, pp. 45, 50; 13, pp. 10-22; 39, pp. 3-8; 55, p. 16

TABLE SW-1. Overland Segments from Sources and Probable Points of Entry					
Source No.	**Source Name**	**Description of Overland Segment**	**Receiving Stream**	**PPE Designation**	**Reference**
M-2A	Brooklyn Mine Adit Discharge	The adit discharge (NAW819) flows east, west, and south overland for approximately 1,460 feet and enters Browns Gulch. The drainage historically flowed over the waste rock pile (Source M-2B) for about 330 feet, but has since been diverted around it.	Browns Gulch	PPE-M-2A	Refs. 6b, pp. 44, 51; 6c, pp. 26-27; 13, pp. 31-34; 39, pp. 1–2; 55, p. 17
M-2B	Brooklyn Mine Waste Rock Pile	Runoff from the waste rock pile (NAD817) enters Browns Gulch at PPE-M-2B, at PPE-U-2B, about 100 feet downstream of PPE-M-2A.		PPE-M-2B	
M-3A	Paradise Mine Adit Discharge	The adit drainage (NAW870) flows northeast over the associated waste rock pile (Source M-3B) for approximately 150 feet and enters Middle Fork Mineral Creek.	Middle Fork Mineral Creek	PPE-M-3A	Refs. 6b, p. 46; 6c pp. 30-31; 13, pp. 45-48; 39, pp. 8-9; 55, p. 18
M-3B	Paradise Mine Waste Rock Pile	The waste rock pile (NADW520) is in direct contact with the stream (Middle Fork Mineral Creek) at PPE-M-3B, at PPE-U-2B, about 50 feet downstream of PPE-M-3A.		PPE-M-3B	
M-4A	Bandora Mine Adit Discharge	The adit discharge (MS4-712) flows southeast overland around the waste rock pile (Source M-4B) for about 920 feet and enters South Fork Mineral Creek. The adit discharge historically flowed over the pile; however, it has since been diverted around it.	South Fork Mineral Creek	PPE-M-4	Refs. 6b, pp. 35, 44, 53; 6c, p. 27; 13, pp. 52-57; 39, pp. 10-16; 55, p. 19
M-4B	Bandora Mine Waste Rock Pile	Runoff from the waste rock pile (NAD399) follows the same flow path as the adit discharge (Source M-4A) and enters South Fork Mineral Creek at the same PPE.			

Note: PPE Probable Point of Entry

In-Water Segments and Stream Types

The in-water segments and target distance limit (TDL) for the site and for each drainage are identified below. The in-water segments for the site and for each drainage extends from the farthest upstream PPE on each drainage to the drainage (TDL), which is measured 15 miles from the farthest downstream PPE on any drainage (Ref. 1, Section 4.1.1.2). The in-water segment for the BPMD site combines the in-water segments for the three drainages and extends from the farthest upstream PPE (i.e., PPE-U-1A) to the farthest downstream TDL (i.e., the maximum distance over which targets are considered in evaluating the site) (Ref. 1, Section 4.1.1.2). The in-water segments and TDLs for the Upper Animas River, Cement Creek, and Mineral Creek drainages are shown on Figures 8, 9, and 10, respectively, and the in-water segment and TDL for the BPMD site are shown on Figure 11.

The in-water segment for the Upper Animas River drainage is shown on Figure 8. This in-water segment extends from PPE-U-1A in West Fork Animas River (aka California Gulch) to PPE-U-6 in Animas River, then 15 miles downstream to the drainage TDL in Animas River below Silverton. The West Fork Animas River portion of the in-water segment also passes through PPE-U-1B, PPE-U-2A, PPE-U-2B, and PPE-U-3. The Animas River portion of the in-water segment also passes through PPE-U-4 and PPE-U-5 (see Figure 8).

The in-water segment for the Cement Creek drainage is shown on Figure 9. This in-water segment extends from PPE-C-1 in Cement Creek to the drainage TDL in Animas River below Silverton, which is measured 15 miles from the farthest downstream PPE (i.e., PPE-C-9 in Prospect Gulch). The Cement Creek portion of the in-water segment passes through PPE-C-2, PPE-C-3, and PPE-C-5. The in-water segment also includes portions of the following tributaries where sources and PPEs are located: North Fork Cement Creek (PPE-C-4A and PPE-C-4B), South Fork Cement Creek (PPE-C-6A and PPE-C-6B), and Prospect Gulch (PPE-C-7A, PPE-C-7B, PPE-C-8, and PPE-C-9) (see Figure 9).

The in-water segment for the Mineral Creek drainage is shown on Figure 10. This in-water segment includes Mineral Creek from PPE-M-1 (near the headwaters) to the confluence with Animas River. The in-water segment also includes portions of the following tributaries where sources and PPEs are located: Browns Gulch (PPE-M-2A and PPE-M-2B), Middle Fork Mineral Creek (PPE-M-3A and PPE-M-3B), and South Fork Mineral Creek (PPE-M-4). The in-water segment extends to the drainage TDL in Animas River below Silverton, which is measured 15 miles from the farthest downstream PPE (i.e., PPE-M-2B in Browns Gulch) (see Figure 10).

Based on the flow characteristics indicated by USGS stream-gauge data and EPA flow measurements, the in-water segment for the site includes three HRS stream types: minimal stream, small to moderate stream, and moderate to large stream (see Table SW-2 below) (Ref. 1, Table 4-13). USGS stream gauges within the three drainages indicate the following average annual discharge rates, in cubic feet per second (cfs) (Ref. 17):

- Animas River at Howardsville: 101.6 cfs (Ref. 17, pp. 1-5)
- Animas River at Silverton: 125.3 cfs (Ref. 17, pp. 6-9)
- Cement Creek at Silverton: 37.7 cfs (Ref. 17, pp. 10-13)
- Mineral Creek above Silverton: 21.9 cfs (Ref. 17, pp. 14-17)
- Mineral Creek at Silverton: 101.8 cfs (Ref. 17, pp. 18-21)
- Animas River below Silverton: 272.1 cfs (Ref. 17, pp. 22-25)
- Animas River at Tall Timber Resort above Tacoma, CO: 500.5 cfs (Ref. 17, pp. 26-29)

In addition to the USGS stream-gauge data, flow measurements from EPA sampling events are available for most of the stream reaches that make up the in-water segment. The flow data and HRS stream types for individual stream reaches that make up the in-water segment are presented below in Table SW-2.

TABLE SW-2. In-Water Segments, Streamflow Data, and Stream Types						
Stream Reach	**Mining Sites (Sources)**	**Discharge Data**			**Stream Type**	**References**
		Location ID	**Date**	**Flow (cfs)**		
California Gulch downstream of PPE-A1	Vermillion Mine (U-1A, U-1B) Frisco/Bagley Tunnel (U-2A, U-2B) Columbus Mine (U-3A, U-3B)	A15	6/10/15	22.83	Small to moderate stream, 10-100 cfs	Ref. 1, Table 4-13; 32, pp. 36, 53
		A13	6/9/15	56.13		
		CG9	6/9/15	53.29		
		A11	6/9/15	56.14		
		CG11	6/9/15	48.57		
		Average		**47.39**		
Animas River – Minnie Gulch to Cunningham Creek	Tom Moore Mine (U-4A, U-4B) Kittimack Tailings (U-5B)	A08	6/10/15	29.69	Small to moderate stream, 10-100 cfs	Ref. 1, Table 4-13; 22, pp. 162-164; 32, pp. 152, 159, 165, 169, 177; 32, pp. 36, 53
		A31	6/9/15	135.06		
		A45	9/25/14	23.27		
		A49	9/25/14	24.80		
		A53AC	9/25/14	52.84		
		A55	9/23/14	89.14		
		A56	10/3/12	24.71		
		A56	9/23/14	93.72		
		Average		**59.15**		
Animas River – Arrastra Creek to TDL	Amy Tunnel (U-6A)	A60	9/23/14	128.53	Moderate to large stream, 100-1,000 cfs	Ref. 1, Table 4-13; 26, pp. 183, 186, 189, 192; 32, pp. 36, 53; 40, pp. 4, 6, 9
		A61	9/23/14	101.81		
		A64	9/23/14	109.53		
		A68	5/14/13	309		
		A68	9/24/14	108		
		A68	6/9/15	730		
		A68	6/10/15	995		
		A66	9/25/14	41.52		
		A70B	10/2/12	42.9		
		A71B	10/2/12	71.7		
		A72	5/14/13	398		
		A72	9/24/14	257		
		A72	6/9/15	1390		
		BRIDGE	10/3/12	120.3		
		Average		**343.09**		

TABLE SW-2. In-Water Segments, Streamflow Data, and Stream Types						
Stream Reach	**Mining Sites (Sources)**	**Discharge Data**			**Stream Type**	**References**
		Location ID	**Date**	**Flow (cfs)**		
Cement Creek – PPE-C1 to PPE-C5	Grand Mogul Mine (C-1A, C-1B) Mogul Mine (C-2A, C-2B) Red and Bonita Mine (C-3A, C-3B)	CC01F	10/3/12	0.05	Minimal stream, < 10 cfs	Ref. 1, Table 4-13; 22, pp. 99, 103, 111, 115, 138; 24, pp. 55, 58; 26, pp. 195, 198, 202, 205, 232, 208; 40, pp. 6, 8, 9
		CC01T	10/3/12	0.31		
		CC01T	9/24/14	1.63		
		CC01U	5/16/12	7.19		
		CC01U	10/3/12	0.34		
		CC01U	9/24/14	1.65		
		CC02B	9/23/14	2.61		
		CC03	5/15/12	8.51		
		CC03	10/3/12	1.41		
		CC03	5/14/13	31.29		
		CC03	9/23/14	3.47		
		CC18B	5/15/12	15.95		
		CC18B	10/3/12	1.95		
		CC18B	9/23/14	4.81		
		CC01H	5/16/12	4.24		
		CC03A	10/3/12	0.65		
		CC03B	5/15/12	11.77		
		CC03B	5/14/13	30.09		
		CC03B	9/23/14	3.40		
		UASW020	5/16/12	8.78		
		Average		**7.00**		
North Fork Cement Creek downstream of PPE-C4	Gold King Mine (C-4A, C-4B)	CC04	9/23/14	0.14	Minimal stream, < 10 cfs	Ref. 1, Table 4-13; 24, pp. 61; 26, p. 217; 40, pp. 4, 6, 8
		CC07	5/15/12	0.89		
		CC07	10/3/12	0.19		
		CC07	5/14/13	3.24		
		CC07	9/23/14	0.38		
		Average		**0.97**		
Cement Creek downstream of PPE-C5	American Tunnel (C-5A)	CC18	5/15/12	11.44	Small to moderate stream, 10-100 cfs	Ref. 1, Table 4-13; 22, pp. 134, 142, 146, 155; 26, pp. 229, 235, 238, 245;
		CC18	5/14/13	32.27		
		CC18	9/23/14	4.66		
		CC21	5/15/12	34.18		

TABLE SW-2. In-Water Segments, Streamflow Data, and Stream Types						
Stream Reach	**Mining Sites (Sources)**	**Discharge Data**			**Stream Type**	**References**
		Location ID	**Date**	**Flow (cfs)**		
		CC21	5/14/13	44.93		40, pp. 4, 6, 8-10.
		CC21	9/23/14	10.99		
		CC21B	5/15/12	32.55		
		CC21B	10/2/12	5.91		
		CC21B	5/14/13	41.24		
		CC21B	9/23/14	13.14		
		CC30N	10/2/12	9.29		
		CC34	10/4/12	9.22		
		CC40B	10/2/12	9.5		
		CC41	5/15/12	50.67		
		CC41	9/23/14	24.18		
		CC45K	10/2/12	13.05		
		CC47C	10/2/12	13		
		CC48	5/14/13	91		
		CC48	9/23/14	28		
		CC48	6/10/15	283		
		Average		**38.11**		
South Fork Cement Creek downstream of PPE-C6	Natalie/Occidental (Silver Ledge) Mine (C-6A, C-6B)	CC15	5/16/12	5.04	Minimal stream, < 10 cfs	Ref. 1, Table 4-13; 22, pp. 122, 130; 24, pp. 64, 67, 71; 26, pp. 220, 223, 226; 40, p. 8
		CC15	10/3/12	0.19		
		CC15	5/15/13	7.50		
		CC15	9/23/14	0.93		
		CC16B	5/16/12	5.92		
		CC16B	10/3/12	1.04		
		CC16B	5/15/13	10.29		
		CC16B	9/23/14	1.69		
		CC17	5/15/12	19.28		
		CC17	5/14/13	17.78		
		CC17	9/23/14	8.10		
		Average		**7.07**		
Prospect Gulch downstream of PPE-A7	Henrietta Mine (C-7A, C-7B) Lark Mine (C-8A)	CC26	5/15/12	6.29	Minimal stream, < 10 cfs	Ref. 1, Table 4-13; 22, p. 149; 24, p.
		CC26	5/14/13	11.39		

TABLE SW-2. In-Water Segments, Streamflow Data, and Stream Types						
Stream Reach	**Mining Sites (Sources)**	**Discharge Data**			**Stream Type**	**References**
		Location ID	**Date**	**Flow (cfs)**		
	Joe and Johns Mine (C-9A)	CC26	9/23/14	1.02		83; 26, p. 241
		Average		**6.24**		
Mineral Creek, PPE-M1 to Middle Fork	Koehler Tunnel (M-1A)	No flow data available; assumed minimal stream based on drainage area			Minimal stream, < 10 cfs	Ref. 1, Table 4-13
Browns Gulch downstream of PPE-M2	Brooklyn Mine (M-2A, M-2B)	No flow data available; assumed minimal stream based on drainage area			Minimal stream, < 10 cfs	Ref. 1, Table 4-13
Middle Fork Mineral Creek downstream of PPE-M3	Paradise Mine (M-3A, M-3B)	No flow data available; assumed minimal stream based on drainage area			Minimal stream, < 10 cfs	Ref. 1, Table 4-13
South Fork Mineral Creek downstream of PPE-M4	Bandora Mine (M-4A, M-4B)	No flow data available; assumed small to moderate stream based on drainage area			Small to moderate stream, 10-100 cfs	Ref. 1, Table 4-13
Mineral Creek, Middle Fork to gauge	no sources or PPEs along this in-water segment	Based on average discharge of 21.9 cfs at historical USGS gauge			Small to moderate stream, 10-100 cfs	Ref. 1, Table 4-13
Mineral Creek at gauge	no sources or PPEs along this in-water segment	M34	5/14/13	185	Moderate to large stream, 100-1,000 cfs	Ref. 1, Table 4-13; 40, pp. 3, 8
		M34	9/24/14	163		
		M34	6/9/15	517		
		Average		**288.33**		

Note: PPE Probable Point of Entry

Elevated Concentrations in the Watershed

Surface water and sediment samples collected by EPA from 2012 to 2015 suggest that the releases from site sources have affected water and sediment quality in streams throughout the in-water segments for the site, as well as downstream below Silverton (Refs. 40; 41). The samples were analyzed according to EPA Contract Laboratory Program Statement of Work for Inorganic Superfund Methods, 200.7, 200.8, 7473—Metals and Mercury (Refs.40; 41). Available results for background sample locations A01, A03, A06, BG1A, A24, A32, EG1, A48, CC01F, CC04, and CC15, which are upstream of and uncontaminated by site sources, indicate that the dissolved water concentrations entering the watershed above site sources range from non-detect concentrations for all five site-related hazardous substances to 1,380 microgram per liter (µg/L) for aluminum, 2.08 µg/L for cadmium, 78.6 µg/L for copper, 159 µg/L for manganese, and 393 µg/L for zinc (Refs. 18, pp. 51, 53, 61-63; 19, pp. 3-4, 6-8, 32-33, 35, 45, 48, 55, 108-110, 117, 120, 125, 194, 197, 226, 243, 299, 312; 21, pp. 33, 44-45; 22, pp. 15, 18, 28, 45, 56, 58, 72; 23, pp. 38, 50-51; 24, pp. 14, 20, 40; 25, pp. 52, 60-61; 26, pp. 23, 33, 84). Background sediment concentrations range from 4,320 to 14,200 milligrams per kilogram (mg/kg) for aluminum; 0.246 to 9.09 mg/kg* for cadmium; 19.4 to 206 mg/kg* for copper; 1,060 to 7,840 mg/kg for manganese; and 130 to 911 mg/kg for zinc (Refs. 18, pp. 53, 61-63; 19, pp. 3, 6-8, 11, 61, 63, 82, 87, 99, 129, 131, 145, 149, 158, 194, 197, 260, 281, 325, 340; 20, pp. 8, 18). These background levels are comparable to background levels recorded by USGS (Ref. 6a). The pH readings at the background locations ranges from 3.77 to 7.68, with the majority of readings above 6 (Ref. 40).

*Note: In the paragraph above and in the tables below, cadmium and copper concentrations that were reported as micrograms per kilogram (µg/kg) have been converted to mg/kg (i.e., divided by 1,000) for consistency within this data presentation.

The following tables present analytical results for stream samples in each drainage that exhibit elevated hazardous substance concentrations indicating extensive metals contamination throughout the watershed. The samples were collected during the same timeframes as the background samples described above (i.e., 2012 to 2015) and were collected and analyzed according to the same standard procedures and methods (Ref.40; 41). Many of the pH values at these downstream locations are below 4, indicating the effects of acid mine drainage in the watershed (Ref. 40). Tables SW-3 and SW-4 present analytical results for dissolved concentrations in surface water and total concentrations in sediment, respectively. Sample locations are listed in upstream-to-downstream order in the tables.

TABLE SW-3. Elevated Dissolved Surface Water Concentrations Downstream of Site Sources					
Sample ID	**Description**	**Date**	**Hazardous Substance**	**Dissolved Concentration (µg/L)**	**References**
CG6	California Gulch below Vermillion Mine tributary	9/30/15	Aluminum	12,000	18, pp. 53, 63; 19, pp. 196, 235, 306
			Cadmium	16.4	
			Copper	35.9	
			Manganese	31,500	
			Zinc	5,310	
A15	California Gulch below Vermillion Mine and above road	6/10/15	Aluminum	1,380	18, pp. 51, 63; 32, pp. 17, 36, 53
			Manganese	4,630	
			Zinc	1,200	
		9/29/15	Aluminum	9,520	18, pp. 53, 63; 19, pp. 5, 40-41, 114
			Cadmium	15.5	
			Copper	36.4	
			Manganese	29,700	
			Zinc	5,100	
A13	California Gulch above both Frisco and Pond	6/9/15	Manganese	1,980	18, pp. 51, 63; 32, pp. 17, 36, 53
		9/29/15	Aluminum	5,590	18, pp. 53, 63; 19, pp. 5, 39-40, 113
			Cadmium	10.2	
			Copper	28.3	
			Manganese	18,900	
			Zinc	3,920	
CG9	California Gulch below Bagley Adit discharge	6/9/15	Manganese	1,880	18, pp. 51, 63; 32, pp. 17, 36, 53
		9/29/15	Aluminum	4,020	18, pp. 53, 63; 19, pp. 196, 236, 306
			Cadmium	10.3	
			Copper	26.8	
			Manganese	18,000	
			Zinc	3,880	
A11	California Gulch below Frisco and Pond, below Bagley Mill tailings	6/9/15	Manganese	1,940	18, pp. 51, 63; 32, pp. 17, 36, 53
		9/29/15	Aluminum	3,870	18, pp. 53, 63; 19, pp. 4, 38, 112
			Cadmium	10.1	
			Copper	27.7	
			Manganese	18,600	
			Zinc	4,110	
CG11	California Gulch above Columbus Mine	6/9/15	Manganese	1,970	18, pp. 51, 63; 32, pp. 17, 36, 53
		9/29/15	Aluminum	3,830	18, pp. 53, 63; 19, pp. 195,

TABLE SW-3. Elevated Dissolved Surface Water Concentrations Downstream of Site Sources					
Sample ID	**Description**	**Date**	**Hazardous Substance**	**Dissolved Concentration (µg/L)**	**References**
			Cadmium	10.2	234, 305
			Copper	27.9	
		9/29/15	Manganese	17,600	18, pp. 53, 63; 19, pp. 195, 234, 305
			Zinc	3,930	
A10	California Gulch mouth, above Animas confluence	6/9/15	Copper	16.2	18, pp. 51, 63; 32, pp. 17, 36, 53
			Manganese	2,080	
		9/29/15	Aluminum	3,800	18, pp. 53, 63; 19, pp. 4, 38, 112
			Cadmium	11.6	
			Copper	39.4	
			Manganese	18,000	
			Zinc	4,560	
A14	Below confluence of Animas and California Gulch	6/9/15	Manganese	1,440	18, pp. 51, 63; 32, pp. 17, 36, 53
		9/29/15	Aluminum	2,930	18, pp. 53, 63; 19, pp. 5, 40, 114
			Cadmium	10.7	
			Copper	32.5	
			Manganese	13,600	
			Zinc	3,800	
UA8	Animas above Burns Gulch	6/9/15	Manganese	752	18, pp. 51, 63; 32, pp. 18, 36, 53
		9/30/15	Manganese	4,580	18, pp. 53, 63; 19, pp. 199, 319
			Zinc	1,420	
A28	Animas below Burns Gulch	6/9/15	Manganese	721	18, pp. 51, 63; 32, pp. 17, 36, 53
		9/30/15	Manganese	3,800	18, pp. 53, 63; 19, pp. 6, 118
			Zinc	1,330	
A30	Animas below Burns Gulch and Silver Wing Mine	6/9/15	Manganese	715	18, pp. 51, 63; 32, pp. 17, 36, 53
		9/30/15	Copper	19.3	18, pp. 53, 63; 19, pp. 6, 47, 119
			Manganese	3,750	
			Zinc	1,410	
A31	Animas above Niagara Gulch	6/9/15	Manganese	617	18, pp. 51, 62; 32, pp. 17, 36, 52
		10/1/15	Manganese	2,460	18, pp. 53, 62; 19, pp. 7, 119
A33	Animas above Eureka Gulch	9/30/15	Manganese	2,500	18, pp. 53, 62; 19, pp. 7, 120
A35	Animas below Eureka Gulch/ South Fork	6/9/15	Manganese	527	18, pp. 51, 62; 32, pp. 17, 36, 52
		9/30/15	Manganese	1,560	18, pp. 53, 62; 19, pp. 7,

TABLE SW-3. Elevated Dissolved Surface Water Concentrations Downstream of Site Sources					
Sample ID	**Description**	**Date**	**Hazardous Substance**	**Dissolved Concentration (µg/L)**	**References**
					121
A40A	Animas above Forest Queen	6/9/15	Manganese	498	18, pp. 51, 62; 32, pp. 17, 36, 52
		9/30/15	Manganese	1,520	18, pp. 53, 62; 19, pp. 8, 122
A40	Animas above Minnie Gulch	6/9/15	Manganese	507	18, pp. 51, 62; 32, pp. 17, 36, 52
		9/30/15	Manganese	1,060	18, pp. 53, 62; 19, pp. 7, 122
A41A	Animas below Minnie Gulch	6/9/15	Manganese	268	18, pp. 51, 62; 32, pp. 17, 36, 52
		9/30/15	Manganese	1,020	18, pp. 53, 62; 19, pp. 8, 123
LA3	Animas below Maggie Gulch	6/9/15	Manganese	222	18, pp. 51, 62; 32, pp. 18, 36, 52
		9/30/15	Manganese	234	18, pp. 53, 62; 19, pp. 199, 317
A45	Animas above Howardsville tailings	6/9/15	Manganese	293	18, pp. 51, 61; 32, pp. 17, 36, 51
A55	Animas ¼-mile below A54	6/9/15	Manganese	284	18, pp. 51, 61; 32, pp. 17, 36, 51
		9/29/15	Manganese	317	18, pp. 53, 61; 19, pp. 8, 125
A56	Animas above Arrastra Creek	6/9/15	Manganese	246	18, pp. 51, 61; 32, pp. 17, 36, 51
		9/29/15	Manganese	256	18, pp. 53, 61; 19, pp. 9, 126
A60	Animas downstream of Arrastra Creek and bridge	6/9/15	Manganese	230	18, pp. 51, 61; 32, pp. 17, 36, 51
		9/29/15	Manganese	228	18, pp. 53, 61; 19, pp. 9, 127
A61	Animas below Arrastra Creek	6/9/15	Manganese	814	18, pp. 51, 61; 32, pp. 17, 36, 51
		9/29/15	Manganese	420	18, pp. 53, 61; 19, pp. 9, 128
A64	Animas downstream of Boulder and Aspen Creeks	6/9/15	Manganese	356	18, pp. 51, 61; 32, pp. 17, 36, 51
		9/29/15	Manganese	724	18, pp. 53, 61; 19, pp. 9, 128
A65	Animas near wetland downstream of Venture	6/9/15	Manganese	375	18, pp. 51, 61; 32, pp. 17, 36, 51
		9/29/15	Manganese	780	18, pp. 53, 61; 19, pp. 193, 295

TABLE SW-3. Elevated Dissolved Surface Water Concentrations Downstream of Site Sources					
Sample ID	**Description**	**Date**	**Hazardous Substance**	**Dissolved Concentration (µg/L)**	**References**
	Snowboard				
A66	Animas at destroyed bridge	6/9/15	Manganese	419	18, pp. 51, 61; 32, pp. 17, 36, 51
		9/29/15	Manganese	1,240	18, pp. 53, 61; 19, pp. 193, 296
A68	14th Street gauge @ 13th Street Bridge	6/9/15	Manganese	538	18, pp. 51, 61; 32, pp. 17, 36, 51
		6/10/15	Manganese	640	18, pp. 51, 61; 32, pp. 20, 36, 51
		9/29/15	Manganese	1,380	18, pp. 53, 61; 19, pp. 193, 297
CC01U	Cement Creek downstream of Sublevel 1 drainages	5/16/12	Cadmium	55.4	21, pp. 33, 45; 22, pp. 15, 28, 38
			Copper	1,240	
		10/3/12	Cadmium	13.1	21, pp. 34, 45; 22, pp. 18, 28, 70
		9/24/14	Manganese	2,970	25, pp. 52, 60-61; 26, pp. 23, 33, 86
CC02B	Cement Creek below Mogul Mine	10/3/12	Cadmium	19.2	21, pp. 34-35, 45; 22, pp. 18, 28, 88
			Manganese	4,020	
			Zinc	6,420	
		9/23/14	Cadmium	14.1	25, pp. 52, 60-61; 26, pp. 23, 33, 86
			Manganese	2,900	
			Zinc	3,530	
CC03	Cement Creek downstream of Red and Bonita and upstream of North Fork	5/15/12	Manganese	3,800	21, pp. 33, 45; 22, pp. 15, 28, 33
		10/3/12	Cadmium	24.7	21, pp. 34, 45; 22, pp. 18, 28, 69
			Manganese	18,300	
			Zinc	10,300	
		5/14/13	Manganese	1,880	23, pp. 38, 50-51; 24, pp. 14, 20, 38
		9/23/14	Cadmium	14.6	25, pp. 52, 60-61; 26, pp. 23, 33, 86
			Manganese	9,190	
			Zinc	5,850	
CC03A	Cement Creek below FD-1	10/3/12	Cadmium	16.9	21, pp. 34, 45; 22, pp. 18, 28, 69
			Manganese	3,770	
			Zinc	5,730	

TABLE SW-3. Elevated Dissolved Surface Water Concentrations Downstream of Site Sources					
Sample ID	**Description**	**Date**	**Hazardous Substance**	**Dissolved Concentration (µg/L)**	**References**
CC03B	Cement Creek immediately upstream of Red and Bonita confluence	10/3/12	Cadmium	15.5	21, p. 34; 22, pp. 18, 28, 70
			Manganese	3,260	
			Zinc	5,030	
		9/23/14	Manganese	2,570	25, pp. 52, 60-61; 26, pp. 23, 33, 86
CC07	North Fork at road crossing	5/15/12	Aluminum	7,490	21, pp. 33, 45; 22, pp. 15, 28, 33
			Cadmium	17.6	
			Copper	925	
			Manganese	5,780	
			Zinc	4,590	
		10/3/12	Aluminum	28,300	21, pp. 34-35, 45; 22, pp. 18, 28, 86
			Cadmium	67.3	
			Copper	3,000	
			Manganese	23,100	
			Zinc	16,600	
		5/14/13	Copper	523	23, pp. 38, 50-51; 24, pp. 14, 20, 38
			Manganese	3,060	
		9/23/14	Aluminum	19,400	25, pp. 52, 60-61; 26, pp. 23, 33, 60
			Cadmium	46.4	
			Copper	1,610	
			Manganese	12,700	
		9/23/14	Zinc	9,790	25, pp. 52, 60-61; 26, pp. 23, 33, 60
CC16B	South Fork below Natalie/Occidental Mine/Silver Ledge	10/3/12	Manganese	1,760	21, pp. 34, 45; 22, pp. 18, 28, 45
CC17	South Fork above Cement Creek	10/3/12	Manganese	1,670	21, pp. 34-35, 45; 22, pp. 18, 28, 85
CC18	Cement Creek above treatment plant	5/15/12	Manganese	4,830	21, pp. 33, 45; 22, pp. 15, 28, 31
			Zinc	3,320	
		10/3/12	Aluminum	7,010	21, pp. 34, 45; 22, pp. 18, 28, 68
			Cadmium	24.7	

TABLE SW-3. Elevated Dissolved Surface Water Concentrations Downstream of Site Sources					
Sample ID	**Description**	**Date**	**Hazardous Substance**	**Dissolved Concentration (µg/L)**	**References**
			Manganese	21,000	
			Zinc	11,600	
		5/14/13	Manganese	2,670	23, pp. 38, 50-51; 24, pp. 14, 20, 37
		9/23/14	Cadmium	15.6	25, pp. 52, 60-61; 26, pp. 23, 33
			Manganese	9,990	
			Zinc	6,220	
CC18B	Cement Creek above American Tunnel confluence	5/15/12	Manganese	3,970	21, pp. 33, 45; 22, pp. 15, 28, 32
		10/3/12	Aluminum	6,840	21, pp. 34, 45; 22, pp. 18, 28, 68
			Cadmium	26.6	
			Manganese	17,900	
			Zinc	10,600	
		5/14/13	Manganese	2,070	22, p. 14
		9/23/14	Cadmium	16.9	25, pp. 52, 60-61; 26, pp. 23, 33
			Manganese	9,610	
			Zinc	6,090	
CC21	Cement Creek below South Fork	5/15/12	Manganese	2,410	21, pp. 33, 45; 22, pp. 15, 28, 55
		10/2/12	Manganese	11,400	21, pp. 34-35, 45; 22, pp. 18, 28, 84
			Zinc	6,020	
		10/3/12	Cadmium	13	21, pp. 34-35, 45; 22, pp. 18, 28, 85
			Manganese	11,200	
			Zinc	5,980	
		5/14/13	Manganese	3,340	22, p.14
CC21B	Cement Creek above Prospect Gulch and below Dry Gulch	5/15/12	Manganese	2,250	21, pp. 33, 45; 22, pp. 15, 28, 55
		10/2/12	Manganese	8,820	21, pp. 34, 45; 22, pp. 18, 28, 84
			Zinc	4,690	
		10/3/12	Manganese	9,140	21, pp. 34, 45; 22, pp. 18, 28, 67
			Zinc	4,840	
		5/14/13	Manganese	2,480	22, p.14
CC26	Prospect Gulch	10/2/12	Aluminum	25,000	21, pp. 34, 45; 22, pp. 18,

TABLE SW-3. Elevated Dissolved Surface Water Concentrations Downstream of Site Sources					
Sample ID	**Description**	**Date**	**Hazardous Substance**	**Dissolved Concentration (µg/L)**	**References**
	mouth				28, 66
		9/23/14	Aluminum	8,760	25, pp. 52, 60-61; 26, pp. 23, 33, 82
CC28C	Cement Creek upstream of Tiger Gulch	10/2/12	Aluminum	9,240	21, pp. 34-35; 22, pp. 18, 28, 83
			Manganese	7,000	
			Zinc	3,830	
		10/3/12	Aluminum	9,070	21, pp. 34-35; 22, pp. 18, 28, 85
			Manganese	7,060	
			Zinc	3,870	
		10/4/12	Aluminum	9,140	21, pp. 34-35; 22, pp. 18, 28, 90
			Manganese	7,090	
			Zinc	3,870	
CC30N	Cement Creek above Fairview Gulch	10/2/12	Aluminum	9,050	21, pp. 34-35; 22, pp. 18, 27, 65
			Manganese	6,740	
			Zinc	3,730	
CC34	Cement Creek above Minnesota Gulch	10/2/12	Aluminum	8,560	21, pp. 34-35; 22, pp. 18, 27, 83
			Manganese	6,420	
			Zinc	3,480	
		10/4/12	Aluminum	8,580	21, pp. 34-35; 22, pp. 18, 27, 74
			Manganese	6,490	
			Zinc	3,480	
CC40B	Cement Creek above Ohio Gulch	10/2/12	Aluminum	8,290	21, pp. 34; 22, pp. 18, 27, 65
			Manganese	6,300	
			Zinc	3,370	
		10/4/12	Aluminum	8,400	21, pp. 34; 22, pp. 18, 27, 89
			Manganese	6,370	
			Zinc	3,390	
CC41	Cement Creek above Illinois Gulch and below Ohio Gulch	5/15/12	Manganese	1,750	21, pp. 33; 22, pp. 15, 27, 54
		10/2/12	Aluminum	8,160	21, pp. 34-35, 44; 22, pp. 18, 27, 82
			Manganese	6,310	

TABLE SW-3. Elevated Dissolved Surface Water Concentrations Downstream of Site Sources					
Sample ID	**Description**	**Date**	**Hazardous Substance**	**Dissolved Concentration (µg/L)**	**References**
			Zinc	3,350	
		5/14/13	Manganese	1,630	23, pp. 38, 50-51; 24, pp. 14, 19, 35
CC44B	Cement Creek above Topeka Gulch	10/2/12	Aluminum	7,350	21, pp. 34-35; 22, pp. 18, 27, 82
			Manganese	5,670	
CC45K	Cement Creek above Niagara Gulch	10/2/12	Aluminum	7,290	21, pp. 34; 22, pp. 18, 27, 64
			Manganese	5,610	
CC46B	Cement Creek below Hancock Gulch	10/2/12	Aluminum	7,540	21, pp. 34-35; 22, pp. 18, 27, 82
			Manganese	5,370	
CC47C	Cement Creek above Soda Gulch	10/2/12	Aluminum	7,460	21, pp. 34; 22, pp. 18, 27, 63
			Manganese	5,120	
CC48	Cement Creek upstream from Animas River	5/15/12	Manganese	1,620	21, pp. 33, 44; 22, pp. 15, 27, 52
		10/2/12	Aluminum	7,480	21, pp. 34-35, 44; 22, pp. 18, 27, 82
			Manganese	5,050	
		10/2/12 duplicate	Aluminum	7,630	
			Manganese	5,270	
		10/4/12	Aluminum	7,520	21, pp. 34-35, 44; 22, pp. 18, 27, 73
			Manganese	5,040	
		5/14/13	Manganese	1,440	23, pp. 38, 50-51; 24, pp. 14, 19, 35
CC49	Cement Creek at mouth	10/2/12	Aluminum	7,660	21, pp. 34-35; 22, pp. 18, 27, 82
			Manganese	5,300	
		10/2/12 duplicate	Aluminum	7,600	
			Manganese	5,200	
A69A	Animas River upstream of Idaho Gulch	10/2/12	Manganese	2,590	21, pp. 34-35; 22, pp. 18, 27,
A70B	Animas River upstream of Mineral Creek	10/2/12	Manganese	2,540	21, pp. 34; 22, pp. 18, 27, 63
M34	Mineral Creek gauge (mouth)	9/29/15	Manganese	466	18, pp. 53, 61; 19, pp. 199, 317

TABLE SW-3. Elevated Dissolved Surface Water Concentrations Downstream of Site Sources					
Sample ID	**Description**	**Date**	**Hazardous Substance**	**Dissolved Concentration (µg/L)**	**References**
A71B	Animas River downstream of Mineral Creek	10/2/12	Manganese	1,660	21, pp. 34; 22, pp. 18, 27, 62
A72	Animas Gauge below Silverton	10/2/12	Manganese	1,580	21, pp. 34-35, 44; 22, pp. 18, 27,
		10/4/12	Manganese	1,660	21, pp. 34, 44; 22, pp. 18, 21, 27, 89
A73	Animas upstream of Elk Creek	10/3/12	Manganese	1,440	21, pp. 34-35; 22, pp. 18, 27,

Notes: µg/L micrograms per liter
ID Identification

TABLE SW-4. Elevated Sediment Concentrations Downstream of Site Sources						
Location	**Description**	**Sample ID**	**Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**References**
A11	California Gulch below Frisco and Pond, below Bagley Mill tailings	C151005-57	9/29/15	Copper	621	18, pp. 53, 63; 19, pp. 5, 72, 138
				Zinc	4,500	
A28	Animas below Burns Gulch	C151005-AU	9/30/15	Zinc	2,790	18, pp. 53, 63; 19, pp. 6, 147
A30	Animas below Burns Gulch and Silver Wing Mine	C151005-BB	9/30/15	Zinc	2,740	18, pp. 53, 63; 19, pp. 6, 148
A31	Animas above Niagara Gulch	C151005-BF	10/1/15	Zinc	2,840 J	18, pp. 53, 62; 19, pp. 7, 148
A33	Animas above Eureka Gulch	C151005-BN	9/30/15	Copper	726	18, pp. 53, 62; 19, pp. 7, 88, 150
				Zinc	4,800	
A40	Animas above Minnie Gulch	C151005-CK	9/30/15	Zinc	4,820	18, pp. 53, 62; 19, pp. 7, 153
A41A	Animas below Minnie Gulch	C151005-CV	9/30/15	Zinc	3,030	18, pp. 53, 62; 19, pp. 8, 155
A56	Animas above Arrastra Creek	C151005-DZ	9/29/15	Zinc	4,480	18, pp. 53, 61; 19, pp. 9, 160
A68	14th Street gauge @ 13th Street Bridge	C151006-16	9/29/15	Zinc	2,770	18, pp. 53, 61; 19, pp. 193, 321

Notes: mg/kg milligrams per kilogram
ID Identification

J The associated value is an estimated quantity, although the presence of the substance is not in doubt.

4.1.2.1 Likelihood of Release

There are documented observed releases to surface water by direct observation, as shown below, as well as chemical analytical results that suggest that the observed releases have had impacts throughout the Upper Animas River watershed. Therefore, the potential to release factor value is not evaluated.

4.1.2.1.1 <u>Observed Release</u>

<u>Observed Release by Direct Observation</u>

Observed release by direct observation is supported by evidence of contaminant-bearing acid mine drainage entering the Upper Animas River watershed from draining mine adits and waste rock piles, as well as observing the presence of waste rock in direct contact with surface water. Section 2.2, Source Characterization for each drainage present all the sources and the hazardous substances associated with each. Adit discharges from multiple sources contain hazardous substances and are known to be entering the watershed, and several waste rock piles are in direct contact with and being eroded by streams. Each PPE is associated with an observed release by direct observation (i.e., either a draining adit that was observed discharging to a perennial stream, or a waste rock pile that is in direct contact with the stream; see Table SW-1). Based on the results presented in Section 2.2 for each source, the observed releases contain some or all of the following hazardous substances: aluminum, cadmium, copper, manganese, and zinc.

TABLE SW-5. Observed Release by Direct Observation

PPE Designation	Stream Name	Evidence	References
PPE-U-1A	West Fork Animas River (California Gulch)	The Vermillion Mine Adit Discharge (Source U-1A), which has pH of 3.1 to 3.7 and contains aluminum, cadmium, copper, manganese, and zinc (sample DM-17), enters West Fork Animas River at PPE-U-1A.	Refs. 14, pp. 12, 71-73, 121, 123, 125, 127; 19, pp. 5, 114; 55, p.1
PPE-U-2A	West Fork Animas River (California Gulch)	The Frisco/Bagley Tunnel Adit Discharge (Source U-2A), which contains aluminum, cadmium, manganese, and zinc (sample DM-19), enters West Fork Animas River at PPE-U-2A	Refs. 14, pp. 12, 75-79, 121, 123, 125, 127, 150, 151; 19, pp. 5, 113; 55, p. 2; 49, pp. 132-133
PPE-U-2B	West Fork Animas River (California Gulch)	The Frisco/Bagley Tunnel Waste Rock Pile (Source U-2B), which contains aluminum, cadmium, copper, manganese, and zinc (sample #10), is in contact with West Fork Animas River at PPE-U-2B.	
PPE-U-3	West Fork Animas River (California Gulch)	The Columbus Mine Adit Discharge (Source U-3A), which contains aluminum, cadmium, copper, manganese, and zinc (sample DM-20), enters West Fork Animas River at PPE-U-3. The Columbus Mine Waste Rock Pile (Source U-3B) contains aluminum, cadmium, copper, manganese, and zinc (sample #13). Leachate from the pile enters the stream at the same PPE.	Refs. 14, pp. 12, 80-82, 121, 123, 125, 127, 150, 151; 19, pp. 5, 39, 113; 55, p. 3

TABLE SW-5. Observed Release by Direct Observation			
PPE Designation	**Stream Name**	**Evidence**	**References**
PPE-U-4	Animas River	The Tom Moore Mine Adit Discharge (Source U-4A), which contains cadmium, manganese, and zinc (sample DM-22), enters Animas River at PPE-U-4. The Tom Moore Mine Waste Rock Pile (Source U-4B) contains aluminum, cadmium, copper, manganese, and zinc (sample #33). Leachate from the pile enters the stream at the same PPE.	Refs. 14, pp. 12, 97-98, 121, 123, 125, 127; 55, p. 4
PPE-U-5	Animas River	The Kittimack Tailings Waste Pile (Source U-5B) contains aluminum, cadmium, copper, manganese, and zinc (sample #13). Erosion into Animas River at PPE-U-5 occurs when the tailings area becomes saturated in spring.	Ref. 15, pp. 26, 128-129, 229-232; 55, p. 5
PPE-U-6	Animas River	The Amy Tunnel of Aspen Mine Adit Discharge (Source U-6A), which contains cadmium, copper, manganese, and zinc (sample DM64), enters Animas River at PPE-U-6.	Refs. 15, pp. 20, 141-143, 187-199; 55, p. 6
PPE-C-1	Cement Creek	The Grand Mogul Mine Adit Discharge (Source C-1A), which contains aluminum, cadmium, copper, manganese, and zinc (sample UASW059), enters Cement Creek at PPE-C1, where a rust-colored stain has been observed on stream rocks at the PPE. The adit discharge emanates from the Grand Mogul Mine Waste Rock Pile (Source C-1B), which contains cadmium, copper, manganese, and zinc (samples UASO010 and UASO011).	Refs. 3, pp. 41-44; 4, pp. 18, 22-24, 27, 60, 62; 5, pp. 6, 15; 12, pp. 1-3; 55, p.7
PPE-C-2	Cement Creek	The Mogul Mine Adit Discharge (Source C-2A), which contains aluminum, cadmium, copper, manganese, and zinc (sample UAAD004), enters Cement Creek at PPE-C-2.	Refs. 2, p. 18; 3, pp. 9-10, 32, 37; 4, pp. 18, 22-24, 27-28, 60, 62; 12, pp. 1-3; 55; p. 8
PPE-C-3	Cement Creek	The Red and Bonita Mine Adit Discharge (Source C-3A), which contains aluminum, cadmium, manganese, and zinc (sample CC03C), enters Cement Creek at PPE-C-3.	Refs. 2, p. 18; 4, pp. 18-19, 27-28, 55, 62; 11, pp. 8-10, 40-41; 12, pp. 1, 2, 4, 5; 26, pp. 20; 55, p. 9
PPE-C-4A	North Fork Cement Creek	The Gold King Mine Adit Discharge (Source C-4A), which contains aluminum, cadmium, copper, manganese, and zinc (sample UAAD002), enters Cement Creek at PPE-C-4A.	Refs. 2, p. 18; 4, pp. 18-19, 27-28, 60, 62; 5, pp. 11, 12,

TABLE SW-5. Observed Release by Direct Observation			
PPE Designation	**Stream Name**	**Evidence**	**References**
PPE-C-4B	North Fork Cement Creek	The Gold King Mine Waste Rock Pile (Source C-4B) contains cadmium, copper, manganese, and zinc (samples UASO015 and UASO016). North Fork Cement Creek actively erodes the pile at PPE-C-4B.	18-19; 12, pp. 1, 2, 4, 5; 55, p. 10; 50, p. 163
PPE-C-5	Cement Creek	The American Tunnel Adit Discharge (Source C-5A), which contains aluminum, cadmium, manganese, and zinc (sample UAAD001), enters Cement Creek at PPE-C-5.	Refs. 4, pp. 18-19, 27-29, 60; 55, p. 11
PPE-C-6A	South Fork Cement Creek/Silver Ledge	The Natalie/Occidental Mine Adit Discharge (Source C-6A), which contains aluminum, cadmium, copper, manganese, and zinc (sample SO-13), enters South Fork Cement Creek at PPE-C-6A.	Refs. 2, pp. 18, 92, 94-96, 167-169,171, 185, 187, 189; 55, p. 12; 50, p. 161
PPE-C-6B	South Fork Cement Creek	The Natalie/Occidental Mine Waste Rock Pile (Source C-6B) contains cadmium, copper, manganese, and zinc (sample Site #20). South Fork Cement Creek runs through and erodes the toe of the pile at PPE-C-6B.	
PPE-C-7A	Prospect Gulch	The Henrietta Mine Adit Discharge (Source C-7A), which contains aluminum, cadmium, copper, manganese, and zinc (sample SO-04), enters Prospect Gulch at PPE-C-7A.	Refs. 2, pp. 19, 105-111, 168, 170,172, 185, 187, 189; 55, p. 13; 50, p. 153
PPE-C-7B	Prospect Gulch	The Henrietta Mine Waste Rock Pile (Source C-7B) contains cadmium, copper, manganese, and zinc (samples Site #3 and Site #10). The pile is being eroded at the toe by the stream (Prospect Gulch) at PPE-C-7B.	
PPE-C-8	Prospect Gulch	The Lark Mine Adit Discharge (Source C-8A), which contains aluminum, cadmium, copper, manganese, and zinc (sample SO-02), enters Prospect Gulch at PPE-C-8.	Refs. 2, pp. 106, 111-113, 168, 170,172; 55, p. 14
PPE-C-9	Prospect Gulch	The Joe and Johns Mine Adit Discharge (Source C-9A), which contains aluminum, cadmium, copper, manganese, and zinc (sample SO-06), enters Prospect Gulch at PPE-C-9.	Refs. 2, pp. 33, 113-115, 168, 170,172; 55, p. 15
PPE-M-1	Mineral Creek	Discharge from the Koehler Tunnel Adit Pool (Source M-1A), which contains aluminum, cadmium, copper, manganese, and zinc (sample MS81), enters Mineral Creek at PPE-M-1.	Refs. 6b, pp. 45, 50; 6d, p. 7; 13, pp. 7-22; 39, pp. 3-8; 55, p. 16

TABLE SW-5. Observed Release by Direct Observation

PPE Designation	Stream Name	Evidence	References
PPE-M-2A	Browns Gulch	The Brooklyn Mine Adit Discharge (Source M-2A), which contains aluminum, cadmium, copper, manganese, and zinc (samples 216/4193-1.306 and several others; see Section 2.2.2-Mineral Creek for full list), enters Browns Gulch at PPE-M-2A. On its way to the PPE, the adit discharge becomes more acidic and metals concentrations increase when it flows over the Brooklyn Mine Waste Rock Pile (Source M-2B), which contains leachable aluminum, cadmium, copper, manganese, and zinc (leach test samples NAD588, NAD817, NAD818, and NAT501).	Refs. 6b, pp. 44, 48, 51; 6c, pp. 26-27; 6d, pp. 2, 8-9, 15, 16, 18; 13, pp. 31-35; 39, pp. 1–2; 55, p. 17
PPE-M-3A	Middle Fork Mineral Creek	The Paradise Mine Adit Discharge (Source M-3A), which contains aluminum, cadmium, copper, manganese, and zinc (sample MS77 and others; see Section 2.2.2-Mineral Creek for full list), enters Middle Fork Mineral Creek at PPE-M-3A.	Refs. 6b, pp. 46, 52; 6c pp. 30-31; 6d, pp. 6-7, 10, 12-14, 16, 17; 13, pp. 45, 47-52; 39, pp. 8-9; 55, p. 18
PPE-M-3B	Middle Fork Mineral Creek	The Paradise Mine Waste Rock Pile (Source M-3B), which contains aluminum, cadmium, copper, manganese, and zinc (leach test samples NAD520, NADW520, NAF520, and NAF521), is in direct contact with Middle Fork Mineral Creek at the same PPE as Source M-3A.	
PPE-M-4	South Fork Mineral Creek	The Bandora Mine Adit Discharge (Source M-4A), which contains aluminum, cadmium, copper, manganese, and zinc (sample 235/4185-1.300 and several others; see Section 2.2.2-Mineral Creek for full list), enters South Fork Mineral Creek at PPE-M4.	Refs. 6b, pp. 35, 44, 49, 53; 6c, p. 27; 6d, pp. 2, 5-6, 12, 15; 13, pp. 52-57; 39, pp. 10-16; 55, p. 19

Note: PPE Probable Point of Entry

<u>Observed Release by Chemical Analysis</u>

Observed release by chemical analysis is not scored for the BPMD site.

<u>Hazardous Substances Released:</u>

Aluminum
Cadmium
Copper
Manganese
Zinc

==

Observed Release Factor Value: 550

4.1.3 Human Food Chain Threat

The human food chain threat is evaluated for the Upper Animas River watershed, which includes the Upper Animas River, Cement Creek, and Mineral Creek drainages.

4.1.3.1 Human Food Chain Threat – Likelihood of Release

The likelihood of release factor value of 550 for the watershed (see Section 4.1.2.1.1) is assigned for the human food chain threat [Ref. 1, Section 4.1.3.1].

Likelihood of Release Factor Value: 550

4.1.3.2 Human Food Chain Threat - Waste Characteristics

4.1.3.2.1 Toxicity/Persistence/Bioaccumulation

The toxicity/persistence/bioaccumulation factor values are based on the hazardous substances associated with the sources (see Section 2.2 Source Characterization for each drainage).

TABLE SW-6. Toxicity/Persistence/Bioaccumulation, Human Food Chain Threat

Hazardous Substance*	Source No.**	Toxicity Factor Value***	Persistence Factor Value**** (River)	Bioaccumulation Factor Value (Fresh)	Toxicity/ Persistence/ Bioaccumulation Factor Value	Reference
Aluminum	OR and all sources	1,000	1.0	50	5×10^{4}	Ref. 16, p. 1
Cadmium	OR and all sources	10,000	1.0	50,000	$\mathbf{5 \times 10^{8}}$	Ref. 16, p. 3
Copper	OR and all sources	100	1.0	50,000	5×10^{6}	Ref. 16, p. 4
Manganese	OR and all sources	10,000	1.0	500	5×10^{6}	Ref. 16, p. 5
Zinc	OR and all sources	10	1.0	500	$5 \text{ X } 10^{3}$	Ref. 16, p. 6

OR Observed Release by Direct Observation
* As shown in Sections 2.2.2 for each drainage.
** As shown in Sections 2.2.3 for each drainage.
*** Toxicity values assigned are based on the predominant surface water category of fresh water.
**** Persistence values assigned are based on the predominant surface water body category "River."

Cadmium has the highest toxicity/persistence/bioaccumulation factor value (5×10^{8}) for this watershed [Ref. 1, Table 4-16; Ref. 16, pp. 1-6]. Cadmium was selected to assign the value to this factor [Ref. 1, Section 4.1.3.2.1.4].

Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^{8}

4.1.3.2.2 Hazardous Waste Quantity

The subtotal hazardous waste quantity factor values for all sources (see Section 2.2 Source Characterization for each drainage) are combined to derive the hazardous waste quantity factor value for the human food chain threat as follows:

TABLE SW-7. Hazardous Waste Quantity, Human Food Chain Threat		
Sources/Mining Sites	**Source Hazardous Waste Quantity (HWQ) Value (Ref. 1, Section 2.4.2.1.5; as shown in section 2.4.2)**	**Is source hazardous constituent quantity data complete?* (yes/no)**
U-1A, Vermillion Mine Adit Discharge	8,409.6	No
U-1B, Vermillion Mine Waste Rock Pile	2,040	No
Vermillion Mine subtotal	*10,449.6*	
U-2A, Frisco/Bagley Tunnel Adit Discharge	167.04	No
U-2B, Frisco/Bagley Tunnel Waste Rock Pile	8,200	No
Frisco/Bagley Tunnel subtotal	*8,367.04*	
U-3A, Columbus Mine Adit Discharge	4.32	No
U-3B, Columbus Mine Waste Rock Pile	9,600	No
Columbus Mine subtotal	*9,604.32*	
U-4A, Tom Moore Mine Adit Discharge	103.68	No
U-4B, Tom Moore Mine Waste Rock Pile	1,600	No
Tom Moore Mine subtotal	*1,703.68*	
U-5B, Kittimack Tailings Waste Rock Pile	9,200	No
Kittimack Tailings subtotal	*9,200*	
U-6A, Amy Tunnel Adit Discharge	547.2	No
Aspen Mine subtotal	*547.2*	
Upper Animas River drainage Subtotal	***39,871.84***	
C-1A, Grand Mogul Mine Adit Discharge	38.17	No
C-1B, Grand Mogul Mine Waste Rock Pile	10,608.4	No
Grand Mogul Mine subtotal	10,646.57	
C-2A, Mogul Mine Adit Discharge	1,008.5	No
C-2B, Mogul Mine Waste Rock Pile	16,549.9	No
Mogul Mine subtotal	17,558.4	
C-3A, Red and Bonita Mine Adit Discharge	4,253.5	No
C-3B, Red and Bonita Mine Waste Rock Pile	1,264	No
Red and Bonita Mine subtotal	5,517.5	
C-4A, Gold King Mine Adit Discharge	4,836.1	No
C-4B, Gold King Mine Waste Rock Pile	10,930.4	No
Gold King Mine subtotal	15,766.5	
C-5A, American Tunnel Adit Discharge	2,568.4	No
American Tunnel Mine subtotal	2,568.4	
C-6A, Natalie/Occidental Mine Adit Discharge	1,139.2	No
C-6B, Natalie/Occidental Mine Waste Rock Pile	2,720	No
Natalie/Occidental Mine subtotal	3,859.2	
C-7A, Henrietta Mine Adit Discharge	129.28	No
C-7B, Henrietta Mine Waste Rock Pile	12,000	No
Henrietta Mine subtotal	*12,129.28*	

TABLE SW-7. Hazardous Waste Quantity, Human Food Chain Threat		
Sources/Mining Sites	**Source Hazardous Waste Quantity (HWQ) Value (Ref. 1, Section 2.4.2.1.5; as shown in section 2.4.2)**	**Is source hazardous constituent quantity data complete?* (yes/no)**
C-8A, Lark Mine Adit Discharge	15.36	No
Lark Mine subtotal	*15.36*	
C-9A, Joe and Johns Mine Adit Discharge	43.52	No
Joe and Johns Mine subtotal	*43.52*	
Cement Creek drainage Subtotal	***68,104.73***	
M-1A, Koehler Tunnel Adit Discharge	1,185.1	No
Koehler Mine subtotal	*1,185.1*	
M-2A, Brooklyn Mine Adit Discharge	332.46	No
M-2B, Brooklyn Mine Waste Rock Pile	12,419.9	No
Brooklyn Mine subtotal	*12,752.36*	
M-3A, Paradise Mine Adit Discharge	1,635.48	No
M-3B, Paradise Mine Waste Rock Pile	280	No
Paradise Mine subtotal	*1,915.48*	
M-4A, Bandora Mine Adit Discharge	616.34	No
M-4B, Bandora Mine Waste Rock Pile	2,200	No
Bandora Mine subtotal	*2,816.34*	
Mineral Creek drainage Subtotal	***18,669.28***	
SUM OF VALUES:	**126,646** (rounded to nearest integer per Ref. 1, Section 2.4.2.2)	

* As shown in Section 2.4.2 for each drainage.

The sum corresponds to a hazardous waste quantity factor value of 10,000 in HRS Table 2-6 [Ref. 1, Section 2.4.2.2]. Therefore, a hazardous waste quantity factor value of 10,000 is assigned for the surface water migration pathway environmental threat [Ref. 1, Section 4.1.3.2.2].

Hazardous Waste Quantity Value: 10,000

4.1.3.2.3 Waste Characteristics Factor Category Value

The waste characteristics factor category value is derived by first multiplying the toxicity/persistence factor value and the hazardous waste quantity factor value for the watershed (subject to a maximum of 1 x 10^8). This product is then multiplied with the bioaccumulation potential factor value for the hazardous substance with the highest value in Section 4.1.3.2.1 (subject to a maximum value of 1 x 10^{12}) [Ref. 1, Section 4.1.3.2.3].

Cadmium, which is associated with multiple sources that have a surface water pathway containment factor value greater than 0 for the watershed and has the highest value in Section 4.1.3.2.1, corresponds to a toxicity/persistence factor value of 10,000 and bioaccumulation potential factor value of 50,000, as shown above [Ref. 1, Section 4.1.3.2.1.4; 16, p. 3].

(Toxicity/persistence factor value) x (Hazardous waste quantity factor value)
= 10,000 x 10,000 = 1 x 10^8
[Ref. 1, Section 4.1.3.2.3]

(Toxicity/persistence factor value x Hazardous waste quantity factor value) x

(Bioaccumulation potential factor value) = $(1 \times 10^8) \times (50{,}000) = 5 \times 10^{12}$
(subject to a maximum value of 1×10^{12}) [Ref. 1, Section 4.1.3.2.3]

The maximum value of 1×10^{12} corresponds to a waste characteristics factor category value of 1,000 in Table 2-7 of the HRS [Ref. 1, Section 2.4.3.1].

Waste Characteristics Factor Category Value: 1,000

4.1.3.3 Human Food Chain Threat - Targets

As shown in Figures 8 and 10, there are two specific fisheries identified within the TDL for the site: Animas River #4 (Howardsville), a reach of the river between Cunningham Creek and Minnie Gulch, and South Fork Mineral Creek (SF Mineral Creek) [Ref. 42, pp. 25-28; 43, pp. 20-22; 44, pp. 1-2]. According to Colorado Parks and Wildlife (CPW), people consume some of the fish that are caught in these reaches [Ref. 44, pp. 1-2]. Although fishing is common in the affected fisheries, CPW does not conduct formal angler surveys and does not record or estimate harvest [Ref. 44, p. 1]. As shown in Figure 8, the observed release at PPE-U-5 affects the Animas River #4 (Howardsville) fishery in the Upper Animas River drainage. As shown in Figure 10, the observed release at PPE-M-4 affects the South Fork Mineral Creek fishery in the Mineral Creek drainage. Based on the observed releases by direct observation, both fisheries are subject to Level II concentrations [Ref. 1, Sections 2.5 and 4.1.3.3].

There is also information indicating that the Animas River watershed, including the reach downstream of Silverton, is part of the Brunot Agreement Area, a designated fishery for Southern Ute tribal members; however, the specific location of fishing areas used for consumption are not documented [Ref. 53, pp. 2-5, 16-20, 32]. The fishery is likely to be subject to potential contamination from sources and releases associated with the site, however, the Brunot Area fishery is not considered in HRS scoring for the site.

Samples for Observed Release/Level I/Level II Concentrations

As described in **Section 4.1.2.1.1**, the observed releases are documented by direct observation; no stream sample data are considered for evaluation of Level I/Level II concentrations. The fisheries where there is an observed release by direct observation are considered as being subject to Level II concentrations [Ref. 1, Sections 2.5 and 4.1.3.3]. The following hazardous substances are associated with the observed releases into both fisheries:

Hazardous Substance: Aluminum
Bioaccumulation Potential: 50

Hazardous Substance: Cadmium
Bioaccumulation Potential: 50,000

Hazardous Substance: Copper
Bioaccumulation Potential: 50,000

Hazardous Substance: Manganese
Bioaccumulation Potential: 500

Hazardous Substance: Zinc
Bioaccumulation Potential: 500

References: See Table SW-6.

4.1.3.3.1 Food Chain Individual

The fisheries in Upper Animas River and South Fork Mineral Creek are considered as being subject to Level II concentrations [Ref. 1, Section 4.1.3.3.2.2] based on the presence of an observed release by direct observation to the fisheries from Kittimack tailings and Bandora mine respectively. Therefore, a food chain individual factor value of 45 is assigned [Ref. 1, Section 4.1.3.3.1].

Food Chain Individual Factor Value: 45

4.1.3.3.2 Population

As shown in **Table SW-2**, the river reaches where the Animas River #4 (Howardsville) (Animas River – Minnie Gulch to Cunningham Creek) and South Fork Mineral Creek (South Fork Mineral Creek downstream of PPE-M4) fisheries are located are categorized as small moderate stream with discharge rates ranging from 10 to 100 cfs [Ref. 1, Table 4-13].

TABLE SW-8. Fisheries

Identity of Fishery	Type of Surface Water Body[1]	Dilution Weight	Reference(s)
Animas River #4 (Howardsville)	Moderate to large stream	0.01	Ref. 1, Table 4-13; 17, pp. 1-9; 44, pp. 1-2
South Fork Mineral Creek	Small to moderate stream	0.1	Ref. 1, Table 4-13; 17, pp. 14-21; 44, pp. 1-2

[1] While the flow rate within the boundaries of each fishery varies annually, based on the flow data available, each stream can be considered a small to moderate stream at the Kittimack tailings and Bandora mine PPEs.

4.1.3.3.2.1 Level I Concentrations

There are no fisheries subject to Level I concentrations; therefore, the Level I concentrations factor value is 0 [Ref. 1, Section 4.1.3.3.2.1].

Level I Concentrations Factor Value: 0

4.1.3.3.2.2 Level II Concentrations

Based on the observed releases by direct observation, both fisheries are subject to Level II concentrations [Ref. 1, Sections 2.5 and 4.1.3.3]. According to CPW, people consume some of the fish that are caught in the Animas River #4 (Howardsville) and South Fork Mineral Creek fisheries [Ref. 42, pp. 25-28; 43, pp. 20-22; 44, pp. 1-2]. Although fishing is common in the affected fisheries, CPW does not conduct formal angler surveys and does not record or estimate harvest [Ref. 44, p. 1]. Based on these considerations, the human food chain production for each fishery is considered to be greater than 0 to 100 pounds per year and a human food chain population value of 0.03 is assigned to each fishery [Ref. 1, Table 4-18].

TABLE SW-9. Level II Fisheries					
Identity of Fishery	**Annual Production (Pounds)**	**Type of Surface Water Body (Ref. 1, Table 4-13)**	**Average Annual Flow (cfs)**	**Assigned Population Value (Ref. 1, Table 4-18)**	**References**
Animas River #4 (Howardsville)	Greater than 0	Moderate to large stream	100<1,000	0.03	Ref. 17, pp. 1-5; 44, p. 1
South Fork Mineral Creek	Greater than 0	Small to moderate stream	10-100	0.03	Ref. 6b, p. 8; 17, pp. 14-21; 44, p. 1

Sum of population values = 0.03 + 0.03 = 0.06
Level II Concentrations Factor Value: 0.06

4.1.3.3.2.3 Potential Human Food Chain Contamination

The two known fisheries within the TDL (i.e., Animas River at Howardsville and South Fork Mineral Creek) are already counted under the Level II concentrations factor value; therefore, they are not included in the potential human food chain contamination factor value [Ref. 1, Section 4.1.3.3.2.3] (however the Animas River fishery is also downstream of the Frisco/Bagley, Columbus, Tom Moore, and Vermillion mines). There is also information indicating that the Animas River watershed, including the reach downstream of Silverton, is part of the Brunot Agreement Area, a designated fishery for Southern Ute tribal members; however, the specific location of fishing areas used for consumption are not documented [Ref. 53, pp. 2-5, 16-20, 32]. This fishery is likely to be subject to potential contamination from sources and releases associated with the site; however, the potential contamination factor value is not scored because the surface water pathway human food chain threat has achieved the maximum score based on Level II concentrations.

Potential Human Food Chain Contamination Factor Value: NS

4.1.3.3.2.4 Population Factor Value

The population factor value for the watershed is the sum of the values for the Level I (0), Level II (0.06), and potential contamination factors (NS) [Ref. 1, Section 4.1.3.3.2.4].

Population Factor Value = 0 + 0.06 + 0 = 0.06

4.1.3.3.3 Human Food Chain Threat-Targets Factor Category Value

The human food chain threat-targets factor category value for the watershed is the sum of the food chain individual factor value (45) and the population factor value (0.06). The sum is not rounded [Ref. 1, Section 4.1.3.3.3].

Human Food Chain Threat-Target Factor Category Value = 45 + 0.06 = 45.06

4.1.3.4 Human Food Chain Threat Score

The human food chain threat score for the watershed is calculated by multiplying the human food chain threat factor category values for likelihood of release (550) (as shown in section 4.1.2.1.1), waste characteristics (1,000) (as show in section 4.1.3.2.3), and targets (45.06) (as shown in section 4.1.3.3.3). The product is rounded to the nearest integer and divided by 82,500. The resulting value, subject to a maximum of 100, is assigned as the Human Food Chain Threat Score for the watershed [Ref. 1, Section 4.1.3.4].

Calculations:

$550 \times 1{,}000 \times 45.06 = 24{,}783{,}000$
$24{,}783{,}000 \div 82{,}500 = 300.4$ (Subject to a maximum of 100)

===
Human Food Chain Threat Score: 100.00

4.1.4 Environmental Threat

The environmental threat is evaluated for the Upper Animas River watershed, which includes the Upper Animas River, Cement Creek, and Mineral Creek drainages.

4.1.4.1 Environmental Threat – Likelihood of Release

The likelihood of release factor value of 550 for the watershed (see **Section 4.1.2.1.1**) is assigned for the environmental threat [Ref. 1, Section 4.1.3.1].

Likelihood of Release Factor Value: 550

4.1.4.2 Environmental Threat Waste Characteristics

4.1.4.2.1 Ecosystem Toxicity/Persistence/Bioaccumulation

The ecosystem toxicity/persistence/bioaccumulation factor values are based on the hazardous substances associated with the sources (see **Section 2.2 Source Characterization** for each drainage).

TABLE SW-10. Ecotoxicity/Persistence/Bioaccumulation, Environmental Threat

Hazardous Substance*	Source No.**	Ecotoxicity Factor Value***	Persistence Factor Value**** (River)	Ecosystem Bioaccumulation Factor Value (Env./Fresh)	Ecotoxicity/ Persistence/ Bioaccumulation Factor Value	Ref.
Aluminum	OR and all sources	100	1.0	50,000	5×10^6	Ref. 16, p. 1
Cadmium	OR and all sources	10,000	1.0	50,000	**5×10^8**	Ref. 16, p. 3
Copper	OR and all sources	1,000	1.0	50,000	5×10^7	Ref. 16, p. 4
Manganese	OR and all sources	100	1.0	50,000	5×10^6	Ref. 16, p. 5
Zinc	OR and all sources	10	1.0	50,000	$5 X 10^5$	Ref. 16, p. 6

OR Observed Release by Direct Observation
* As shown in source section 2.2.2 for each drainage.
** As shown in source section 2.2.3 for each drainage.
*** Ecotoxicity values assigned are based on the predominant surface water category of fresh water.
**** Persistence values assigned are based on the predominant surface water body category "River."

Cadmium has the highest ecosystem toxicity/persistence/bioaccumulation factor value (5×10^8) for this watershed [Ref. 1, Table 4-21; Ref. 16, pp. 1-6]. Cadmium was selected to assign the value to this factor [Ref. 1, Section 4.1.4.2.1.4].

Ecosystem Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^8

4.1.4.2.2 Hazardous Waste Quantity

The subtotal hazardous waste quantity factor values for all sources (see **Section 2.2 Source Characterization** for each drainage) are combined to derive the hazardous waste quantity factor value for the environmental threat as follows:

TABLE SW-11. Hazardous Waste Quantity, Environmental Threat		
Sources/Mining Sites	**Source Hazardous Waste Quantity (HWQ) Value (Ref. 1, Section 2.4.2.1.5; as shown in section 2.4.2)**	**Is source hazardous constituent quantity data complete?* (yes/no)**
U-1A, Vermillion Mine Adit Discharge	8,409.6	No
U-1B, Vermillion Mine Waste Rock Pile	2,040	No
Vermillion Mine subtotal	*10,449.6*	
U-2A, Frisco/Bagley Tunnel Adit Discharge	167.04	No
U-2B, Frisco/Bagley Tunnel Waste Rock Pile	8,200	No
Frisco/Bagley Tunnel subtotal	*8,367.04*	
U-3A, Columbus Mine Adit Discharge	4.32	No
U-3B, Columbus Mine Waste Rock Pile	9,600	No
Columbus Mine subtotal	*9,604.32*	
U-4A, Tom Moore Mine Adit Discharge	103.68	No
U-4B, Tom Moore Mine Waste Rock Pile	1,600	No
Tom Moore Mine subtotal	*1,703.68*	
U-5B, Kittimack Tailings Waste Rock Pile	9,200	No
Kittimack Tailings subtotal	*9,200*	
U-6A, Amy Tunnel Adit Discharge	547.2	No
Aspen Mine subtotal	*547.2*	
Upper Animas River drainage Subtotal		***39,871.84***
C-1A, Grand Mogul Mine Adit Discharge	38.17	No
C-1B, Grand Mogul Mine Waste Rock Pile	10,608.4	No
Grand Mogul Mine subtotal	10,646.57	
C-2A, Mogul Mine Adit Discharge	1,008.5	No
C-2B, Mogul Mine Waste Rock Pile	16,549.9	No
Mogul Mine subtotal	17,558.4	
C-3A, Red and Bonita Mine Adit Discharge	4,253.5	No
C-3B, Red and Bonita Mine Waste Rock Pile	1,264	No
Red and Bonita Mine subtotal	5,517.5	
C-4A, Gold King Mine Adit Discharge	4,836.1	No
C-4B, Gold King Mine Waste Rock Pile	10,930.4	No
Gold King Mine subtotal	15,766.5	
C-5A, American Tunnel Adit Discharge	2,568.4	No
American Tunnel Mine subtotal	2,568.4	
C-6A, Natalie/Occidental Mine Adit Discharge	1,139.2	No
C-6B, Natalie/Occidental Mine Waste Rock Pile	2,720	No
Natalie/Occidental Mine subtotal	3,859.2	
C-7A, Henrietta Mine Adit Discharge	129.28	No

TABLE SW-11. Hazardous Waste Quantity, Environmental Threat		
Sources/Mining Sites	**Source Hazardous Waste Quantity (HWQ) Value (Ref. 1, Section 2.4.2.1.5; as shown in section 2.4.2)**	**Is source hazardous constituent quantity data complete?* (yes/no)**
C-7B, Henrietta Mine Waste Rock Pile	12,000	No
Henrietta Mine subtotal	*12,129.28*	
C-8A, Lark Mine Adit Discharge	15.36	No
Lark Mine subtotal	*15.36*	
C-9A, Joe and Johns Mine Adit Discharge	43.52	No
Joe and Johns Mine subtotal	*43.52*	
Cement Creek drainage Subtotal		***68,104.73***
M-1A, Koehler Tunnel Adit Discharge	1,185.1	No
Koehler Mine subtotal	*1,185.1*	
M-2A, Brooklyn Mine Adit Discharge	332.46	No
M-2B, Brooklyn Mine Waste Rock Pile	12,419.9	No
Brooklyn Mine subtotal	*12,752.36*	
M-3A, Paradise Mine Adit Discharge	1,635.48	No
M-3B, Paradise Mine Waste Rock Pile	280	No
Paradise Mine subtotal	*1,915.48*	
M-4A, Bandora Mine Adit Discharge	616.34	No
M-4B, Bandora Mine Waste Rock Pile	2,200	No
Bandora Mine subtotal	*2,816.34*	
Mineral Creek drainage Subtotal		***18,669.28***
SUM OF VALUES:	**126,646** (rounded to nearest integer per Ref. 1, Section 2.4.2.2)	

* As shown in Section 2.4.2 for each drainage.

The sum corresponds to a hazardous waste quantity factor value of 10,000 in HRS Table 2-6 [Ref. 1, Section 2.4.2.2]. Therefore, a hazardous waste quantity factor value of 10,000 is assigned for the surface water migration pathway environmental threat [Ref. 1, Section 4.1.4.2.2].

Hazardous Waste Quantity Value: 10,000

4.1.4.2.3. Waste Characteristics Factor Category Value

The waste characteristics factor category value is derived by first multiplying the ecotoxicity/persistence factor value and the hazardous waste quantity factor value for the watershed (subject to a maximum of 1×10^8). This product is then multiplied with the ecosystem bioaccumulation potential factor value for the hazardous substance with the highest value in Section 4.1.4.2.1 (subject to a maximum value of 1×10^{12}) [Ref. 1, Section 4.1.4.2.3]. Cadmium, which is associated with multiple sources that have a surface water pathway containment factor value greater than 0 for the watershed, corresponds to an ecotoxicity/persistence factor value of 10,000 and bioaccumulation potential factor value of 50,000, as shown above [Ref. 1, Section 4.1.3.2.1.4; 16, p. 3].

(Ecotoxicity/persistence factor value) x (hazardous waste quantity factor value) = 10,000 x 10,000
= 1×10^8 [Ref. 1, Section 4.1.4.2.3]

(Ecotoxicity/persistence factor value x hazardous waste quantity factor value) x
(bioaccumulation potential factor value) = $(1 \times 10^8) \times (50{,}000) = 5 \times 10^{12}$
(subject to a maximum value of 1×10^{12}) [Ref. 1, Section 4.1.4.2.3]

The maximum value of 1×10^{12} corresponds to a waste characteristics factor category value of 1,000 in Table 2-7 of the HRS [Ref. 1, Section 2.4.3.1].

Waste Characteristics Factor Category Value: 1,000

4.1.4.3 Environmental Threat - Targets

As shown in Figures 8 through 11, the available documentation indicates that all of the documented observed releases by direct observation except for that for the Vermillion mine are associated with PPEs into all three drainages, and are located within habitat known to be used by the Canada Lynx, a Federal designated threatened species [Ref. 29, pp. 1-2; 30, pp. 1, 6; 45, p. 1]. The habitat extends throughout the Upper Animas River, Cement Creek, and Mineral Creek drainages. Based on these considerations, Canada Lynx habitat is considered to be subject to actual contamination in all three drainages [Ref. 1, Section 4.1.4.3.1]. Additional information indicates that habitat areas for other endangered and threatened species are located within the study area, however, exact habitat locations are unspecified [Ref. 46, pp. 1-4]. Due to the lack of precise locational data, it is unknown if these additional habitats are subject to actual or potential contamination and they are not scored.

As shown in Figures 8 through 10, HRS-eligible wetlands are located along the in-water segments in all three drainages [Ref. 1, Section 4.1.4.3.1; 27, pp. 1-9; 28, p. 13; 47, p. 1]. The total HRS-eligible wetland frontages are 6.4706 miles in the Upper Animas River drainage, 1.9267 miles in the Cement Creek drainage, 11.1549 miles in the Mineral Creek drainage, and 1.9280 miles in the Animas River downstream of the confluence with Mineral Creek to the TDL [Ref. 47, p. 1]. Therefore, the total HRS-eligible wetland frontage along the site in-water segments is greater than 20 miles [Ref. 47, p. 1].

Samples for Observed Release/Level I/Level II Concentrations

As described in Section 4.1.2.1.1, the observed releases are documented by direct observation; there are no sample data to consider for evaluation of Level I/Level II concentrations. Therefore, the sensitive environments within the zone of contamination for the Bonita Peak Mining District site (i.e., Canada Lynx habitat areas located where observed release by direct observation is documented) are considered as being subject to Level II concentrations [Ref. 1, Sections 2.5].

4.1.4.3.1 Sensitive Environments

4.1.4.3.1.1 Level I Concentrations

There are no sensitive environments or wetlands subject to Level I concentrations; therefore, the Level I concentrations factor value is 0 [Ref. 1, Section 4.1.4.3.1.1].

Level I Concentrations Factor Value: 0

4.1.4.3.1.2 Level II Concentrations

Sensitive Environments

TABLE SW-12. Level II Concentrations – Sensitive Environments			
Sensitive Environment	**Distance from PPE[1]**	**References**	**Sensitive Environment Rating Value (HRS Table 4-23)**
Habitat known to be used by Federal designated threatened species (Canada Lynx)	0 mile	Figures 8-11; 29, pp. 1-2; 30, pp. 1, 6; 45, p. 1	75

[1] The habitat of the Canadian Lynx overlaps the PPEs for all the sources except for those of the Vermillion Mine. For the Vermillion Mine, there is habitat within the TDL that would apply to that individual mine (see Figures 8-11).

Sum of Sensitive Environment Values = 75 [Ref. 1, Table 4-23]

Wetlands

While there are wetlands subject to exposure to releases of hazardous substances, because the site score is sufficient to qualify the site for listing without scoring these targets, wetlands subject to Level II concentrations are not scored; therefore, the wetland value is 0 [Ref. 1, Section 4.1.4.3.1.2].

Sum of Wetland Values: 0

Sum of Sensitive Environments Value + Wetland Value = 75 + 0 = 75

Level II Concentrations Factor Value: 75

4.1.4.3.1.3 Potential Contamination

As shown below in Table SW-15 and on Figures 8 through 11, there are greater than 20 miles of HRS-eligible wetland frontage along the in-water segments of the three drainages and the downstream portion of the Animas River [Ref. 27, pp. 1-9; 28, p. 13; 38, pp. 1-45; 47, p. 1]. The HRS-eligible wetlands along the in-water segments include freshwater emergent, freshwater forested/shrub, and riverine wetlands [Ref. 38, pp. 1-45]. The wetland frontage along the in-water segment is subject to potential contamination [Ref. 1, Section 4.1.4.3.1; 47, p. 1]; however, the potential contamination factor value is not scored because the surface water pathway environmental threat has achieved the maximum score based on Level II concentrations.

TABLE SW-13. Wetland Frontage Along the In-Water Segment		
Wetland	**Wetland Frontage (miles)**	**Reference**
Upper Animas River drainage	6.4706	Ref. 27, pp. 1-4; 47, p. 1
Cement Creek drainage	1.9267	Ref. 28, p. 13; 47, p. 1
Mineral Creek drainage	11.1549	Ref. 27, pp. 5-9; 47, p. 1
Animas River downstream	1.9280	Ref. 47, p. 1
Total, Bonita Peak Mining District	**21.4802**	Ref. 47, p. 1

Potential Contamination Factor Value: NS

4.1.4.3.1.4 Environmental Threat-Targets Factor Category Value

The environmental threat target factor category value for the watershed is the sum of the values for the Level I (0), Level II (75) and potential contamination factors (NS) [Ref. 1, Section 4.1.4.3.1.4].

Environmental Threat-Target Factor Category Value = 0 + 75 + 0 = 75

4.1.4.4 Environmental Threat Score

The environmental threat score for the watershed is calculated by multiplying the environmental threat factor category values for likelihood of release (550) (as shown in section 4.1.2.1.1), waste characteristics (1,000) (as show in section 4.1.3.2.3), and targets (75) (as shown in 4.1.4.3.1.4). The product is rounded to the nearest integer and divided by 82,500. The resulting value, subject to a maximum of 60, is assigned as the Environmental Threat Score for the watershed [Ref. 1, Section 4.1.4.4].

Calculations:

550 x 1,000 x 75 = 41,250,000
41,250,000 ÷ 82,500 = 500 (Subject to a maximum of 60)

Environmental Threat Score: 60.00

APPENDIX A

MINE-SPECIFIC AND DRAINAGE-SPECIFIC SCORING

The Bonita Peak Mining District site includes, but is not limited to, nineteen mines within the three drainage areas. Mine-specific scoring information for each of the nineteen mines and for the three drainages is provided in the tables below. The relevant section or table of the HRS documentation record from which the values can be determined is cited for each HRS scoring value. This information demonstrates that even if each drainage and each mine were evaluated independently, all would qualify for placement on the NPL.

Mine-Specific Scoring Information

Mine		Human Food Chain Threat										Environmental Threat									
		Waste Characteristics				Targets						Waste Characteristics			Targets						
	Likelihood of Release	Toxicity/Persistence/Bioaccumulation	Mine Waste Quantity	Pathway Hazardous Waste Quantity[1]	Waste Characteristics[2]	Food Chain Individual[3]	Level II Concentrations	Potential Human Food Chain Contamination	Total Population[4]	Target Score[5]	Human Food Chain Threat Score[6]	Ecosystem Toxicity/Persistence/Bioaccumulation	Pathway Hazardous Waste Quantity[1]	Waste Characteristics[2]	Level II Concentrations	Potential Contamination	Sensitive Environments Total	Target Score[7]	Environmental Threat Score[8]	Surface Water Overland/Flood Migration Component Score For A Watershed[9]	Site Score[10]
Upper Animas Drainage																					
Vermillion Mine	550	5×10^8	10,449.6	10,000	1,000	20	0	0.00003	0.00003	20.00003	100	5×10^8	10,000	1,000	0	0.75	0.75	0.75	5	100	50.00
Frisco/Bagley Tunnel	550	5×10^8	8,367.04	100	320	20	0	0.00003	0.0003	20.00003	42	5×10^8	100	320	75	0	75	75	60	100	50.00
Columbus Mine	550	5×10^8	9,604.32	100	320	20	0	0.00003	0.0003	20.00003	42	5×10^8	100	320	75	0	75	75	60	100	50.00
Tom Moore Mine	550	5×10^8	1,703.68	100	320	20	0	0.00003	0.0003	20.00003	42	5×10^8	100	320	75	0	75	75	60	100	50.00
Kittimack Mine	550	5×10^8	9,200	100	320	45	0.03	0	0.03	45.03	96	5×10^8	100	320	75	0	75	75	60	100	50.00
Amy Tunnel of Aspen Mine	550	5×10^8	547.2	100	320	0	0	0	0	0	0	5×10^8	100	320	75	0	75	75	60	60	30.00
Cement Creek Drainage																					
Grand Mogul Mine	550	5×10^8	10,646.57	10,000	1,000	0	0	0	0	0	0	5×10^8	10,000	1,000	75	0	75	75	60	60	30.00
Mogul Mine	550	5×10^8	17,558.4	10,000	1,000	0	0	0	0	0	0	5×10^8	10,000	1,000	75	0	75	75	60	60	30.00
Red and Bonita Mine	550	5×10^8	5,517.5	100	320	0	0	0	0	0	0	5×10^8	100	320	75	0	75	75	60	60	30.00
Gold King Mine	550	5×10^8	15,766.5	10,000	1,000	0	0	0	0	0	0	5×10^8	10,000	1,000	75	0	75	75	60	60	30.00
American Tunnel	550	5×10^8	2,568.4	100	320	0	0	0	0	0	0	5×10^8	100	320	75	0	75	75	60	60	30.00
Natalie/Occidental Mine	550	5×10^8	3,859.2	100	320	0	0	0	0	0	0	5×10^8	100	320	75	0	75	75	60	60	30.00
Henrietta Mine	550	5×10^8	12,129.28	10,000	1,000	0	0	0	0	0	0	5×10^8	10,000	1,000	75	0	75	75	60	60	30.00
Lark Mine	550	5×10^8	15.36	100	320	0	0	0	0	0	0	5×10^8	100	320	75	0	75	75	60	60	30.00
Joe and Johns Mine	550	5×10^8	43.52	100	320	0	0	0	0	0	0	5×10^8	100	320	75	0	75	75	60	60	30.00

Mine	Likelihood of Release	Human Food Chain Threat										Environmental Threat								Surface Water Overland/Flood Migration Component Score For A Watershed[9]	Site Score[10]
		Waste Characteristics				Targets					Human Food Chain Threat Score[6]	Waste Characteristics			Targets				Environmental Threat Score[8]		
		Toxicity/Persistence/Bioaccumulation	Mine Waste Quantity	Pathway Hazardous Waste Quantity[1]	Waste Characteristics[2]	Food Chain Individual[3]	Level II Concentrations	Potential Human Food Chain Contamination	Total Population[4]	Target Score[5]		Ecosystem Toxicity/Persistence/Bioaccumulation	Pathway Hazardous Waste Quantity[1]	Waste Characteristics[2]	Level II Concentrations	Potential Contamination	Sensitive Environments Total	Target Score[7]			
Mineral Creek Drainage																					
Koehler Tunnel	550	5×10^8	1,185.1	100	320	0	0	0	0	0	0	5×10^8	100	320	75	NS	75	75	60	60	30.00
Brooklyn Mine	550	5×10^8	12,752.36	10,000	1,000	0	0	0	0	0	0	5×10^8	10,000	1,000	75	NS	75	75	60	60	30.00
Paradise Mine	550	5×10^8	1,915.48	100	320	0	0	0	0	0	0	5×10^8	100	320	75	NS	75	75	60	60	30.00
Bandora Mine	550	5×10^8	2,816.34	100	320	45	0.03	0	0.03	45.03	96	5×10^8	100	320	75	NS	75	75	60	100	50.00
HRS Documentation Record Support Sections/Tables	Section 4.1.2.1.1	Section 4.1.3.2.1	Table SW-7			Section 4.1.3.3	Section 4.1.3.3.2.2	Section 4.1.3.3.2.3				Section 4.1.4.2.1			Section 4.1.4.3	Section 4.1.4.3.2.2	Section 4.1.3.3.2.3				

1 The pathway hazardous waste quantity as assigned per HRS Sections 4.1.3.2.2 and 2.4.2.2.
2 The waste characteristics factor category value as calculated per HRS Section 4.1.3.2.3
3 The food chain individual factor value is assigned per HRS section 4.1.3.3.1.
4 The human food chain total population is assigned per HRS section 4.1.3.3.2.4.
5 The human food chain target score is assigned per HRS section 4.1.3.3.3.
6 The human food chain threat score is assigned per HRS section 4.1.3.4.
7 The environmental threat target score is assigned per HRS section 4.1.4.3.1.4
8 The environmental threat score is assigned per HRS section 4.1.4.4.
9 The surface water pathway score is assigned per HRS section 4.1.1.3
10 The HRS site score is assigned per HRS section 2.1.1

Drainage-Specific Scoring Information

Drainage		Human Food Chain Threat										Environmental Threat									
		Waste Characteristics				Targets						Waste Characteristics			Targets						
	Likelihood of Release	Toxicity/Persistence/Bioaccumulation	Drainage Waste Quantity	Pathway Hazardous Waste Quantity[1]	Waste Characteristics[2]	Food Chain Individual[3]	Level II Concentrations	Potential Human Food Chain Contamination	Total Population[4]	Target Score[5]	Human Food Chain Threat Score[6]	Ecosystem Toxicity/Persistence/Bioaccumulation	Pathway Hazardous Waste Quantity[1]	Waste Characteristics[2]	Level II Concentrations	Potential Contamination	Sensitive Environments Total	Target Score[7]	Environmental Threat Score[8]	Surface Water Overland/Flood Migration Component Score For A Watershed[9]	Site Score[10]
Upper Animas Drainage	550	5×10^8	39,871.84	10,000	1,000	45	0.03	0.03	0.03	45.03	100	5×10^8	10,000	1,000	75	0	75	75	60	100	50.00
Cement Creek Drainage	550	5×10^8	68,104.73	10,000	1,000	0	0	0	0	0	0	5×10^8	10,000	1,000	75	0	75	75	60	60	30.00
Mineral Creek Drainage	550	5×10^8	18,669.28	10,000	1,000	45	0.03	0.03	0.03	45.03	100	5×10^8	10,000	1,000	75	0	75	75	60	100	50.00
HRS Documentation Record Support Sections/Tables	Section 4.1.2.1.1	Section 4.1.3.2.1	Table SW-7			Section 4.1.3.3	Section 4.1.3.3.2.2	Section 4.1.3.3.2.3				Section 4.1.4.2.1			Section 4.1.4.3	Section 4.1.4.3.2.2	Section 4.1.3.3.2.3				

[1] The pathway hazardous waste quantity as assigned per HRS Sections 4.1.3.2.2 and 2.4.2.2.
[2] The waste characteristics factor category value as calculated per HRS Section 4.1.3.2.3
[3] The human food chain individual factor value is assigned per HRS section 4.1.3.3.1.
[4] The human food chain total population is assigned per HRS section 4.1.3.3.2.4.
[5] The human food chain target score is assigned per HRS section 4.1.3.3.3.
[6] The human food chain threat score is assigned per HRS section 4.1.3.4.
[7] The environmental threat target score is assigned per HRS section 4.1.4.3.1.4
[8] The environmental threat score is assigned per HRS section 4.1.4.4.
[9] The surface water pathway score is assigned per HRS section 4.1.1.3
[10] The HRS site score is assigned per HRS section 2.1.1