Total Maximum Daily Load Assessment
Clear Creek
Clear Creek/Gilpin/Jefferson Counties, Colorado

Colorado Department of Public Health and Environment
Water Quality Control Division

August, 2008

Final Draft

TMDL Summary	
Waterbody Description / WBID	Mainstem of Clear Creek, including all tributaries, lakes reservoirs and wetlands, from the I-70 bridge above Silver Plume to the Farmers Highline Canal diversion in Golden, except for North Fork Clear Creek (Segment 13b). / COSPCL02, COSPCL03a, COSPCL03b, COSPCL06, COSPCL09a, COSPCL09b, COSPCL11.
Pollutants Addressed	Dissolved Cadmium, Dissolved Copper, Dissolved Lead, and Dissolved Zinc
Relevant Portion of Segment (as applicable)	The mainstem of Clear Creek in Segments 2 and 11, mainstem South Clear Creek in Segment 3a, mainstem Leavenworth Creek 3b, Mad Creek in Segment 6, mainstem Fall River in Segment 9a, Trail Creek and all tributaries in Segment 9b.
Use Classifications / Designation	Segments 2, 3a, 6, 9a, 9b: Aquatic Life Cold 1, Recreation 1a, Water Supply, Agriculture / Reviewable Segment 3b: Aquatic Life Cold 2, Recreation 1a, Water Supply, Agriculture / Reviewable Segment 11: Aquatic Life Cold 1, Recreation 1a, Water Supply, Agriculture / Use Protected
Water Quality Targets (for dissolved fraction of metals)	

Segment 2	Chronic	Acute
Cu-D	TVS	TVS
Pb-D	TVS	TVS
Zn-D	200	TVS
Segment 3a	**Chronic**	**Acute**
Zn-D	TVS	TVS
Segment 3b	**Chronic**	**Acute**
Pb-D	TVS	TVS
Zn-D	TVS	TVS
Segment 6	**Chronic**	**Acute**
Zn-D	TVS	TVS
Segment 9a	**Chronic**	**Acute**
Cu-D	TVS	TVS
Segment 9b	**Chronic**	**Acute**
Cd-D	TVS	TVS
Cu-D	TVS	TVS
Pb-D	TVS	TVS
Zn-D	200	TVS
Segment 11	**Chronic**	**Acute**
Cd-D	TVS	TVS
Pb-D	TVS	TVS
Zn-D	300	none

TMDL Goal	Attainment of Aquatic Life Classification

EXECUTIVE SUMMARY

The Clear Creek watershed is tributary to the South Platte River (Figure 1). The mainstem of Clear Creek from Silver Plume to the Farmers Highline Canal diversion in Golden, and several tributaries including South Clear Creek, Leavenworth Creek, Mad Creek, Fall River, and Trail Creek, appear on the Colorado 2006 303(d) list for non-attainment of chronic dissolved cadmium, copper, lead, and zinc standards (Table 1) (WQCC 2006a). These metals impair the Aquatic Life Cold 1 or 2 Use classifications while all other uses (Recreation, Water Supply, and Agriculture) are supported. The high concentration of metals is primarily the result of mining activity in the watershed since 1859 through the present. The Clear Creek watershed was placed on the National Priority List for cleanup under Superfund in 1983 in response to concern about the high concentrations of heavy metals.

Segment #	Segment Description	Portion	2006 303(d) Listed Contaminants
Segment 2	Mainstem of Clear Creek, I-70 bridge above Silver Plume to Argo Tunnel in Idaho Springs	mainstem	Cu, Pb, Zn
Segment 3a	Mainstem of South Clear Creek	all	Zn
Segment 3b	Leavenworth Creek	all	Pb, Zn
Segment 6	West Clear Creek tributaries	Mad Creek	Zn
Segment 9a	Fall River and tributaries	Fall River	Cu
Segment 9b	Trail Creek and tributaries	all	Cd, Cu, Pb, Zn
Segment 11	Mainstem Clear Creek, Argo Tunnel in Idaho Springs to Farmers Highline Canal Diversion in Golden	all	Cd, Pb, Zn

Table 1. Segments within the upper Clear Creek watershed that appear on the 2006 303(d) list of impaired waters for excessive heavy metals.

Reduction of metals in the upper Clear Creek watershed has been accomplished mainly through Superfund/CERCLA activities including the treatment of acid mine drainage from several large tunnels and contaminated groundwater, capping or removing numerous mining related rock piles and tailings within the watershed, and NPDES permitting of the Henderson Mine and treatment improvements there . However, there are currently no plans for CERCLA to further address any of the tributaries except for North Clear Creek.

I. INTRODUCTION

Section 303(d) of the federal Clean Water Act requires States to periodically submit to the U. S. Environmental Protection Agency (EPA) a list of water bodies that are water-quality impaired. A water-quality impaired segment does not meet the standards for its assigned use classification. This list of impaired water bodies is referred to as the “303(d) List”. The List is adopted by the Water Quality Control Commission (WQCC) as Regulation No. 93.

For waterbodies and streams on the 303(d) list a Total Maximum Daily Load (TMDL) is used to determine the maximum amount of a pollutant that a water body may receive and still

maintain water quality standards. The allowable load is an approximation of the waterbody's natural capacity to assimilate pollutants into the stream system as calculated by a mass balance. The TMDL is the sum of the Waste Load Allocation (WLA), which is the load from point source discharge, Load Allocation (LA) which is the load attributed to natural background and/or non-point sources, and a Margin of Safety (MOS) (Equation 1).

(Equation 1) $$TMDL = WLA + LA + MOS$$

The mainstem of the upper Clear Creek watershed and several of its tributaries, are included on the 2006 303(d) list for exceeding the Aquatic Life Use standards for dissolved cadmium, copper, lead, and zinc (Table 1) (WQCC, 2006b). Alternatively, if a TMDL is not completed, a segment or pollutant may be removed from the list if the applicable standard is attained, if implementation of clean up activities via an alternate means will result in attainment of standards, if the original listing decision is shown to be in error, or if the standards have been changed as the result of a Use Attainability Analysis (UAA).

II. GEOGRAPHICAL EXTENT

The mainstem Clear Creek headwaters are located at the Continental Divide (elevation 12,000-14,000 ft) near the Eisenhower/Johnson Tunnels and follow I-70 east through the towns of Silver Plume, Georgetown, Lawson, Downieville, Dumont, and Idaho Springs. At the junction of I-70 and US 6, Clear Creek continues eastward along US 6 to Golden (elevation 5,500 ft). The headwaters of Clear Creek and its tributaries drain high mountain peaks, alpine tundra, and forested lands within Arapaho National Forest and the Mt. Evans Wilderness. The watershed also drains numerous abandoned and a few active mines that discharge water containing metals. Within the mountain valleys, Clear Creek receives runoff from roads and urban areas from the I-70 corridor, Hwy 6, and Hwy 40, and effluent from several wastewater treatment plants and other permitted operations. There are six major tributaries, South Clear Creek, West Clear Creek, Fall River, Chicago Creek, North Clear Creek, Beaver Brook/Soda Creek, and numerous minor tributaries including Trail Creek (Figure 1). The entire Clear Creek watershed lies within the USGS hydrologic unit code 10190004.

The tributaries of Clear Creek that are also listed on the 303(d) list include South Clear Creek, Leavenworth Creek, Mad Creek (tributary to West Clear Creek), Fall River, and Trail Creek. Leavenworth and South Clear Creek drain several high mountain lakes (13,000 ft) near Guanella Pass, and flow north to their confluence above Georgetown (WQCC 2006a). Nine mine tunnels are known to exist within the watershed of South Clear Creek, and six are known within the watershed of Leavenworth Creek (EPA 2004).

Mad Creek drains the mountains of the Continental Divide (13,000 ft) near Berthoud Pass and then flows southeast to its confluence with the West Fork Clear Creek above the town of Empire. The mouth of West Fork Clear Creek is located at the junction of US 40 and I-70 where it flows into the mainstem.

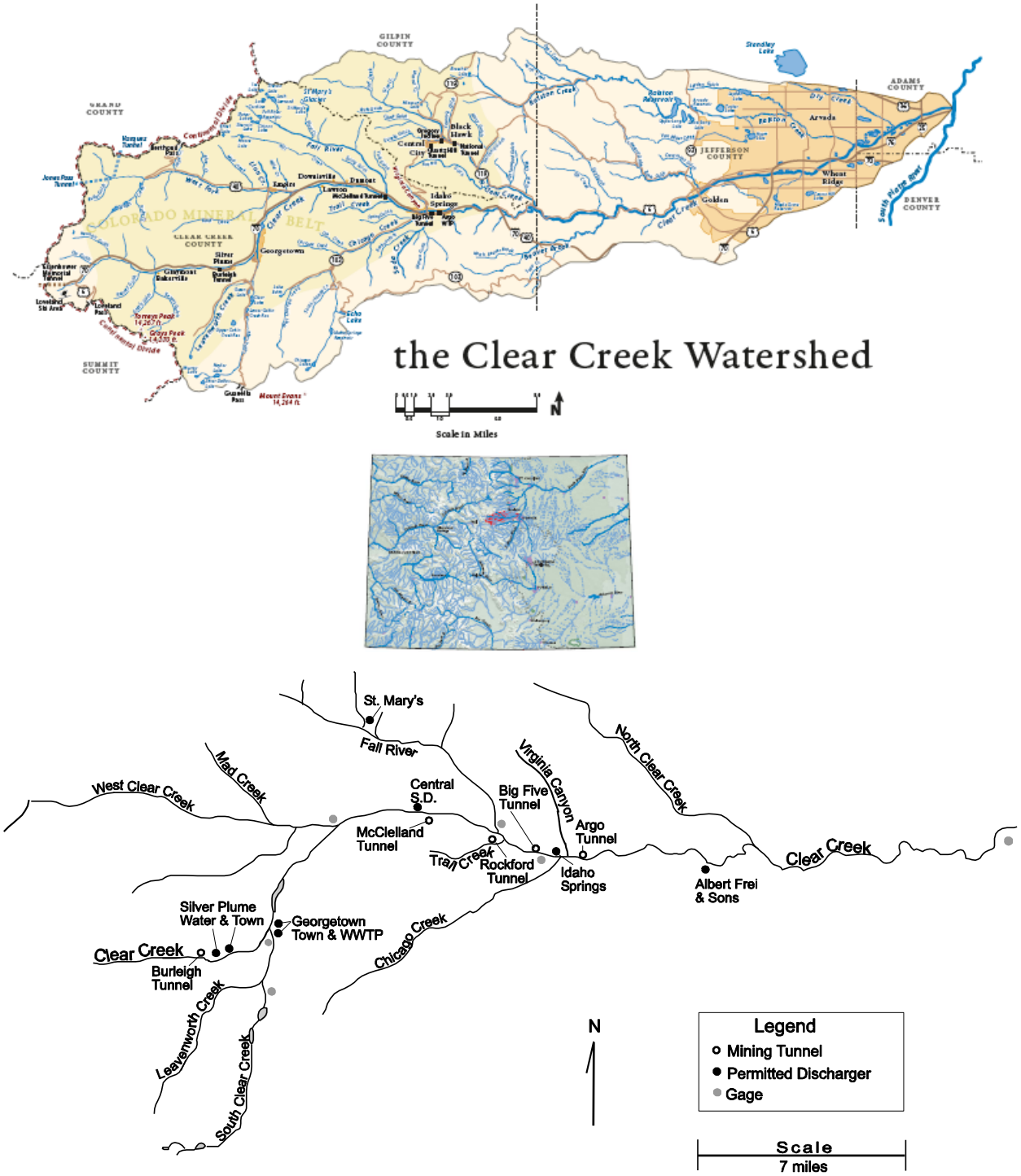


Figure 1. Large and smaller scale maps of the upper Clear Creek watershed.

Fall River drains numerous high mountain lakes near the Continental Divide as well as St. Mary's glacier and the town of Alice. Fall River flows southeast to its confluence with the mainstem between the towns of Dumont and Idaho Springs. Nineteen mine tunnels are known to exist within the watershed of Fall River. The Fall River is also known to have reproducing brook and brown trout populations.

The headwaters of Trail Creek are located south of the town of Lawson. Trail Creek then flows east to its confluence with the mainstem just downstream of Fall River. Twelve mine tunnels are known to exist within the small watershed of Trail Creek.

III. WATER QUALITY STANDARDS

Standards Framework

Waterbodies in Colorado are divided into discrete units or "segments". The Colorado *Basic Standards and Methodologies for Surface Water*, Regulation 31(WQCC 2006b), discusses segmentation of waterbodies in terms of several broad considerations:

> *31.6(4)(b)…Segments may constitute a specified stretch of a river mainstem, a specific tributary, a specific lake or reservoir, or a generally defined grouping of waters within the basin (e.g., a specific mainstem segment and all tributaries flowing into that mainstem segment.*
>
> *(c) Segments shall generally be delineated according to the points at which the use, physical characteristics or water quality characteristics of a watercourse are determined to change significantly enough to require a change in use classifications and/or water quality standards*

As noted in paragraph 31.6(4)(c), the use or uses of surface waters are an important consideration with respect to segmentation. In Colorado there are four categories of beneficial use which are recognized. These include Aquatic Life Use, Recreational Use, Agricultural Use and Water Supply Use. A segment may be designated for any or all of these "Use Classifications":

> *31.6 Waters shall be classified for the present beneficial uses of the water or the beneficial uses that may be reasonably expected in the future for which the water is suitable in its present condition or the beneficial uses for which it is to become suitable as a goal.*

Each assigned use is associated with a series of pollutant specific numeric standards. These pollutants may vary and are relevant to a given Classified Use. Numeric pollutant criteria are identified in sections 31.11 and 31.16 of the *Basic Standards and Methodologies for Surface Water.*

The Colorado Basic Standards and Methodologies for Surface Water, Regulation 31

identifies standards applicable to all surface waters statewide (WQCC 2006b). The pollutants of concern for this assessment are dissolved cadmium, copper, lead, and zinc. All remaining parameters were assessed through the 303(d) List assessment process and were found to be in attainment of their chronic stream standards. Chronic standards were used in the Clear Creek TMDL because they represent a more conservative approach than the acute standards. Chronic standards represent the level of pollutants that protect 95 percent of the genera from chronic toxic effects of metals. By reducing metals concentrations to attain the chronic standards, acute standards will also be attained. Per Regulation 31, chronic toxic effects include but are not limited to demonstrable abnormalities and adverse effects on survival, growth, or reproduction (WQCC 2006b). The specific numeric standards assigned to the listed stream segments are contained in the Classifications and Numeric Standards for the South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin (WQCC, 2006c).

Most of the relevant standards for the stream segments addressed in this document are chronic Table Value Standards, which vary based on hardness. Because hardness fluctuates seasonally, standards are listed on a monthly basis using the average hardness for each month to calculate the standard. Per the 303(d) Listing Methodology, hardness-based chronic metal standards are evaluated by comparing the 85th percentile data against the assigned hardness-based equation using the mean hardness. The highest hardness values, and therefore more lenient standards, occurred during low flow, which helped to offset the lack of dilution available at these times (Table 2). However, exceedance of the standard at low flow was common. Exceedances were also common on the rising limb of spring runoff when metal-laden water is displaced from shallow aquifers by melting snow.

All of the stream segments addressed here are use classified as Aquatic Life Cold 1 (except Leavenworth Creek, which is Aquatic Life Cold 2), Recreation 1a, Water Supply, and Agriculture. In all cases the elevated levels of listed heavy metals exceed the Aquatic Life standards, while other uses are supported.

IV. PROBLEM IDENTIFICATION

There are relatively few permitted dischargers within the Clear Creek basin and four of the listed segments including South Clear Creek (Segment 3a), Leavenworth Creek (Segment 3b), Mad Creek (Segment 6), and Trail Creek (Segment 9b) have no permitted dischargers within their watersheds (Table 3).

Much of the heavy metal loading throughout the Clear Creek basin is the result of natural geologic conditions and historic mining activities. The upper Clear Creek watershed has experienced widespread mining activity throughout the basin beginning in 1859, and one large mining operation (Climax Molybdenum Co.) presently operates within the watershed of West Fork Clear Creek, and discharges to Woods Creek, a tributary to the West Fork. However, most mining tunnels, waste rock piles, and mine tailings have long been abandoned, and these mining features are a significant source of heavy metals within the upper Clear Creek watershed.

	Clear Cr. Silver Plume to Idaho Springs				South Clear Cr.		Leavenworth Cr.			Mad Cr.		Fall R.		Trail Cr.					Clear Cr. Idaho Springs to Golden			
	Segment 2				Segment 3a		Segment 3b			Segment 6		Segment 9a		Segment 9b					Segment 11			
Month	Hard. mg/L	Cu-D ug/L	Pb-D ug/L	Zn-D ug/L	Hard. mg/L	Zn-D ug/L	Hard. mg/L	Pb-D ug/L	Zn-D ug/L	Hard. mg/L	Zn-D ug/L	Hard. mg/L	Cu-D ug/L	Hard. mg/L	Cd-D ug/L	Cu-D ug/L	Pb-D ug/L	Zn-D ug/L	Hard. mg/L	Cd-D ug/L	Pb-D ug/L	Zn-D ug/L
Jan	105*	9.3	2.7	200	55*	71	60*	1.4	77	13	21	41*	4.2	140	2.9	11.9	3.6	200	116*	2.5	3.0	300
Feb	112	9.9	2.9	200	56	72	62	1.5	79	16	25	45	4.5	147	3.0	12.5	3.8	200	121	2.6	3.1	300
Mar	107*	9.5	2.7	200	55*	71	62*	1.5	79	27	39	44*	4.4	160	3.2	13.4	4.2	200	118*	2.5	3.0	300
Apr	102	9.1	2.6	200	55	71	61	1.5	78	19	29	43	4.4	136	2.8	11.7	3.5	200	116	2.5	3.0	300
May	59	5.7	1.4	200	40	54	38	0.9	52	13*	21	27	2.9	101	2.3	9.1	2.6	200	55	1.4	1.3	300
Jun	34	3.6	0.8	200	30	43	25	0.6	37	7	12	17	2.0	59	1.5	5.7	1.4	200	35	1.0	0.8	300
Jul	37	3.8	0.8	200	34	47	32	0.7	45	8	14	16	1.8	82	1.9	7.6	2.0	200	41	1.2	0.9	300
Aug	49	4.9	1.2	200	40	54	40	0.9	54	9	15	18	2.1	94	2.1	8.5	2.4	200	57	1.5	1.4	300
Sep	55*	5.4	1.3	200	45*	60	45*	1.0	60	12	19	19*	2.2	115	2.5	10.1	2.9	200	67*	1.7	1.6	300
Oct	61	5.9	1.5	200	50	66	50	1.2	66	12	20	20	2.3	120	2.6	10.5	3.1	200	76	1.8	1.9	300
Nov	80*	7.4	2.0	200	52*	68	53*	1.3	69	12	20	28*	3.1	130	2.7	11.2	3.3	200	94*	2.1	2.4	300
Dec	98	8.8	2.5	200	55	71	57	1.4	73	12	20	37	3.8	140	2.9	11.9	3.6	200	111	2.4	2.8	300

*No hardness data were available for this month. Value is an average of the previous and following monthly averages.

Table 2. Average hardness and chronic stream standards for 303(d) listed segments of Clear Creek. Data are from the Upper Clear Creek Watershed Association (UCCWA) and Colorado Department of Public Health and Environment (CDPHE).

	Dischargers	NPDES ID	SIC DESC	Design Capacity, mgd
Segment 2	Central Clear Creek S.D.	COG588055	sewer systems	0.10
	Georgetown WWTP	CO0027961	sewer systems	0.58
	Georgetown, Town of	COG600624	amusement & recreation	N/A
	Silver Plume, Town of	COG641113	water supply	N/A
Segment 3a	None	N/A	N/A	N/A
Segment 3b	None	N/A	N/A	N/A
Segment 6	None	N/A	N/A	N/A
Segment 9a	St. Mary's Glacier	COG380004	water supply	N/A
	St. Mary's Glacier W&SD	CO0023094	sewer systems	0.60
Segment 9b	None	N/A	N/A	N/A
Segment 11	Albert Frei & Sons Inc	COG500268	construction sand/gravel	0.03
	Argo Tunnel Treatment Plant	COU000100	lead & zinc	1.559
	Idaho Springs, City of	COG641029	water supply	0.214
	Idaho Springs, Town of WWTP	COG650097	sewer systems	0.60

Table 3. Permitted dischargers in 303(d) listed streams segments of Clear Creek.

Historically, CERCLA identified five mine tunnels on the mainstem that discharged high metals loads: Argo Tunnel (Idaho Springs), Burleigh Tunnel (Silver Plume), Big Five Tunnel (Idaho Springs), Rockford Tunnel (Idaho Springs), and the McClelland Tunnel (Dumont) (Table 4). These tunnels account for a large portion of the copper and zinc load in Clear Creek especially during low flow. The flows from Big Five and Argo tunnels are now treated at the Argo WTP, as well as baseflow from Virginia Canyon. The flows from the McClelland and Rockford Tunnels remain untreated although their loads are much smaller. The Burleigh Tunnel also remains untreated and contributes a significant zinc load to Segment 2 near Silver Plume (Table 4). Additionally, over 200 smaller mining tunnels (only some of which have discharges) have been identified within the watershed, and there are at least 800 abandoned mines within the affected portions of the watershed (US EPA 2004b).

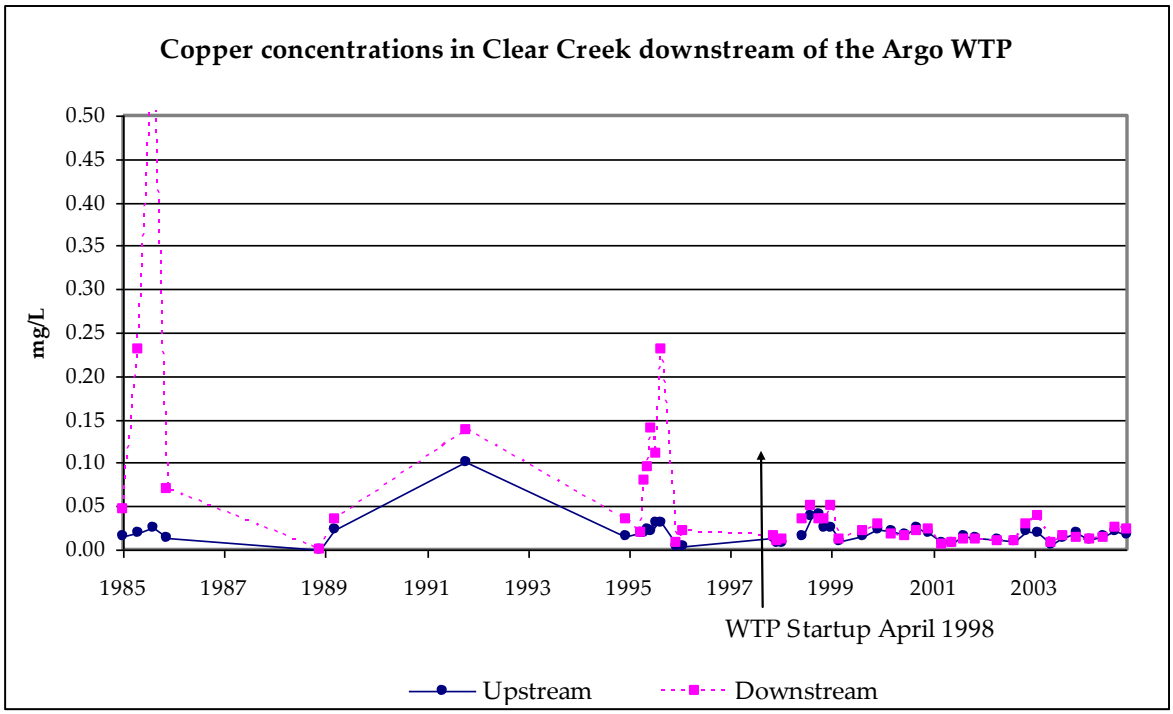
	Jun-89			Sep-89		
Tunnels	Cu-D lbs/day	Pb-D lbs/day	Zn-D lbs/day	Cu-D lbs/day	Pb-D lbs/day	Zn-D lbs/day
Argo	13.5	0.024	108	10.6	N/A	91.4
Burleigh	0.002	0.003	11.4	0.000	0.002	19.5
	Jun-89			Sep-89		
Big Five	0.138	0.001	1.818	0.105	0.001	1.127
McClelland	0.031	0.001	1.093	0.003	0.000	0.490
Rockford	0.092	0.001	0.486	0.068	0.000	0.273

Table 4. Historic loads for mine tunnels discharging to the mainstem of Clear Creek. Discharges from the Argo and Big Five Tunnels are currently treated at the Argo WTP. The Burleigh, McClelland and Rockford tunnels all currently discharge to Segment 2. Samples were also taken in May-02, which represented an unusually low flow spring runoff, so loads were assumed be less than average.

In addition to mining, Clear Creek receives runoff and gravel from roads and road construction (primarily I-70, US 6, and US 40), urban drainage from numerous small towns, and treated effluent from permitted dischargers including municipal wastewater treatment plants and water supply systems.

The Argo Tunnel, in Idaho Springs, was the largest single source of metals contamination to Clear Creek. Construction of a 700 gallon per minute treatment facility was completed in 1998. Full time operation of the treatment plant began in April 1998. Since completion, approximately 1200 pounds of metals are prevented from entering Clear Creek each day due to treatment of the Argo Tunnel (Figure 2). The removed metals are pressed into a solid waste and disposed of in a solid waste landfill. The treated water is then discharged into Clear Creek. Copper and zinc concentrations from 1998 through 2005 are shown in Figure 3 after the Argo WTP began operation. Since April of 2006, discharges from the Big Five Tunnel and Virginia Canyon have been piped to the Argo WTP, which further improves water quality in the mainstem below Idaho Springs (Segment 11).

In 1993, pursuant to the OU3 ROD, a passive treatment system was constructed as a pilot-scale wetland demonstration project at the portal to the Burleigh Tunnel.



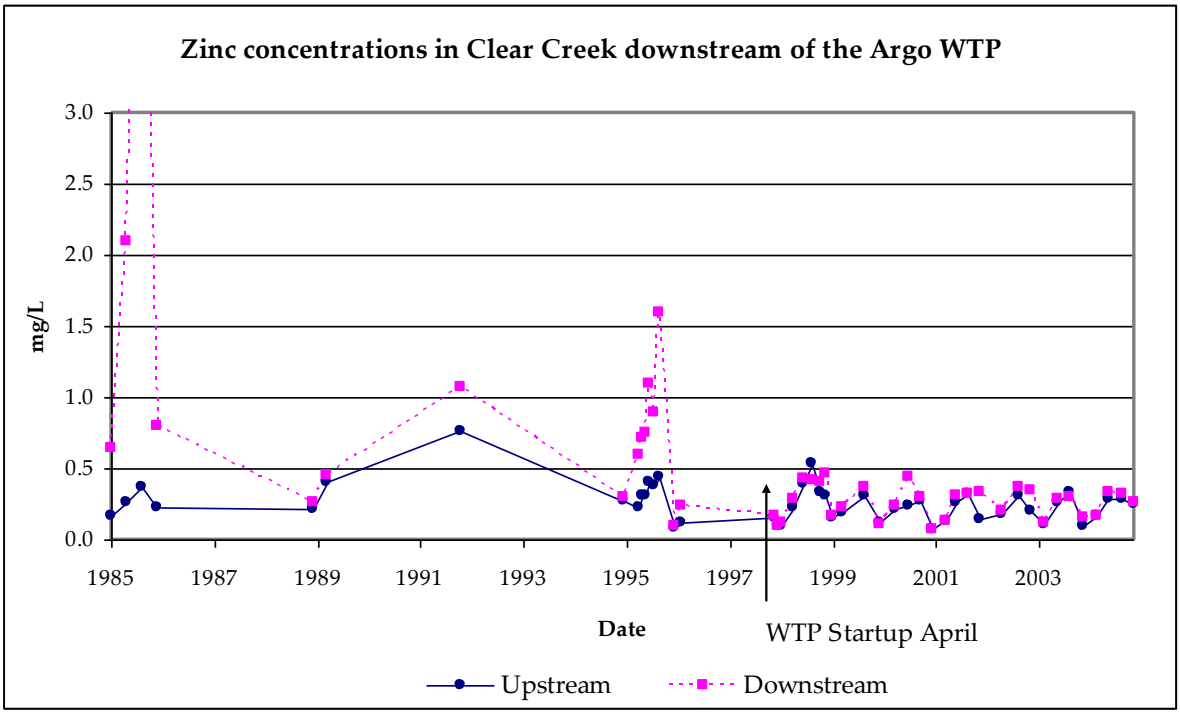
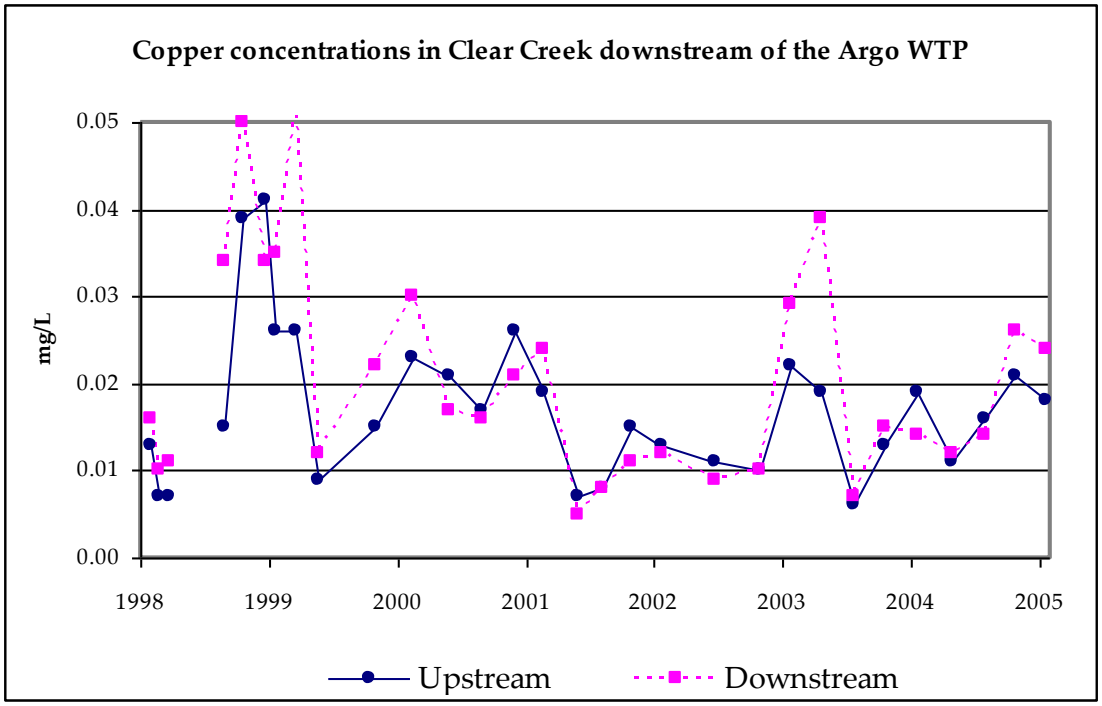


Figure 2. Historic copper and zinc concentrations on Clear Creek upstream and downstream of the Argo Treatment plant.



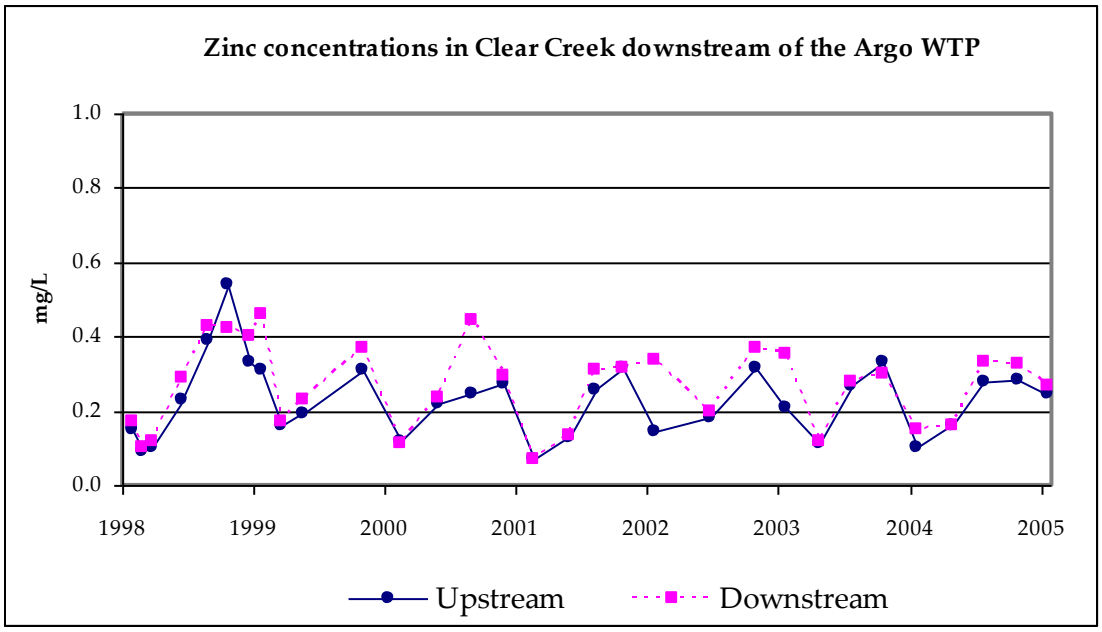


Figure 3. Copper and zinc concentrations on Clear Creek upstream and downstream of the Argo Treatment plant after WTP startup in April 1998.

After three years of operation and data collection, it was concluded that a number of factors prevented the system from meeting the 99.5 percent zinc removal efficiency that was initially assumed. Over time, the removal efficiency dropped to less than fifty percent based on the following factors: (1) restricted biological activity during the winter, (2) increased concentrations of dissolved oxygen during spring adversely affected the anaerobic conditions of the system, and (3) inconsistencies in the hydraulics of the wetlands created fluctuations in the residence time of the discharge in the wetland reducing zinc removal. As a result, passive wetland treatment of the Burleigh discharge was no longer considered a viable option (Lewis, 2003b). Once the bioreactors were decommissioned, the discharge was allowed to infiltrate into the contaminated subsurface in the area under the footprint of the wetland system.

Remediation has not been planned for any of the mining features in the watersheds of South Clear Creek (Segment 3a), Leavenworth Creek (Segment 3b), Mad Creek (Segment 6), Fall Creek (Segment 9a), or Trail Creek (Segment 9b). Without continued remedial action in the watershed, improvement in water quality will not occur.

The high metals concentrations within 303(d) listed segments of the upper Clear Creek basin exceed the standards to protect aquatic life. Biological studies over the last 15 years by the CDOW and U.S. Environmental Protection Agency (EPA) concluded that cadmium, copper, and zinc threaten trout and macroinvertebrates. Lead also exceeds the Aquatic Life use based standards in parts of the upper Clear Creek watershed.

V. WATER QUALITY GOALS

The water quality goal for 303(d) listed segments of Clear Creek is attainment of the Aquatic Life Cold 1 or 2 use classification. In the case of the mainstem (Segments 2 and 11), it is not known to what extent treating the discharges of the Big Five Tunnel and Virginia Canyon

will have to reduce metal loads since treatment of those flows has begun only recently. Continued monitoring at UCCWA and CDPHE sites on the mainstem will determine the effect of treating those discharges.

To mitigate the problematic metals loading into the upper Clear Creek watershed there have been CERCLA cleanup activities associated with the Clear Creek/Central City Superfund site (COD980717557). Operable units were used to prioritize or break up the Clear Creek clean up into manageable parts. Operable Unit 1 sought to use passive treatment (constructed wetland) to treat the discharges at the Big Five and Argo tunnel as well as three other tunnels or adits on the North Fork of Clear Creek (Quartz Hill, National Tunnel, Gregory Incline). Operable Unit 2 included remediation of the waste piles at the five OU1 locations. However, the goals of OU's 1 and 2 have been modified or superceded by OU's 3 and 4 which were amended in September 2006. Operable Unit 3 brought about the completion of the Argo WTP (April 1998) that is used to treat metal-laden water from the Argo Tunnel, and recently, water from Virginia Canyon and the Big Five Tunnel as well. A passive treatment system was attempted at the Burleigh Tunnel site, but the project was later abandoned, thus Burleigh discharges remain untreated (US EPA 2004b) (Table 5). Operable Unit 4 calls for active treatment of the Gregory Incline (plus base groundwater from Gregory Gulch) and passive treatment of the National Tunnel both of which discharge into North Clear Creek. Since North Clear Creek is a significant source of metals to the mainstem of Clear Creek (Segment 11), remediation of metals sources in North Clear Creek would improve water quality in the mainstem.

	Dissolved Metals ug/L, 10/29/1995					
	Cd	Cu	Fe	Mn	Pb	Zn
Abv Burleigh	<0.5	0.5	82	10	--	<4
Burleigh	242	4.3	<5	4844	--	101600
Below Burleigh	2.6	0.7	55	32	--	682
	Dissolved Metals ug/L, 4/10/1997					
	Cd	Cu	Fe	Mn	Pb	Zn
Abv Burleigh	<0.5	1.7	68.0	19.3	<1.0	<20
Burleigh	136	6.9	<10	2910	4.2	65400
Below Burleigh	2.8	1.1	12.2	38.0	<1.0	989
	Dissolved Metals ug/L, 6/3/1997					
	Cd	Cu	Fe	Mn	Pb	Zn
Abv Burleigh	<0.5	0.9	59.7	7.6	<1	6.0
Burleigh	144	8.6	4.5	2407	10.0	56010
Below Burleigh	0.7	1.5	46.8	7.7	1	154

Table 5. Dissolved cadmium, manganese, and zinc increase dramatically below the Burleigh Tunnel. The Burleigh Tunnel contributes the largest metal loads of the tunnels that remain untreated. Data from Lockheed Martin 1999.

Mine tailings at the McClelland Tunnel have been remediated, but the adit discharge remains untreated, while the Rockford Tunnel has not been remediated in any way. Roadcuts from I-70 may contribute an unknown proportion of metals to the watershed by exposing mineralized rock. Relatively small contributions of metals come from the undisturbed surrounding watershed.

The Colorado Division of Reclamation and Mine Safety have been working to improve the water quality in Fall River and Silver Creek by addressing the mine contamination that exists near St. Mary's Glacier and the former town of Alice. In 1988, the Division filled in the dangerous "glory hole" in the area (a glory hole is a very large vertical mine opening). This work significantly reduced the acid mine drainage from the glory hole. In 1996, using funding from the Non-Point Source program, the Division addressed the mill tailings which were scattered around the area, including under a trailer park at the site of Alice and in Silver Creek itself. Water quality impacts from the mill tailings were significantly reduced by the construction of french drains around the mill tailings. Initial sampling results indicate that the french drains are working. One challenge remains. There is acid mine drainage that typically flows during May and June from a mine opening. This opening used to provide access to the glory hole. The mine drainage from this lower access point has not been addressed by the Division due to Good Samaritan liability concerns (EPA 1997).

VI. INSTREAM CONDITIONS

Hydrology

The hydrograph of Clear Creek and its tributaries are typical of high mountain streams, with low flows occurring in the late fall to early spring followed by a large increase in flow, usually in May, due to snowmelt that tails off through the summer (Figure 4, Table 6). The smaller tributaries show the same pattern, but tend to show greater influences from summer rain events.

Median monthly flows were calculated from the nearest USGS gage where available, except for Trail Creek and Mad Creek (Table 6). The flow for Trail Creek was recorded on 6 dates between 1989 and 1999, and the four most recent dates coincided with daily measurements. The gage used in calculations of Segment 2 loads (Clear Creek above Johnson Gulch near Idaho Springs) is located in Segment 11 slightly downstream of Segment 2. Flows from this gage were used in load calculations as opposed to the upstream Lawson gage since the gage encompasses the accumulation of tributary flows into the mainstem of Clear Creek.

There are three minor trans-basin diversions into the watershed, the Vidler Tunnel, Gumlick Tunnel, and the Berthoud Ditch that have no known effect on metal concentrations in the upper Clear Creek watershed.

	Clear Cr.** Silver Plume to Idaho Springs	South Clear Cr.	Leavenworth Cr.	Mad Cr.	Fall R.	Trail Cr.	Clear Cr.*** Idaho Springs to Golden
Gage #	6718300	6714600	6714800		6717000	6717400*	6719505
POR	10/1/1994-9/30/2005	10/1/1994-9/30/1997	10/1/1994-9/30/2005		4/1/1930-9/30/1938	10/1/1994-9/30/2005	10/1/1994-9/30/2007
Month	Segment 2	Segment 3a	Segment 3b	Segment 6	Segment 9a	Segment 9b	Segment 11
Jan	40	4.5	2.2	N/A	4.0	0.20*	49
Feb	37	3.9	1.9	N/A	3.0	0.11*	46
Mar	43	6.3	1.8	N/A	4.0	0.13*	50
Apr	66	6.5	2.6	N/A	7.0	0.39*	85
May	258	11	12	N/A	38	0.90*	343
Jun	705	62	47	N/A	70	1.08*	720
Jul	418	48	28	N/A	35	0.83*	357
Aug	196	24	12	N/A	28	0.70*	163
Sep	140	16	7.9	N/A	11.5	0.59*	123
Oct	103	9	5.8	N/A	8.0	0.43*	90
Nov	64	6.3	3.8	N/A	6.0	0.23*	67
Dec	47	5.5	2.7	N/A	4.3	0.24*	53

*Trail Creek flows are estimated from flows in the adjacent basin of Chicago Creek using the equation Trail Creek = 0.4134Ln(Chicago Creek) – 0.4666 (R^2 = 0.87).
** Clear Creek above Johnson Gulch near Idaho Springs gage
***Clear Creek at Golden gage.

Table 6. Monthly median flows (cfs), for 303(d) listed stream segments in the upper Clear Creek watershed. No flow data are available for Mad Creek or Trail Creek. POR = period of record. available in the adjacent watershed of Chicago Creek. The logarithmic relationship between the flows in Chicago Creek and Trail Creek was: Trail Creek = 0.4134 * Ln(Chicago Creek) – 0.4666, and had an r^2 = 0.87. From this equation a flow record for Trail Creek was calculated from Chicago Creek.

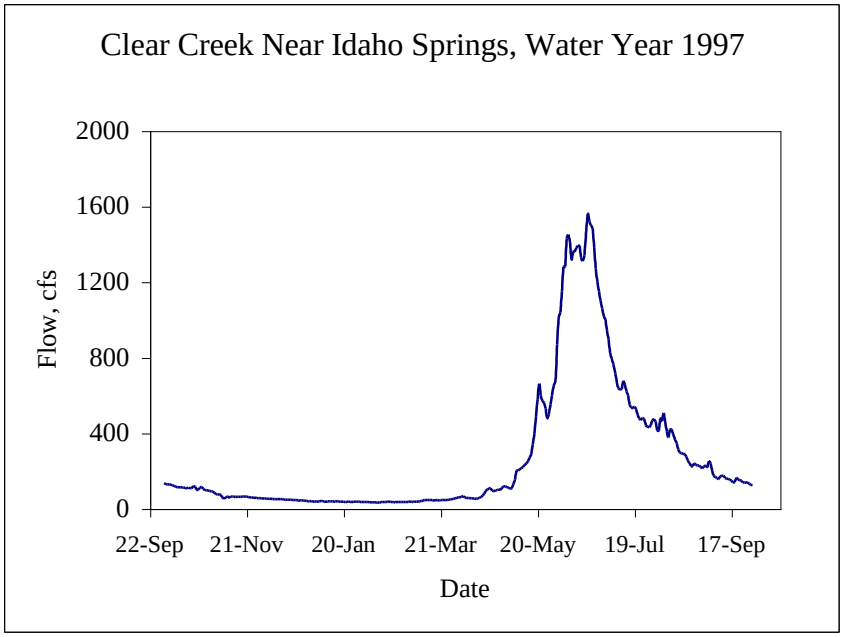


Figure 4. Hydrograph of Clear Creek near Idaho Springs, USGS gage 6718300.

Ambient Water Quality Data

To identify exceedances of the chronic water-quality standard the eighty-fifth percentile concentration of metals was calculated using the most current available data from UCCWA and in some cases data was supplemented by CDPHE (Tables 7 & 9). Exceedances of the standard and percent reductions needed to meet the standard for 303(d) listed segments of the Clear Creek watershed are listed in Tables 10 and 11.

Segment	Period of Record	N hardness samples	N metals samples	Sample Location	Source
2	4/03-8/07	23	22	Clear Cr. Above Chicago Cr	UCCWA
3a	2/94-8/07	78	89	South Clear Cr. Above Leavenworth Cr.	UCCWA
3b	5/99-8/07	48	48	Leavenworth Cr. Near mouth	UCCWA
6	9/02-10/03	13	13	Mad Cr. At US 40	CDPHE
9a	2/94-8/07	83	93	Fall R. near mouth	UCCWA
9b	1/03-8/07	22	23	Trail Cr. Near mouth	UCCWA/CDPHE
11	2/95-8/07	98	95	Clear Cr. At Golden	UCCWA

Table 7. Sources of water-quality data for 303(d) listed stream segments in the upper Clear Creek basin.

UCCWA sampling site CC-34, Clear Creek above Chicago Creek, was chosen to represent Segment 2 since it reflects ambient water quality at the most downstream UCCWA sampling point. At the bottom of Segment 2 (mainstem, Silver Plume to Idaho Springs), the concentration of copper was highest during the low flow months, and exceedances of the

standard occurred during the low flow months of January-April, early runoff in May and June, and in October (Tables 9-11). Exceedance of the copper standard in May and June is probably related to the lower hardness values during those months (Table 8). Typically, Segment 2 attains copper standards during the falling limb of spring runoff (July-September). The average lead concentration did not exceed the standard in Segment 2 at any time of year (Tables 9-11). Zinc exceeded the standard during low flow at the beginning of the year, and again in December, but was not a problem once spring runoff began in May through November (Tables 9-11). It should be noted that the mouth of West Clear Creek, a large tributary to the mainstem, discharges into Segment 2 and the effect on water quality of this inflow is discussed below.

Acute copper standards were exceeded in twenty-three of the thirty-six samples (64%). Exceedances are observed in months when hardness values are low, and thus acute standards are more stringent. There were no exceedances of the acute lead standard in the mainstem of Clear Creek Segment 2. Eighty-nine percent of the zinc samples exceeded the acute table value standard (32 out of 36). Exceedances of the standard were prevalent year round.

In Segment 3a (South Clear Creek), zinc exceeded the standard in all months of the year (Tables 8-11). The highest concentrations of zinc were observed in May-June which coincided with spring runoff and low hardness (Tables 8 & 9). Forty-six percent (39 out of 85) of the samples exceeded the acute zinc standard. Exceedances of the acute standard are most often observed in the months of May and June, when hardness values are low and similarly, the corresponding standards are more stringent.

In Segment 3b (Leavenworth Creek), lead exceeded the standard February-October. The concentration of lead was highest in May at 3.3 ug/L. Hardness values were also low when lead exceedances occurred in June-October (Tables 8-11). Zinc exceeded the standard in all months (Table 9 & 10). Zinc concentrations were slightly lower June-September (less than 200 ug/L), but still exceeded the standard in these months due to low hardness values (Table 8 & 9). There were no exceedances of the acute lead standard; however the acute zinc standard was exceeded in thirty-three of thirty-three samples (100%).

In Segment 6 (Mad Creek), zinc exceeded the standard October-January, and in April and May (Tables 9 & 10). Elevated concentrations of zinc were observed October-May (Table 9). Hardness values were extremely low (8 to 27 mg/L) in Mad Creek throughout the year, but were slightly higher in February and March, which suggests that hardness may have been protective during those months when flows are typically low (although no flow data was available for Mad Creek) (Table 8). No exceedances of the acute standard occurred. In most cases, the levels of zinc observed in Mad Creek (13 to 41 ug/L) would be considered as natural background. However, since the stream hardness values are so low, it is the primary reason for 303(d) listing. Since the mechanism for zinc toxicity is thought to be hypocalcemia, the toxicity of zinc at very low hardness levels may actually be greater than expected because the low hardness can be a stress by itself (Hogstrand and Wood, 1996).

In Segment 9a (Fall River), copper exceeded the standard for the entire year (Table 9 & 10). Copper concentrations were very high during the rising limb of the hydrograph (May and June), with concentrations of 27.1 and 14.5 ug/l, respectively. Hardness values were also very low during these months (Table 8 & 9). Acute copper standards were exceeded in forty of the ninety-seven samples (41%). Exceedances were more prevalent during runoff months (May-June).

In Segment 9b (Trail Creek), cadmium exceeded the standard in all months of the year

and will continue to exceed the new cadmium standard year round when it goes into effect in 2009 (Tables 9-11). Copper also exceeded the standard in all months of the year (Tables 9-11). Lead exceeded the standard in all months except March, July-August, and November (Tables 9 & 10). The high hardness in March and low concentration of lead in March was protective (Tables 8-11). In July, August, and November the average lead concentration was low (Table 9). The highest concentration of lead was observed in October at 10.5 ug/L (Table 9). Zinc exceeded the standard at all times of the year, and the highest concentrations and exceedances were observed in April and May (Tables 9 & 10). Concentrations were greater than 1000 ug/L in February-May, September-October, and December. In three out of the four metals, dissolved cadmium, dissolved copper, and dissolved zinc, twenty-seven out of the twenty-nine (93%) samples exceeded its acute standard. The acute dissolved lead standard was not exceeded in any of the samples. One sample each in July and August are in attainment of the acute cadmium, copper, and zinc standards.

In Segment 11 (mainstem, Idaho Springs to Golden), cadmium exceeded the standard in May when hardness was low (Tables 9 & 10). Lead did not exceed the standard at any time of the year (Table 9-11). Zinc exceeded the standard November-April when the highest average zinc concentrations were observed (Tables 9-11). Twenty-one percent (21 out of 98) of the samples were in exceedance of the acute trout cadmium standard. Only one sample in June of 1994 exceeded the acute lead standard. Zinc, on the other hand, exceeded the acute standard in seventy-four of the ninety-five samples (78%). Zinc exceedances were observed during all flow regimes.

It should be noted that the mouth of West Clear Creek discharges into Segment 2, and North Clear Creek, another large tributary to the mainstem, discharges into Segment 11, and the degradation of water quality from these inflows are discussed below. The West Fork of Clear Creek contributes a significant metals load to the mainstem of Clear Creek, Segment 2. The West Fork contributes an annual average cadmium load of 0.4 lbs/day during peak flows and 0.04 lbs/day during low flow periods. Copper loads average one pound per day during high flow and 0.15 lbs/day during low flow. Zinc loads average 50 lbs/day annually from May-July and 4 lbs/day August-April.

North Clear Creek also contributes a significant metals load to the mainstem of Clear Creek, Segment 11. It is addressed separately in its own TMDL. However, it is responsible for 0.65 lbs/day of cadmium during high flow and 0.14 lbs/day during low flows. Since North Clear Creek has an ambient copper standard of 64 ug/l, there is a large copper load contributed to the mainstem. Almost eight lbs/day of copper are contributed during high flows while 0.5 lbs/day are contributed during low flows. Additionally, 134 lbs/day of zinc are contributed to the mainstem during high flow and 31 lbs/day are contributed during low flows. Ongoing Superfund cleanup on North Clear Creek will decrease metals loads into Clear Creek Segment 11.

An overview of Clear Creek can be illustrated by looking at sample results of metals concentrations and metals loadings by sample location. The following graphs represent the average of eight comprehensive EPA and State basinwide sample events. While the average that includes both high flow and low flow is not representative of critical conditions, it is illustrative of the overall dynamics of the stream and helps one understand the locations where metal loadings occur (Abel and Steele, 2003).

The upper mainstem of Clear Creek increases in metals concentrations, primarily zinc, in the vicinity of Silver Plume (SW-26). Zinc concentrations are diluted with the introduction of

water from the West Fork of Clear Creek (SW-21). As demonstrated in figure 5, concentrations trend upward as the stream works its way down to and through Idaho Springs (SW-5) (Abel and Steele, 2003). The Upper Clear Creek Watershed Plan was prepared by Tim Steele in 2006 (Steele, 2006). The plan details the changing conditions in metals concentrations in Segment 2 as one travels downstream. In the 2007 Addendum to the plan, results from the most recent data were used to separate out water-quality changes strictly due to hydrology versus beneficial changes resulting from mining related remediation projects in the watershed (Steele, 2007).

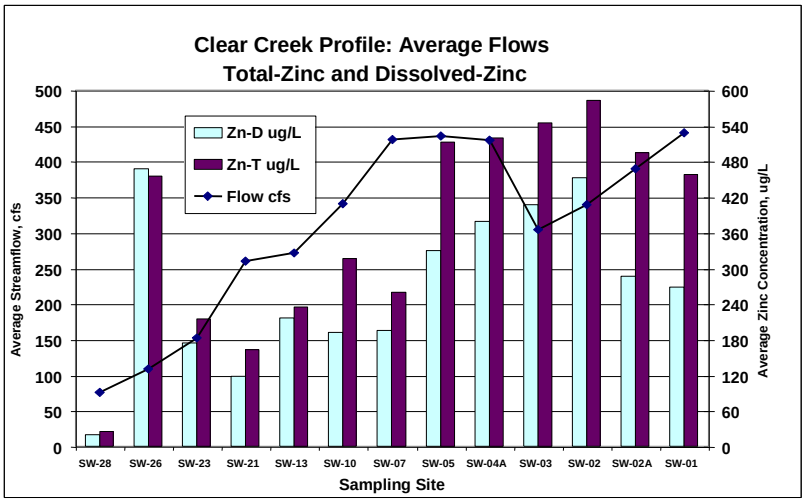


Figure 5. Profile of dissolved zinc in mainstem Clear Creek.

	Clear Cr. Silver Plume to Idaho Springs	South Clear Cr.	Leavenworth Cr.	Mad Cr.	Fall R.	Trail Cr.	Clear Cr. Idaho Springs to Golden
	Segment 2	Segment 3a	Segment 3b	Segment 6	Segment 9a	Segment 9b	Segment 11
Month	Hard., mg/L	Hard., mg/L	Hard., mg/L	Hard, mg/L	Hard., mg/L	Hard., mg/L	Hard., mg/L
Jan	105*	55*	60*	13	41*	140	116
Feb	112	56	62	16	45	147	121
Mar	107*	55*	62*	27	44*	160	118
Apr	102	55	61	19	43	136	116
May	59	40	38	13*	27	101	55
Jun	34	30	25	7	17	59	35
Jul	37	34	32	8	16	82	41
Aug	49	40	40	9	18	94	57
Sep	55*	45*	45*	12	19*	115	67
Oct	61	50	50	12	20	120	76
Nov	80*	52*	53*	12	28*	130	94
Dec	98	55	57	12	37	140	111

*No data were available for this month. Value is an average of the previous and following monthly averages.

Table 8. Hardness concentrations for 303(d) listed stream segments in the upper Clear Creek basin.

Ambient stream concentrations expressed as 85th percentile concentrations															
	Clear Cr. Silver Plume to Idaho Springs			South Clear Cr.	Leavenworth Cr.		Mad Cr.	Fall R.	Trail Cr.				Clear Cr. Idaho Springs to Golden		
	Segment 2			Segment 3a	Segment 3b		Segment 6	Segment 9a	Segment 9b				Segment 11		
Month	Cu-D µg/L	Pb-D µg/L	Zn-D µg/L	Zn-D µg/L	Pb-D µg/L	Zn-D µg/L	Zn-D µg/L	Cu-D µg/L	Cd-D µg/L	Cu-D µg/L	Pb-D µg/L	Zn-D µg/L	Cd-D µg/L	Pb-D µg/L	Zn-D µg/L
Jan	**10.2***	0.15*	**273***	**95***	1.3*	**224***	**29**	**4.4***	**3.4**	**120**	**4.0**	**890**	1.73*	1.1*	**450***
Feb	**12.8**	0.15	**303**	**79**	**1.6**	**224**	22	**4.7**	**4.1**	**160**	**5.3**	**1136**	1.60	1.8	**400**
Mar	**12.0***	0.15*	**289***	**76***	**1.7***	**217***	30	**4.9***	**5.9**	**122**	4.1	**1359**	1.70*	1.1*	**360***
Apr	**11.1**	0.15	**274**	**73**	**1.7**	**209**	**50**	**5.1**	**8.9**	**174**	**7.1**	**1797**	1.79	0.5	**321**
May	**7.8**	0.48	114	**166**	**3.3**	**217**	**25***	**27.1**	**6.3**	**201**	**8.2**	**1340**	**2.15**	0.9	225
Jun	**5.5**	0.46	90	**102**	**1.8**	**142**	0	**14.5**	**2.9**	**55**	**3.8**	**698**	1.00	0.7	180
Jul	3.3	0.39	77	**85**	**1.3**	**136**	0	**4.7**	**3.3**	**58**	1.3	**931**	0.62	0.7	121
Aug	3.7	0.33	87	**84**	**1.3**	**164**	0	**4.4**	**4.3**	**42**	1.2	**860**	1.20	0.5	197
Sep	5.3*	0.43*	101*	**88***	**1.3***	**183***	6.5	**3.5***	**4.0**	**77**	**5.2**	**1005**	1.20*	0.6*	239*
Oct	**6.9**	0.54	114	**91**	**1.3**	**202**	**31**	**2.6**	**4.5**	**104**	**10.5**	**1033**	1.20	0.7	281
Nov	7.2*	0.34*	178*	**101***	1.1*	**213***	**66**	**3.3***	**3.1**	**67**	2.0	**750**	1.53*	0.6*	**391***
Dec	7.5	0.15	**242**	**110**	1.0	**225**	**22**	**4.1**	**4.7**	**147**	**8.3**	**1051**	1.86	0.5	**501**

*No data were available for this month. Value is an average of the previous and following monthly concentrations.

Table 9. Ambient concentrations expressed as 85th percentile concentrations (per the 303(d) assessment methodology for chronic standards) of heavy metals in the 303(d) listed segments of Clear Creek. Data used to generate ambient stream concentrations are identified in Table 7.

Month	Clear Cr. Silver Plume to Idaho Springs			South Clear Cr.	Leavenworth Cr.		Mad Cr.	Fall R.	Trail Cr.				Clear Cr. Idaho Springs to Golden		
	Segment 2			Segment 3a	Segment 3b		Segment 6	Segment 9a	Segment 9b				Segment 11		
	Cu-D	Pb-D	Zn-D	Zn-D	Pb-D	Zn-D	Zn-D	Cu-D	Cd-D	Cu-D	Pb-D	Zn-D	Cd-D	Pb-D	Zn-D
Jan	X	O	X	X	O	X	X	X	X	X	X	X	O	O	X
Feb	X	O	X	X	X	X	O	X	X	X	X	X	O	O	X
Mar	X	O	X	X	X	X	O	X	X	X	O	X	O	O	X
Apr	X	O	X	O	X	X	X	X	X	X	X	X	O	O	X
May	X	O	O	X	X	X	X	X	X	X	X	X	X	O	O
Jun	X	O	O	X	X	X	O	X	X	X	X	X	O	O	O
Jul	O	O	O	X	X	X	O	X	X	X	O	X	O	O	O
Aug	O	O	O	X	X	X	O	X	X	X	O	X	O	O	O
Sep	O	O	O	X	X	X	O	X	X	X	X	X	O	O	O
Oct	X	O	O	X	X	X	X	X	X	X	X	X	O	O	O
Nov	O	O	O	X	O	X	X	X	X	X	O	X	O	O	X
Dec	O	O	X	X	O	X	X	X	X	X	X	X	O	O	X

Table 10. Exceedances of the chronic Aquatic Life Use based standard for 303(d) listed stream segments in the Clear Creek watershed. X indicates the standard is exceeded.

Month	Clear Cr. Silver Plume to Idaho Springs			South Clear Cr.	Leavenworth Cr.		Mad Cr.	Fall R.	Trail Cr.				Clear Cr. Idaho Springs to Golden		
	Segment 2			Segment 3a	Segment 3b		Segment 6	Segment 9a	Segment 9b				Segment 11		
	Cu-D	Pb-D	Zn-D	Zn-D	Pb-D	Zn-D	Zn-D	Cu-D	Cd-D	Cu-D	Pb-D	Zn-D	Cd-D	Pb-D	Zn-D
Jan	8%	-	27%	25%	-	66%	28%	5%	16%	90%	10%	78%	-	-	33%
Feb	23%	-	34%	8%	6%	65%	-	4%	27%	92%	28%	82%	-	-	25%
Mar	21%	-	31%	6%	11%	64%	-	9%	46%	89%	-	85%	-	-	17%
Apr	18%	-	27%	3%	15%	63%	42%	14%	68%	93%	50%	89%	-	-	6%
May	26%	-	-	67%	73%	76%	16%	89%	64%	95%	69%	85%	33%	-	-
Jun	35%	-	-	58%	69%	74%	-	86%	48%	90%	63%	71%	-	-	-
Jul	-	-	-	44%	43%	67%	-	61%	41%	87%	-	79%	-	-	-
Aug	-	-	-	35%	28%	67%	-	53%	50%	80%	-	77%	-	-	-
Sep	-	-	-	32%	18%	67%	-	38%	38%	87%	44%	80%	-	-	-
Oct	15%	-	-	28%	8%	67%	36%	12%	43%	90%	71%	81%	-	-	-
Nov	-	-	-	33%	-	68%	70%	8%	12%	83%	-	73%	-	-	23%
Dec	-	-	17%	35%	-	67%	11%	7%	39%	92%	56%	81%	-	-	40%

Table 11. Percent reduction in concentration to meet the chronic water quality standards for 303(d) listed stream segments of the Clear Creek basin. Monthly reduction values are based on 85th% values versus the chronic standard

VII. SOURCES, TECHNICAL ANALYSIS, AND TMDL LOAD ALLOCATIONS

The vast majority of the metal loads into Clear Creek is from historic and present day mining activities and is difficult to allocate as non-point sources. The metal loads to Clear Creek vary along the length of the stream, and correspondingly so do the ambient concentrations of metals. Additionally there are 15 permitted dischargers within the upper Clear Creek watershed (Table 3). Potential sources of metals contamination for the 303(d) listed segments are identified in Table 12.

Segment	Source	Flow Rate (MGD)	Permitted/treated
2	Central Clear Creek	0.1	Yes
	Georgetown WWTP	0.58	Yes
	Georgetown, Town of	NA	Yes
	Silver Plume WW	0.36	Yes
	Silver Plume, Town of	NA	Yes
	Burleigh Tunnel		No - Untreated
	McClelland Tunnel		No - Untreated
	Big Five Tunnel		Yes – Treated at Argo
	Rockford Tunnel		No - Untreated
	Virginia Canyon (portion)		Yes – Treated at Argo
	Unidentified Sources between Silver Plume and West Clear Creek		
3a	9 mine tunnels/Mine wastes		No
	Upstream sources of Zn not determined		
3b	6 mine tunnels		No
	Unidentified sources		
6	3 mine tunnels		No
	Mad Creek no flow data for loading		
9a	St Mary's Glacier	NA	Yes
	St. Mary's Glacier W&SD	0.6	Yes
	19 mine Tunnels		No
	Fall River no data to track sources		
9b	12 mine Tunnels		No
	Mine complexes including:		
	Lamartine		No
	Freeland Phoenix		No
	Champion Dirt		No
	Old Settler		No
	Sunnyside		No
	Baby Eddie		No
	Groundwater Source		No
11	Albert Frei & Sons Inc	0.3	Yes
	Argo Tunnel Treatment Plant	1.559	Yes
	Idaho Springs, City of	0.214	Yes
	Idaho Springs, Town of WWTP	0.6	Yes
	Argo Tunnel		Yes – Treated at Argo
General	200 smaller mining tunnels		No
	800 abandoned mines		No
	Gravel Road Run-off		No

Segment	Source	Flow Rate (MGD)	Permitted/treated
	Road Construction I-70, US 6, US 40		Not as point source

Table 12. Potential sources of metals contamination for the 303(d) listed segments of the Clear Creek watershed.

For most of the stream segments, the highest metal loads occurred in May or June, when flows were highest, and in some cases, concentrations were high in those months as well (Tables 7, 13-30). Exceedance of the standard is likely to occur during low flow when there is less dilution available, or in spring when snowmelt infiltrates shallow aquifers displacing metal-laden water stored within the aquifer to adjacent streams, but it should be noted that exceedances of the standards occurred at all times of the year (Tables 9 & 10).

Total Maximum Daily Loads ("TMDL")

A TMDL is comprised of the Load Allocation (LA), which is that portion of the pollutant load attributed to natural background or the non-point sources, the Waste Load Allocation (WLA), which is that portion of the pollutant load associated with point source discharges, and a Margin of Safety (MOS). The TMDL may be expressed as the sum of the LA, WLA and MOS.

$$TMDL = WLA + LA + MOS$$

TMDL = Sum of Waste Load Allocations + Sum of Load Allocations + Margin of Safety

The TMDL was calculated using the median monthly flow from the nearest gage and the existing stream standard. Metal loads from dischargers were calculated using the design capacity for flow, and the effluent limits listed in their current permit. Where no limits were given, the limit was assumed to be equal to the stream standard. Modeled discharges and non-permitted draining mine tunnels were also given waste load allocations (WLA). The WLA for non-permitted abandoned mine features was calculated by first determining a background metals load from upstream concentrations. The difference in upstream and downstream concentrations was attributed to influence from mining features. The monthly percent contribution from the mines was averaged to determine an annual percent contribution. The annual percent contribution was then multiplied by the monthly TMDL to assign a WLA to the non-permitted mine discharges. An average value was used as opposed to monthly values in order to alleviate the complexity of calculating individual monthly WLAs. Load allocations (LA) were calculated by subtracting the WLAs from the TMDL. Where the ambient stream load is higher than the TMDL a load reduction was calculated. In the case of Leavenworth Creek where no upstream data were available and impacts from past mining activity (Waldorf Mine) are observed close to the creek's headwaters near Argentine Pass (EPA1997), the entire load reduction was assigned as a WLA to non-permitted mine discharges.

In the mainstem from Silver Plume to Idaho Springs (Segment 2) the highest copper loading comes from the Fall River in May and June (Table 14), and West Clear Creek contributes a significant load in May and June as well (Table 14). The highest lead and zinc loading to Segment 2 occurs from unidentified sources between Silver Plume and West Clear Creek (Tables

16 & 18), but may be attributable in part to the untreated discharges of the Burleigh Tunnel (Table 19). Although the Burleigh Tunnel contributes a significant zinc load to the mainstem, CERCLA has decided not to take any further action to remediate that site (Table 19). The five permitted facilities on Segment 2 contribute only a small percentage of the total metals load to the stream. Flows from the Burleigh Tunnel, McClelland Tunnel, and Rockford Tunnel still contribute loads to Segment 2, with zinc loads from the Burleigh Tunnel being particularly high.

In a November 2001 study of the lower portion of Segment 2, zinc loading incrementally increased from Silver Creek, near the McClelland tunnel, and near the Rockford Tunnel, Fall River, and Trail Creek (Lewis, 2002). The Rockford Tunnel and Trail Creek area was also identified as an area of copper loading as well. There appears to be a gradual increase in loading from above McClelland to Idaho Springs which has been generally unidentified or considered to be a result of multiple accumulative point and non-point source loading.

South Clear Creek and Leavenworth Creek are significant loaders of lead to the mainstem Clear Creek, Segment 2, during periods of peak flow (May-July) (Table 16). South Clear Creek and Leavenworth Creek are also significant sources of zinc to the mainstem throughout the entire year (Table 18.In South Clear Creek (Segment 3a) significant zinc loading occurred in June and July (Table 20), but there are no available data to further track the upstream sources of these metals. Loads could not be determined for Mad Creek (Segment 6) because no flow records were available and attempts to estimate the flow from other data sources gave unreasonable estimates.

The highest lead and zinc loads in Leavenworth Creek also occurred during periods of snowmelt (May-July). The Waldorf Mine is located near the headwaters of Leavenworth Creek and it, in addition to five other abandoned mines, contributes to the downstream elevated concentrations of lead and zinc.

Copper loads were highest in the Fall River (Segment 9a) in May and June (Table 22). The St. Mary's Glacier Water and Sanitation District have discharge permits on the Fall River, but contribute a relatively small load of copper to Fall River (Tables 3 & 22). No data were available to further trace the upstream sources of copper in Fall River.

In Trail Creek (Segment 9b) the highest loads for cadmium, copper, lead, zinc occurred in May when both the flow and concentrations of metals were high (Tables 24-27). Several mining complexes exist in the Trail Creek watershed including the Lamartine, Freeland, Phoenix, Champion Dirt, Old Settler, Sunnyside, and Baby Eddie. In a 2003 report on the hydrology of Trail Creek, Lewis suggested that cumulatively, the mine impacts appear to cause the high metals concentrations in Trail Creek. He also found that there was discharge of contaminated ground water near the mouth and that additional loading from ground water was probably occurring in the mainstem in the vicinity of Trail Creek. Trail Creek appeared to lose surface water near the mouth before its confluence with Clear Creek.

In the mainstem from Idaho Springs to Golden (Segment 11) the highest cadmium loads occurred in May, and only in May and June did cadmium loads ever exceed the TMDL (Table 28). The North Fork of Clear Creek contributes a significant portion of the cadmium load to the mainstem although loads are somewhat diluted by the time they reach Golden at the end of Segment 11 (Table 28). Four dischargers have permits in Segment 11, and the Argo WTP has the highest effluent limits but consistently discharges well below their allowable limit (Table 28). The highest loads of lead occurred in June during peak runoff, but lead did not exceed the TMDL in any month (Table 29). Due to one abnormally high lead sample on 4/5/1994, Segment

11 remained on the 2008 303(d) List for exceeding the chronic lead standard. The highest zinc loads occurred in May and June, although the standard was only exceeded during low flow (October-April) when there is less dilution (Table 30).

North Fork Clear Creek contributes a significant zinc load to the mainstem, but dilution from other sources and assimilation/precipitation to the stream channel reduces the loads by the time the mainstem reaches Golden (Table 30). The permitted dischargers contribute a very small portion of the overall metals load in the mainstem. The Argo Tunnel, and recently mine water from the Big Five Tunnel and baseflow from Virginia Canyon are being treated at the Argo WTP.

Copper – Mainstem Clear Creek, Silver Plume to Idaho Springs										
								WLA*, lbs/day		
Month	TMDL, lbs/day	Total Discharger WLA, lbs/day	Total Abandoned Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction Required	Town of Silver Plume	George-town WWTP	Central Clear Cr. S.D.
Jan	1.46	0.036	1.31	0.11	2.20	0.74	34%	0.0001	0.031	0.0053
Feb	1.54	0.036	1.39	0.12	2.56	1.02	40%	0.0001	0.031	0.0053
Mar	1.48	0.036	1.33	0.11	2.78	1.30	47%	0.0001	0.031	0.0053
Apr	1.67	0.036	1.50	0.13	3.97	2.30	58%	0.0001	0.031	0.0053
May	1.54	0.036	1.39	0.12	10.80	9.26	86%	0.0001	0.031	0.0053
Jun	1.98	0.036	1.78	0.16	21.08	19.10	91%	0.0001	0.031	0.0053
Jul	1.49	0.036	1.34	0.11	7.42	5.93	80%	0.0001	0.031	0.0053
Aug	1.60	0.036	1.44	0.12	3.96	2.36	59%	0.0001	0.031	0.0053
Sep	1.69	0.036	1.52	0.13	4.04	2.35	58%	0.0001	0.031	0.0053
Oct	1.24	0.036	1.12	0.09	3.86	2.62	68%	0.0001	0.031	0.0053
Nov	1.20	0.036	1.08	0.08	2.50	1.30	52%	0.0001	0.031	0.0053
Dec	1.37	0.036	1.24	0.10	1.91	0.54	28%	0.0001	0.031	0.0053

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Table 13. Copper total maximum daily load, waste load allocation, and load allocations for Segment 2 (mainstem Silver Plume to Idaho Springs). Stream loads are given for dissolved copper, waste loads are given for potentially dissolved copper. Existing stream loads are calculated as 85th% values. Monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software while stream loads are calculated using median flows.

Copper – Mainstem Clear Creek, Silver Plume to Idaho Springs										
								WLA*, lbs/day		
Month	TMDL with a 10% MOS, lbs/day	Total Discharger WLA, lbs/day	Total Abandoned Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction Required	Town of Silver Plume	George-town WWTP	Central Clear Cr. S.D.
Jan	1.82	0.036	1.64	0.15	2.20	0.38	17%	0.0001	0.031	0.0053
Feb	1.77	0.036	1.60	0.14	2.56	0.79	31%	0.0001	0.031	0.0053
Mar	1.98	0.036	1.78	0.16	2.78	0.80	29%	0.0001	0.031	0.0053
Apr	2.91	0.036	2.62	0.25	3.97	1.06	27%	0.0001	0.031	0.0053
May	7.15	0.036	6.43	0.68	10.80	3.65	34%	0.0001	0.031	0.0053
Jun	12.33	0.036	11.10	1.20	21.08	8.75	42%	0.0001	0.031	0.0053
Jul	7.70	0.036	6.93	0.73	7.42	-0.28	0%	0.0001	0.031	0.0053
Aug	4.64	0.036	4.17	0.43	3.96	-0.68	0%	0.0001	0.031	0.0053
Sep	3.66	0.036	3.30	0.33	4.04	0.38	9%	0.0001	0.031	0.0053
Oct	2.95	0.036	2.66	0.26	3.86	0.91	24%	0.0001	0.031	0.0053
Nov	2.30	0.036	2.07	0.19	2.50	0.21	8%	0.0001	0.031	0.0053
Dec	2.01	0.036	1.81	0.16	1.91	-0.10	0%	0.0001	0.031	0.0053

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Table 13. Copper total maximum daily load, waste load allocation, and load allocations for Segment 2 (mainstem Silver Plume to Idaho Springs). Stream loads are given for dissolved copper, waste loads are given for potentially dissolved copper. Existing stream loads are calculated as 85th% values. In the first panel (pg. 25), monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software, while stream loads are calculated using median flows. The second panel reflects TMDL and stream loads based on median flows with an explicit 10% Margin of Safety.

Current Copper Load in Mainstem and Tributaries of Segment 2, lbs/day								
Upstream Clear Cr*.	South Clear Cr.	Leaven-worth Cr.	Clear Cr. Abv West Fork	West Clear Cr.	Clear Cr. @ Lawson	Fall R.	Trail Cr.	Chicago Cr.
0.09	0.05	0.03	0.19	0.09	0.54	0.09	0.13	0.04
0.09	0.05	0.02	0.18	0.09	0.47	0.08	0.09	0.04
0.21	0.09	0.02	0.23	0.1	0.52	0.11	0.08	0.06
0.33	0.09	0.03	0.27	0.12	0.58	0.19	0.37	0.07
1.72	0.35	0.49	3.67	1.03	8.92	5.56	0.97	0.51
3.05	1.30	1.25	4.80	1.61	9.43	5.44	0.32	0.42
1.54	0.68	0.41	2.26	0.70	3.71	0.89	0.26	0.29
0.63	0.27	0.18	1.00	0.30	2.17	0.67	0.16	0.27
0.42	0.22	0.12	0.75	0.23	1.52	0.22	0.25	0.19
0.21	0.15	0.09	0.50	0.17	0.86	0.11	0.24	0.11
0.15	0.09	0.05	0.35	0.13	0.74	0.11	0.08	0.08
0.09	0.06	0.03	0.20	0.10	0.62	0.09	0.19	0.05

* UCCWA Site CC-05, Clear Creek Mainstem at Bakerville

Table 14. Current copper loads in the mainstem and tributaries of Segment 2 (mainstem Silver Plume to Idaho Springs). Stream loads are given for dissolved copper. Existing stream loads are calculated as 85th% values and median flows.

Lead – Mainstem Clear Creek, Silver Plume to Idaho Springs										
								WLA, lbs/day*		
Month	TMDL, lbs/day	Total Discharger WLA, lbs/day	Total Abandoned Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction Required	Town of Silver Plume	George-town WWTP	Central Clear Cr. S.D.
Jan	0.42	0.008	0.15	0.26	0.03	-0.38	0%	0.00002	0.007	0.001
Feb	0.44	0.008	0.16	0.28	0.03	-0.41	0%	0.00002	0.007	0.001
Mar	0.42	0.008	0.15	0.26	0.03	-0.39	0%	0.00002	0.007	0.001
Apr	0.47	0.008	0.17	0.29	0.05	-0.42	0%	0.00002	0.007	0.001
May	0.38	0.008	0.14	0.23	0.67	0.29	43%	0.00002	0.007	0.001
Jun	0.42	0.008	0.15	0.26	1.75	1.32	76%	0.00002	0.007	0.001
Jul	0.33	0.008	0.12	0.20	0.87	0.55	63%	0.00002	0.007	0.001
Aug	0.38	0.008	0.14	0.23	0.35	-0.03	0%	0.00002	0.007	0.001
Sep	0.41	0.008	0.15	0.25	0.33	-0.08	0%	0.00002	0.007	0.001
Oct	0.31	0.008	0.11	0.19	0.30	-0.01	0%	0.00002	0.007	0.001
Nov	0.32	0.008	0.11	0.20	0.12	-0.20	0%	0.00002	0.007	0.001
Dec	0.38	0.008	0.14	0.24	0.04	-0.35	0%	0.00002	0.007	0.001

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Lead – Mainstem Clear Creek, Silver Plume to Idaho Springs with a 10% Margin of Safety										
								WLA, lbs/day*		
Month	TMDL, lbs/day	Total Discharger WLA, lbs/day	Total Abandoned Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction Required	Town of Silver Plume	George-town WWTP	Central Clear Cr. S.D.
Jan	0.51	0.008	0.18	0.32	0.03	-0.48	0%	0.00002	0.007	0.001
Feb	0.51	0.008	0.18	0.32	0.03	-0.48	0%	0.00002	0.007	0.001
Mar	0.57	0.008	0.20	0.35	0.03	-0.53	0%	0.00002	0.007	0.001
Apr	0.82	0.008	0.29	0.52	0.05	-0.77	0%	0.00002	0.007	0.001
May	1.76	0.008	0.63	1.12	0.67	-1.09	0%	0.00002	0.007	0.001
Jun	2.64	0.008	0.95	1.68	1.75	-0.89	0%	0.00002	0.007	0.001
Jul	1.68	0.008	0.61	1.07	0.87	-0.81	0%	0.00002	0.007	0.001
Aug	1.10	0.008	0.40	0.69	0.35	-0.75	0%	0.00002	0.007	0.001
Sep	0.89	0.008	0.32	0.56	0.33	-0.56	0%	0.00002	0.007	0.001
Oct	0.74	0.008	0.27	0.46	0.30	-0.44	0%	0.00002	0.007	0.001
Nov	0.61	0.008	0.22	0.38	0.12	-0.49	0%	0.00002	0.007	0.001
Dec	0.56	0.008	0.20	0.35	0.04	-0.52	0%	0.00002	0.007	0.001

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Table 15. Lead total maximum daily load, waste load allocation, and load allocations for Segment 2 (mainstem Silver Plume to Idaho Springs). Stream loads are given for dissolved lead, waste loads are given for potentially dissolved lead. Existing stream loads are calculated as 85th% values. In the first panel (pg. 28), monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software, while stream loads are calculated using median flows. The second panel reflects TMDL and stream loads based on median flows with an explicit 10% Margin of Safety.

Current Lead Load in Mainstem and Tributaries of Segment 2, lbs/day								
Upstream Clear Cr.*	South Clear Cr.	Leaven-worth Cr.	Clear Cr. Abv West Fork	West Clear Cr.	Clear Cr. @ Lawson	Fall R.	Trail Cr.	Chicago Cr.
0.03	0.02	0.015	0.07	0.02	0.07	0.012	0.004	0.02
0.03	0.02	0.016	0.08	0.02	0.06	0.009	0.003	0.02
0.3	0.03	0.016	0.09	0.02	0.07	0.012	0.003	0.05
0.56	0.03	0.024	0.09	0.02	0.07	0.02	0.015	0.09
0.33	0.1	0.213	1.40	0.25	1.35	0.103	0.04	0.11
0.58	0.56	0.445	2.13	0.37	1.82	0.158	0.022	0.25
0.55	0.24	0.191	1.86	0.28	1.53	0.095	0.006	0.22
0.17	0.08	0.083	0.40	0.13	0.58	0.076	0.005	0.10
0.12	0.06	0.054	0.28	0.10	0.40	0.036	0.017	0.07
0.08	0.03	0.04	0.16	0.06	0.22	0.029	0.024	0.03
0.05	0.02	0.023	0.11	0.04	0.15	0.019	0.003	0.02
0.03	0.02	0.015	0.06	0.02	0.07	0.012	0.011	0.01

* UCCWA Site CC-05, Clear Creek Mainstem at Bakerville

Table 16. Current lead loads in the mainstem and tributaries of Segment 2 (mainstem Silver Plume to Idaho Springs). Stream loads are given for dissolved lead. Existing stream loads are calculated as 85th% values and median flows. Segment 2 is currently in attainment of the chronic dissolved lead standard for all months of the year.

Zinc – Mainstem Clear Creek, Silver Plume to Idaho Springs										
								WLA, lbs/day*		
Month	TMDL, lbs/day	Total Discharger WLA, lbs/day	Total Abandoned Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction Required	Town of Silver Plume	George-town WWTP	Central Clear Cr. S.D.
Jan	31.2	1.14	29.3	0.7	58.9	27.7	47%	0.0027	0.97	0.167
Feb	31.2	1.14	29.3	0.7	60.6	29.4	48%	0.0027	0.97	0.167
Mar	31.2	1.14	29.3	0.7	67.0	35.8	53%	0.0027	0.97	0.167
Apr	36.7	1.14	34.5	1.1	97.6	60.9	62%	0.0027	0.97	0.167
May	54.0	1.14	50.8	2.1	158.5	104.5	66%	0.0027	0.97	0.167
Jun	110.2	1.14	103.6	5.5	342.9	232.7	68%	0.0027	0.97	0.167
Jul	78.8	1.14	74.1	3.6	173.2	94.4	54%	0.0027	0.97	0.167
Aug	65.9	1.14	61.9	2.8	92.3	26.4	29%	0.0027	0.97	0.167
Sep	62.6	1.14	58.9	2.6	76.1	13.5	18%	0.0027	0.97	0.167
Oct	42.1	1.14	39.6	1.4	63.5	21.4	34%	0.0027	0.97	0.167
Nov	32.4	1.14	30.5	0.8	61.6	29.2	47%	0.0027	0.97	0.167
Dec	31.2	1.14	29.3	0.7	61.4	30.2	49%	0.0027	0.97	0.167

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Zinc – Mainstem Clear Creek, Silver Plume to Idaho Springs with a 10% Margin of Safety										
								WLA, lbs/day*		
Month	TMDL, lbs/day	Total Discharger WLA, lbs/day	Total Abandoned Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction Required	Town of Silver Plume	George-town WWTP	Central Clear Cr. S.D.
Jan	38.9	1.14	36.5	1.2	58.9	20.0	34%	0.0027	0.97	0.167
Feb	36.0	1.14	33.8	1.0	60.6	24.6	41%	0.0027	0.97	0.167
Mar	41.8	1.14	39.3	1.4	67.0	25.2	38%	0.0027	0.97	0.167
Apr	64.2	1.14	60.3	2.7	97.6	33.4	34%	0.0027	0.97	0.167
May	250.7	1.14	235.7	13.9	158.5	-92.2	0%	0.0027	0.97	0.167
Jun	684.8	1.14	643.7	39.9	342.9	-341.9	0%	0.0027	0.97	0.167
Jul	406.3	1.14	381.9	23.2	173.2	-233.1	0%	0.0027	0.97	0.167
Aug	190.5	1.14	179.1	10.3	92.3	-98.2	0%	0.0027	0.97	0.167
Sep	136.1	1.14	127.9	7.0	76.1	-60.0	0%	0.0027	0.97	0.167
Oct	100.1	1.14	94.1	4.9	63.5	-36.6	0%	0.0027	0.97	0.167
Nov	62.2	1.14	58.5	2.6	61.6	-0.6	0%	0.0027	0.97	0.167
Dec	45.7	1.14	43.0	1.6	61.4	15.7	26%	0.0027	0.97	0.167

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Table 17. Zinc total maximum daily load, waste load allocation, and load allocations for Segment 2 (mainstem Silver Plume to Idaho Springs). Stream loads are given for dissolved zinc, waste loads are given for potentially dissolved zinc. Existing stream loads are calculated as 85th% values. In the first panel (pg. 31), monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software, while stream loads are calculated using median flows. The second panel reflects TMDL and stream loads based on median flows with an explicit 10% Margin of Safety.

Current Zinc Load in Mainstem and Tributaries of Segment 2, lbs/day								
Upstream Clear Cr.	South Clear Cr.	Leaven-worth Cr.	Clear Cr. Abv West Fork	West Clear Cr.	Clear Cr. @ Lawson	Fall R.	Trail Cr.	Chicago Cr.
0.98	2.3	2.6	37.0	3.4	35.4	0.9	0.96	0.21
0.55	1.7	2.3	26.2	3.0	27.6	0.8	0.65	0.11
1.15	2.6	2.1	30.4	3.6	28.9	1.04	0.93	0.16
1.75	2.6	2.9	34.5	4.1	30.2	1.79	3.79	0.22
13.96	9.9	14.1	214.9	62.8	221.4	8.53	6.48	3.45
47.71	34.0	36.0	282.7	68.3	328.5	7.51	4.06	4.06
11.72	22.0	20.6	136.1	17.3	116.6	3.78	4.17	2.26
12.29	10.9	10.6	118.2	6.9	80.4	3.11	3.27	1.56
7.69	7.6	7.8	84.2	5.3	58.8	1.25	3.22	0.93
3.1	4.4	6.3	50.2	3.7	37.3	0.84	2.4	0.3
2.26	3.4	4.4	48.9	3.8	40.2	0.87	0.95	0.31
1.42	3.3	3.3	47.7	3.9	43.1	0.79	1.35	0.32

Table 18. Current zinc loads in the mainstem and tributaries of Segment 2 (mainstem Silver Plume to Idaho Springs). Stream loads are given for dissolved zinc. Existing stream loads are calculated as 85th% values and median flows.

	Jun-89				Sep-89				May-02		
	Cu-D	Pb-D	Zn-D		Cu-D	Pb-D	Zn-D		Cu-D	Pb-D	Zn-D
Tunnels	lbs/day	lbs/day	lbs/day		lbs/day	lbs/day	lbs/day		lbs/day	lbs/day	lbs/day
Rockford	0.092	0.001	0.486		0.068	0.000	0.273		0.079	N/A	0.185
McClelland	0.031	0.001	1.093		0.003	0.000	0.49		0.006	N/A	1.06
Burleigh	0.002	0.003	11.4		0.000	0.002	19.5		N/A	N/A	N/A

Table 19. Average load from largest untreated tunnels discharging into Segment 2 (Silver Plume to Idaho Springs). Loads derived from three EPA sampling dates in 6/89, 9/89, and 5/02.

Zinc- South Clear Creek						
Month	TMDL, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction
Jan	1.58	1.40	0.17	2.3	0.72	31%
Feb	1.60	1.42	0.18	1.7	0.10	6%
Mar	1.54	1.37	0.17	2.6	1.06	41%
Apr	1.58	1.40	0.17	2.6	1.02	39%
May	1.35	1.20	0.15	9.9	8.55	86%
Jun	1.77	1.58	0.19	34.0	32.23	95%
Jul	4.09	3.64	0.45	22.0	17.91	81%
Aug	2.91	2.59	0.32	10.9	7.99	73%
Sep	2.79	2.48	0.31	7.6	4.81	63%
Oct	1.70	1.51	0.19	4.4	2.70	61%
Nov	1.69	1.50	0.19	3.4	1.71	50%
Dec	1.77	1.57	0.19	3.3	1.53	46%

Zinc- South Clear Creek						
Month	TMDL with a 10% MOS, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction
Jan	1.56	1.39	0.17	2.3	0.74	32%
Feb	1.37	1.22	0.15	1.7	0.33	19%
Mar	2.18	1.94	0.24	2.6	0.42	16%
Apr	2.25	2.00	0.25	2.6	0.35	14%
May	2.91	2.59	0.32	9.9	6.99	71%
Jun	12.83	11.42	1.41	34.0	21.17	62%
Jul	11.05	9.83	1.22	22.0	10.95	50%
Aug	6.34	5.64	0.70	10.9	4.56	42%
Sep	4.67	4.16	0.51	7.6	2.93	39%
Oct	2.87	2.56	0.32	4.4	1.53	35%
Nov	2.08	1.85	0.23	3.4	1.32	39%
Dec	1.90	1.69	0.21	3.3	1.40	42%

Table 20. Zinc total maximum daily load, waste load allocation, and load allocations for Segment 3a (South Clear Creek). Stream loads are given for dissolved zinc, waste loads are given for potentially dissolved zinc. Existing stream loads are calculated as 85th% values. In the first panel, monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software, while stream loads are calculated using median flows. The second panel reflects TMDL and stream loads based on median flows with an explicit 10% Margin of Safety.

Lead – Leavenworth Creek						
Month	TMDL, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction
Jan	0.014	0.014	0.0	0.015	0.001	8%
Feb	0.013	0.013	0.0	0.016	0.003	19%
Mar	0.013	0.013	0.0	0.016	0.003	20%
Apr	0.013	0.013	0.0	0.024	0.011	47%
May	0.008	0.008	0.0	0.213	0.205	96%
Jun	0.010	0.010	0.0	0.445	0.435	98%
Jul	0.014	0.014	0.0	0.191	0.177	93%
Aug	0.016	0.016	0.0	0.083	0.067	81%
Sep	0.018	0.018	0.0	0.054	0.036	67%
Oct	0.013	0.013	0.0	0.04	0.027	67%
Nov	0.014	0.014	0.0	0.023	0.009	38%
Dec	0.015	0.015	0.0	0.015	0.000	3%

Lead – Leavenworth Creek						
Month	TMDL with a 10% MOS, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction
Jan	0.015	0.016	0.0	0.015	0.000	1%
Feb	0.014	0.015	0.0	0.016	0.002	13%
Mar	0.013	0.014	0.0	0.016	0.003	19%
Apr	0.018	0.020	0.0	0.024	0.006	23%
May	0.051	0.057	0.0	0.213	0.162	76%
Jun	0.126	0.140	0.0	0.445	0.319	72%
Jul	0.098	0.109	0.0	0.191	0.093	49%
Aug	0.054	0.060	0.0	0.083	0.029	35%
Sep	0.040	0.044	0.0	0.054	0.014	26%
Oct	0.033	0.037	0.0	0.04	0.007	18%
Nov	0.023	0.026	0.0	0.023	0.000	0%
Dec	0.018	0.020	0.0	0.015	-0.003	0%

Table 21. Lead total maximum daily load, waste load allocation, and load allocations for Segment 3b (Leavenworth Creek). Stream loads are given for dissolved lead, waste loads are given for potentially dissolved lead. Existing stream loads are calculated as 85th% values. In the first panel, monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software, while stream loads are calculated using median flows. The second panel reflects TMDL and stream loads based on median flows with an explicit 10% Margin of Safety.

Zinc – Leavenworth Creek						
Month	TMDL, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction
Jan	0.74	0.74	0.0	2.6	1.86	71%
Feb	0.68	0.68	0.0	2.3	1.62	70%
Mar	0.68	0.68	0.0	2.11	1.43	68%
Apr	0.67	0.67	0.0	2.94	2.27	77%
May	0.48	0.48	0.0	14.06	13.58	97%
Jun	0.69	0.69	0.0	36.02	35.33	98%
Jul	0.87	0.87	0.0	20.64	19.77	96%
Aug	0.94	0.94	0.0	10.6	9.66	91%
Sep	1.04	1.04	0.0	7.79	6.75	87%
Oct	0.74	0.74	0.0	6.32	5.58	88%
Nov	0.78	0.78	0.0	4.38	3.60	82%
Dec	0.79	0.79	0.0	3.28	2.49	76%

Zinc – Leavenworth Creek						
Month	TMDL with a 10% MOS, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction
Jan	0.80	0.80	0.0	2.6	1.80	69%
Feb	0.73	0.73	0.0	2.3	1.57	68%
Mar	0.69	0.69	0.0	2.11	1.42	67%
Apr	0.98	0.98	0.0	2.94	1.96	67%
May	3.03	3.03	0.0	14.06	11.03	78%
Jun	8.34	8.34	0.0	36.02	27.68	77%
Jul	6.12	6.12	0.0	20.64	14.52	70%
Aug	3.17	3.17	0.0	10.6	7.43	70%
Sep	2.31	2.31	0.0	7.79	5.48	70%
Oct	1.85	1.85	0.0	6.32	4.47	71%
Nov	1.27	1.27	0.0	4.38	3.11	71%
Dec	0.96	0.96	0.0	3.28	2.32	71%

Table 22. Zinc total maximum daily load, waste load allocation, and load allocations for Segment 3b (Leavenworth Creek). Stream loads are given for dissolved zinc, waste loads are given for potentially dissolved zinc. Existing stream loads are calculated as 85th% values. In the first panel, monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software, while stream loads are calculated using median flows. The second panel reflects TMDL and stream loads based on median flows with an explicit 10% Margin of Safety.

Copper – Fall River								
Month	TMDL, lbs/day	Total Mine WLA, lbs/day	Discharger WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction	WLA,* lbs/day St Mary's Glacier W&SD
Jan	0.05	0.029	0.015	0.003	0.09	0.04	48%	0.015
Feb	0.05	0.032	0.015	0.004	0.08	0.03	36%	0.015
Mar	0.04	0.019	0.015	0.002	0.11	0.07	68%	0.015
Apr	0.07	0.053	0.015	0.006	0.19	0.12	61%	0.015
May	0.08	0.058	0.015	0.006	5.56	5.48	99%	0.015
Jun	0.17	0.141	0.015	0.016	5.44	5.27	97%	0.015
Jul	0.08	0.062	0.015	0.007	0.89	0.81	91%	0.015
Aug	0.07	0.050	0.015	0.006	0.67	0.60	89%	0.015
Sep	0.05	0.033	0.015	0.004	0.22	0.17	76%	0.015
Oct	0.04	0.020	0.015	0.002	0.11	0.07	66%	0.015
Nov	0.03	0.018	0.015	0.002	0.11	0.08	68%	0.015
Dec	0.04	0.025	0.015	0.003	0.09	0.05	52%	0.015

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Copper – Fall River								
Month	TMDL with a 10% MOS, lbs/day	Total Mine WLA, lbs/day	Discharger WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	% Reduction	WLA,* lbs/day St Mary's Glacier W&SD
Jan	0.08	0.059	0.015	0.007	0.09	0.01	10%	0.015
Feb	0.07	0.045	0.015	0.005	0.08	0.01	18%	0.015
Mar	0.06	0.042	0.015	0.005	0.11	0.05	44%	0.015
Apr	0.15	0.121	0.015	0.013	0.19	0.04	21%	0.015
May	0.54	0.474	0.015	0.053	5.56	5.02	90%	0.015
Jun	0.67	0.591	0.015	0.066	5.44	4.77	88%	0.015
Jul	0.31	0.268	0.015	0.030	0.89	0.58	65%	0.015
Aug	0.28	0.241	0.015	0.027	0.67	0.39	58%	0.015
Sep	0.12	0.096	0.015	0.011	0.22	0.10	45%	0.015
Oct	0.09	0.066	0.015	0.007	0.11	0.02	19%	0.015
Nov	0.09	0.067	0.015	0.007	0.11	0.02	19%	0.015
Dec	0.08	0.057	0.015	0.006	0.09	0.01	13%	0.015

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Table 23. Copper total maximum daily load, waste load allocation, and load allocations for Segment 9a (Fall River). Stream loads are given for dissolved copper, waste loads are given for potentially dissolved copper. Existing stream loads are calculated as 85th% values. In the first panel, monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software, while stream loads are calculated using median flows. The second panel reflects TMDL and stream loads based on median flows with an explicit 10% Margin of Safety.

Cadmium – Trail Creek								
Month	TMDL, lbs/day	10% Margin of Safety	TMDL with a 10% MOS	Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Est. Reduction to Meet TMDL, lbs/day	% Reduction
Jan	0.0031	0.0003	0.0030	0.003	0.0001	0.004	0.001	24%
Feb	0.0017	0.0002	0.0020	0.001	0.0001	0.002	0.001	34%
Mar	0.0022	0.0002	0.0020	0.002	0.0001	0.004	0.002	52%
Apr	0.0059	0.0006	0.0050	0.005	0.0003	0.019	0.013	72%
May	0.0109	0.0011	0.0100	0.009	0.0005	0.030	0.021	68%
Jun	0.0089	0.0009	0.0080	0.008	0.0004	0.017	0.009	53%
Jul	0.0086	0.0009	0.0080	0.007	0.0004	0.015	0.007	47%
Aug	0.0081	0.0008	0.0070	0.007	0.0004	0.016	0.009	55%
Sep	0.0080	0.0008	0.0070	0.007	0.0004	0.013	0.006	44%
Oct	0.0059	0.0006	0.0050	0.005	0.0003	0.010	0.005	48%
Nov	0.0034	0.0003	0.0030	0.003	0.0002	0.004	0.001	21%
Dec	0.0037	0.0004	0.0030	0.003	0.0002	0.006	0.003	45%

Table 24. Estimated cadmium total maximum daily load, waste load allocation, and load allocations for Segment 9b (Trail Creek). Stream loads are based on estimated flow data derived from four measurements of flow on Trail Creek and the adjacent basin of Chicago Creek. Existing stream loads are calculated as 85th% values.

Copper – Trail Creek								
Month	TMDL, lbs/day	10% Margin of Safety	TMDL with a 10% MOS	Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Est. Reduction to Meet TMDL, lbs/day	% Reduction
Jan	0.013	0.001	0.012	0.010	0.0001	0.13	0.12	91%
Feb	0.007	0.001	0.006	0.010	0.0001	0.09	0.09	93%
Mar	0.009	0.001	0.008	0.010	0.0001	0.08	0.08	90%
Apr	0.025	0.002	0.022	0.020	0.0002	0.37	0.34	94%
May	0.044	0.004	0.039	0.040	0.0004	0.97	0.93	96%
Jun	0.033	0.003	0.030	0.030	0.0003	0.32	0.29	91%
Jul	0.034	0.003	0.030	0.030	0.0003	0.26	0.23	88%
Aug	0.032	0.003	0.029	0.030	0.0003	0.16	0.13	82%
Sep	0.032	0.003	0.029	0.030	0.0003	0.25	0.22	88%
Oct	0.024	0.002	0.022	0.020	0.0002	0.24	0.22	91%
Nov	0.014	0.001	0.013	0.010	0.0001	0.08	0.07	85%
Dec	0.015	0.002	0.014	0.010	0.0001	0.19	0.18	93%

Table 25. Estimated copper total maximum daily load, waste load allocation, and load allocations for Segment 9b (Trail Creek). Stream loads are based on estimated flow data derived from four measurements of flow on Trail Creek and the adjacent basin of Chicago Creek. Existing stream loads are calculated as 85th% values.

Lead – Trail Creek								
Month	TMDL, lbs/day	10% Margin of Safety	TMDL with a 10% MOS	Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Est. Reduction to Meet TMDL, lbs/day	% Reduction
Jan	0.004	0.0004	0.003	0.003	0.0003	0.004	0.001	19%
Feb	0.002	0.0002	0.002	0.002	0.0002	0.003	0.001	36%
Mar	0.003	0.0003	0.003	0.002	0.0002	0.003	0.000	8%
Apr	0.007	0.0007	0.007	0.006	0.0006	0.015	0.008	55%
May	0.012	0.0012	0.011	0.010	0.0010	0.04	0.029	72%
Jun	0.008	0.0008	0.007	0.007	0.0007	0.022	0.015	66%
Jul	0.009	0.0009	0.008	0.007	0.0007	0.006	-0.003	0%
Aug	0.009	0.0009	0.008	0.007	0.0007	0.005	-0.003	0%
Sep	0.009	0.0009	0.008	0.008	0.0008	0.017	0.008	49%
Oct	0.007	0.0007	0.006	0.006	0.0006	0.024	0.018	74%
Nov	0.004	0.0004	0.004	0.003	0.0003	0.003	-0.001	0%
Dec	0.005	0.0005	0.004	0.004	0.0004	0.011	0.006	61%

Table 26. Estimated lead total maximum daily load, waste load allocation, and load allocations for Segment 9b (Trail Creek). Stream loads are based on estimated flow data derived from four measurements of flow on Trail Creek and the adjacent basin of Chicago Creek. Existing stream loads are calculated as 85th% values.

Zinc – Trail Creek								
Month	TMDL, lbs/day	10% Margin of Safety	TMDL with a 10% MOS	Total WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Est. Reduction to Meet TMDL, lbs/day	% Reduction
Jan	0.17	0.02	0.15	0.15	0.002	0.96	0.80	84%
Feb	0.09	0.01	0.08	0.08	0.001	0.65	0.57	87%
Mar	0.12	0.01	0.11	0.11	0.001	0.93	0.82	88%
Apr	0.32	0.03	0.29	0.29	0.003	3.79	3.50	92%
May	0.58	0.06	0.52	0.51	0.005	6.48	5.96	92%
Jun	0.44	0.04	0.40	0.39	0.004	4.06	3.67	90%
Jul	0.45	0.04	0.40	0.40	0.004	4.17	3.77	90%
Aug	0.43	0.04	0.38	0.38	0.004	3.27	2.89	88%
Sep	0.43	0.04	0.38	0.38	0.004	3.22	2.84	88%
Oct	0.32	0.03	0.29	0.29	0.003	2.40	2.11	88%
Nov	0.19	0.02	0.17	0.17	0.002	0.95	0.78	82%
Dec	0.20	0.02	0.18	0.18	0.002	1.35	1.17	87%

Table 27. Estimated zinc total maximum daily load, waste load allocation, and load allocations for Segment 9b (Trail Creek). Stream loads are based on estimated flow data derived from four measurements of flow on Trail Creek and the adjacent basin of Chicago Creek. Existing stream loads are calculated as 85th% values.

Cadmium– Mainstem Clear Creek, Idaho Springs to Golden													
								WLA, lbs/day*				Current Load in Mainstem and Tribs of Segment 11, lbs/day	
Month	TMDL, lbs/day	Total Discharger WLA, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL , lbs/day	% Reduction	ARGO WWTP	Albert Frei & Sons Inc	Idaho Springs Water Supply	Idaho Spring WWTP	Clear Cr. @ Kermits (junction I-70 & Hwy 6)	N. Fork Clear Cr.
Jan	0.33	0.038	0.13	0.16	0.46	0.13	29%	0.025	0.0005	0.003	0.009	0.604	0.10
Feb	0.34	0.038	0.14	0.16	0.40	0.06	15%	0.025	0.0005	0.003	0.009	0.476	0.09
Mar	0.33	0.038	0.14	0.16	0.46	0.13	28%	0.025	0.0005	0.003	0.009	0.904	0.12
Apr	0.49	0.038	0.21	0.24	0.82	0.33	41%	0.025	0.0005	0.003	0.009	0.791	0.35
May	0.39	0.038	0.16	0.19	3.97	3.58	90%	0.025	0.0005	0.003	0.009	5.059	1.03
Jun	0.46	0.038	0.20	0.23	3.89	3.43	88%	0.025	0.0005	0.003	0.009	6.373	0.56
Jul	0.35	0.038	0.14	0.17	1.20	0.85	71%	0.025	0.0005	0.003	0.009	2.167	0.20
Aug	0.36	0.038	0.15	0.17	1.06	0.70	66%	0.025	0.0005	0.003	0.009	1.953	0.23
Sep	0.40	0.038	0.17	0.20	0.79	0.39	49%	0.025	0.0005	0.003	0.009	0.178	0.16
Oct	0.37	0.038	0.15	0.18	0.58	0.21	37%	0.025	0.0005	0.003	0.009	0.909	0.13
Nov	0.28	0.038	0.11	0.13	0.55	0.27	49%	0.025	0.0005	0.003	0.009	0.82	0.11
Dec	0.32	0.038	0.13	0.15	0.53	0.21	40%	0.025	0.0005	0.003	0.009	0.732	0.10

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Cadmium– Mainstem Clear Creek, Idaho Springs to Golden															
										WLA, lbs/day*				Current Load in Mainstem and Tribs of Segment 11, lbs/day	
Month	TMDL, lbs/day	10% Margin of Safety	TMDL with a 10% MOS	Total Discharger WLA, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL , lbs/day	% Reduction	ARGO WWTP	Albert Frei & Sons Inc	Idaho Springs Water Supply	Idaho Spring WWTP	Clear Cr. @ Kermits (junction I-70 & Hwy 6)	N. Fork Clear Cr.
Jan	0.66	0.07	0.60	0.038	0.259	0.341	0.46	-0.14	0%	0.025	0.0005	0.003	0.009	0.604	0.1
Feb	0.64	0.06	0.58	0.038	0.249	0.331	0.40	-0.18	0%	0.025	0.0005	0.003	0.009	0.476	0.09
Mar	0.68	0.07	0.61	0.038	0.263	0.347	0.46	-0.15	0%	0.025	0.0005	0.003	0.009	0.904	0.12
Apr	1.15	0.11	1.03	0.038	0.456	0.574	0.82	-0.21	0%	0.025	0.0005	0.003	0.009	0.791	0.35
May	2.67	0.27	2.40	0.038	1.087	1.313	3.97	1.57	40%	0.025	0.0005	0.003	0.009	5.059	1.03
Jun	4.00	0.40	3.60	0.038	1.639	1.961	3.89	0.29	7%	0.025	0.0005	0.003	0.009	6.373	0.56
Jul	2.24	0.22	2.01	0.038	0.907	1.103	1.20	-0.81	0%	0.025	0.0005	0.003	0.009	2.167	0.2
Aug	1.30	0.13	1.17	0.038	0.521	0.649	1.06	-0.11	0%	0.025	0.0005	0.003	0.009	1.953	0.23
Sep	1.10	0.11	0.99	0.038	0.438	0.552	0.79	-0.20	0%	0.025	0.0005	0.003	0.009	0.178	0.16
Oct	0.89	0.09	0.80	0.038	0.351	0.449	0.58	-0.22	0%	0.025	0.0005	0.003	0.009	0.909	0.13
Nov	0.77	0.08	0.70	0.038	0.305	0.395	0.55	-0.15	0%	0.025	0.0005	0.003	0.009	0.82	0.11
Dec	0.69	0.07	0.62	0.038	0.268	0.352	0.53	-0.09	0%	0.025	0.0005	0.003	0.009	0.732	0.1

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Table 28. Cadmium total maximum daily load, waste load allocation, and load allocations for Segment 11 (mainstem Idaho Springs to Golden). Stream loads are given for dissolved cadmium, waste loads are given for potentially dissolved cadmium. Existing stream loads are calculated as 85th% values. In the first panel (pg. 38), monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software, while stream loads are calculated using median flows. The second panel reflects TMDL and stream loads based on median flows with an explicit 10% Margin of Safety.

Lead– Mainstem Clear Creek, Idaho Springs to Golden													
								WLA, lbs/day*				Current Load in Mainstem and Tribs of Segment 11, lbs/day	
Month	TMDL, lbs/day	Total Discharger WLA, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL LA, lbs/day	% Reduction	ARGO WWTP	Albert Frei & Sons Inc	Idaho Springs Water Supply	Idaho Spring WWTP	Clear Cr. @ Kermits (junction I-70 & Hwy 6)	N. Fork Clear Cr.
Jan	0.39	0.05	0.070	0.264	0.30	-0.09	0%	0.04	0.0005	0.004	0.01	0.33	0.009
Feb	0.41	0.05	0.074	0.278	0.44	0.03	0%	0.04	0.0005	0.004	0.01	0.5	0.008
Mar	0.39	0.05	0.071	0.269	0.31	-0.08	0%	0.04	0.0005	0.004	0.01	0.05	0.024
Apr	0.58	0.05	0.109	0.412	0.24	-0.34	0%	0.04	0.0005	0.004	0.01	0.25	0.105
May	0.35	0.05	0.063	0.236	1.73	1.38	80%	0.04	0.0005	0.004	0.01	2.13	0.429
Jun	0.35	0.05	0.063	0.237	2.62	2.27	86%	0.04	0.0005	0.004	0.01	2.8	0.372
Jul	0.28	0.05	0.048	0.182	1.26	0.98	77%	0.04	0.0005	0.004	0.01	2.15	0.085
Aug	0.33	0.05	0.058	0.218	0.44	0.11	25%	0.04	0.0005	0.004	0.01	0.86	0.018
Sep	0.39	0.05	0.071	0.268	0.38	-0.01	0%	0.04	0.0005	0.004	0.01	0.19	0.016
Oct	0.37	0.05	0.067	0.251	0.32	-0.05	0%	0.04	0.0005	0.004	0.01	0.34	0.015
Nov	0.31	0.05	0.053	0.201	0.22	-0.09	0%	0.04	0.0005	0.004	0.01	0.25	0.011
Dec	0.37	0.05	0.066	0.249	0.15	-0.22	0%	0.04	0.0005	0.004	0.01	0.16	0.009

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Lead– Mainstem Clear Creek, Idaho Springs to Golden															
										WLA, lbs/day*				Current Load in Mainstem and Tribs of Segment 11, lbs/day	
Month	TMDL, lbs/day	10% Margin of Safety	TMDL with a 10% MOS	Total Discharger WLA, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Existing Stream Load, lbs/day	Reduction to Meet TMDL LA, lbs/day	% Reduction	ARGO WWTP	Albert Frei & Sons Inc	Idaho Springs Water Supply	Idaho Spring WWTP	Clear Cr. @ Kermits (junction I-70 & Hwy 6)	N. Fork Clear Cr.
Jan	0.78	0.08	0.70	0.05	0.137	0.564	0.30	0.00	0%	0.04	0.0005	0.004	0.01	0.33	0.009
Feb	0.77	0.08	0.69	0.05	0.134	0.556	0.44	0.00	0%	0.04	0.0005	0.004	0.01	0.5	0.008
Mar	0.81	0.08	0.73	0.05	0.143	0.587	0.31	0.00	0%	0.04	0.0005	0.004	0.01	0.05	0.024
Apr	1.36	0.14	1.22	0.05	0.246	0.974	0.24	0.00	0%	0.04	0.0005	0.004	0.01	0.25	0.105
May	2.43	0.24	2.18	0.05	0.447	1.733	1.73	0.00	0%	0.04	0.0005	0.004	0.01	2.13	0.429
Jun	3.07	0.31	2.76	0.05	0.569	2.191	2.62	0.00	0%	0.04	0.0005	0.004	0.01	2.8	0.372
Jul	1.81	0.18	1.63	0.05	0.332	1.298	1.26	0.00	0%	0.04	0.0005	0.004	0.01	2.15	0.085
Aug	1.20	0.12	1.08	0.05	0.216	0.864	0.44	0.00	0%	0.04	0.0005	0.004	0.01	0.86	0.018
Sep	1.07	0.11	0.96	0.05	0.191	0.769	0.38	0.00	0%	0.04	0.0005	0.004	0.01	0.19	0.016
Oct	0.90	0.09	0.81	0.05	0.160	0.650	0.32	0.00	0%	0.04	0.0005	0.004	0.01	0.34	0.015
Nov	0.85	0.09	0.77	0.05	0.151	0.619	0.22	0.00	0%	0.04	0.0005	0.004	0.01	0.25	0.011
Dec	0.81	0.08	0.73	0.05	0.143	0.587	0.15	0.00	0%	0.04	0.0005	0.004	0.01	0.16	0.009

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Table 29. Lead total maximum daily load, waste load allocation, and load allocations for Segment 11 (mainstem Idaho Springs to Golden). Stream loads are given for dissolved lead, waste loads are given for potentially dissolved lead. Existing stream loads are calculated as 85th% values. In the first panel (pg. 40), monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software, while stream loads are calculated using median flows. The second panel reflects TMDL and stream loads based on median flows with an explicit 10% Margin of Safety.

Zinc – Mainstem Clear Creek, Idaho Springs to Golden													
								WLA, lbs/day*				Current Load in Mainstem and Tribs of Segment 11, lbs/day	
Month	TMDL, lbs/day	Total Discharger WLA, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL LA, lbs/day	% Reduction	ARGO WWTP	Albert Frei & Sons Inc	Idaho Springs Water Supply	Idaho Spring WWTP	Clear Cr. @ Kermits (junction I-70 & Hwy 6)	N. Fork Clear Cr.
Jan	39.4	4.02	21.2	14.1	119	79.6	67%	1.9	0.075	0.54	1.5	167	25.6
Feb	39.4	4.02	21.2	14.1	99	59.6	60%	1.9	0.075	0.54	1.5	118	22.3
Mar	39.4	4.02	21.2	14.1	97	57.6	59%	1.9	0.075	0.54	1.5	177	30.2
Apr	58.3	4.02	32.6	21.7	147	88.7	60%	1.9	0.075	0.54	1.5	186	84.4
May	81.0	4.02	46.2	30.8	417	336.0	81%	1.9	0.075	0.54	1.5	664	201
Jun	134.5	4.02	78.3	52.2	700	565.5	81%	1.9	0.075	0.54	1.5	1023	117.7
Jul	90.7	4.02	52.0	34.7	233	142.3	61%	1.9	0.075	0.54	1.5	434	40.5
Aug	72.9	4.02	41.3	27.6	173	100.1	58%	1.9	0.075	0.54	1.5	505	39.4
Sep	72.9	4.02	41.3	27.6	158	85.1	54%	1.9	0.075	0.54	1.5	47	33
Oct	59.9	4.02	33.6	22.4	136	76.1	56%	1.9	0.075	0.54	1.5	216	30.7
Nov	39.4	4.02	21.2	14.1	141	101.6	72%	1.9	0.075	0.54	1.5	216	29.4
Dec	39.4	4.02	21.2	14.1	143	103.6	72%	1.9	0.075	0.54	1.5	217	29.1

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Zinc – Mainstem Clear Creek, Idaho Springs to Golden															
										WLA, lbs/day*				Current Load in Mainstem and Tribs of Segment 11, lbs/day	
Month	TMDL, lbs/day	10% Margin of Safety	TMDL with a 10% MOS	Total Discharger WLA, lbs/day	Total Mine WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL LA, lbs/day	% Reduction	ARGO WWTP	Albert Frei & Sons Inc	Idaho Springs Water Supply	Idaho Spring WWTP	Clear Cr. @ Kermits (junction I-70 & Hwy 6)	N. Fork Clear Cr.
Jan	79.4	7.9	71.4	4.08	40.4	31.0	119	47.6	40%	1.9	0.075	0.54	1.5	167	25.6
Feb	74.5	7.5	67.1	4.08	37.8	29.3	99	31.9	32%	1.9	0.075	0.54	1.5	118	22.3
Mar	81.0	8.1	72.9	4.08	41.3	31.6	97	24.1	25%	1.9	0.075	0.54	1.5	177	30.2
Apr	137.7	13.8	123.9	4.08	71.9	52.0	147	23.1	16%	1.9	0.075	0.54	1.5	186	84.4
May	555.7	55.6	500.1	4.08	297.6	202.5	417	-83.1	0%	1.9	0.075	0.54	1.5	664	201
Jun	1165.6	116.6	1049.0	4.08	627.0	422.1	700	-349.0	0%	1.9	0.075	0.54	1.5	1023	117.7
Jul	578.3	57.8	520.5	4.08	309.9	210.7	233	-287.5	0%	1.9	0.075	0.54	1.5	434	40.5
Aug	264.1	26.4	237.7	4.08	140.1	97.5	173	-64.7	0%	1.9	0.075	0.54	1.5	505	39.4
Sep	198.5	19.8	178.6	4.08	104.7	73.9	158	-20.6	0%	1.9	0.075	0.54	1.5	47	33
Oct	145.8	14.6	131.2	4.08	76.3	54.9	136	4.8	4%	1.9	0.075	0.54	1.5	216	30.7
Nov	108.5	10.9	97.7	4.08	56.2	41.5	141	43.3	31%	1.9	0.075	0.54	1.5	216	29.4
Dec	85.9	8.6	77.3	4.08	43.9	33.4	143	65.7	46%	1.9	0.075	0.54	1.5	217	29.1

*WLAs are superseded by type iii Temporary Modifications (31.14(15)(b)).

Table 30. Zinc total maximum daily load, waste load allocation, and load allocations for Segment 11 (mainstem Idaho Springs to Golden). Stream loads are given for dissolved zinc, waste loads are given for potentially dissolved zinc. In the first panel (pg. 42), monthly TMDLs are calculated using 30-day chronic low flows generated by USEPA DFLOW software, while stream loads are calculated using median flows. The second panel reflects TMDL and stream loads based on median flows with an explicit 10% Margin of Safety.

Margin of Safety

The margin of safety is the TMDL component that accounts for unknowns or uncertainties in the development of the TMDL. The margin of safety may be explicit (a separate value in the TMDL) or implicit (included in factors determining the TMDL). In the case of the Clear Creek TMDL, the margin of safety lies in the calculation of the allowable TMDL based on 30-day chronic low flows. Ambient stream loads were calculated using median stream flows. As a result, proposed reductions also address exceedances of the acute cadmium (trout) standard as well as all other acute standards assigned to this segment. The proposed reductions are conservative over-estimates of the reductions needed in order to attain chronic standards; however, they also take into account the stringent acute standards for cadmium. A ten percent explicit margin of safety was included in this assessment for Segment 9b, Trail Creek. The calculation of Trail Creek loads was completed through estimation of flows from the adjacent gaged watershed of Chicago Creek. In this case, additional load reductions are also required. The calculation of a monthly TMDL is also reflective of the extremely variable hydrograph of the Clear Creek Basin and more adequately reflects the current water quality situation.

TMDL for Segment 2

For the dissolved copper TMDL for mainstem Clear Creek Segment 2, a ten percent explicit Margin of Safety was included. Tables 12 through 17 list the TMDLs and current metals loads for copper, lead, and zinc, respectively. The TMDL is divided into both Waste Load and Load Allocations. Separate waste load allocations are given for both the dischargers and the sum of the three remaining major tunnels (Burleigh, Rockford, and McClelland). The waste load allocation for the tunnels was determined first by calculating a background, or upstream concentration from the UCCWA sampling site Clear Creek Mainstem at Bakerville (CC-05). A concentration for downstream of the mine influence, Clear Creek above Chicago Creek (CC-34), was also calculated. The difference in upstream and downstream concentrations was attributed to mine influence. An annual average of the monthly contribution was then multiplied by the calculated TMDL to generate a WLA for abandoned mines. The percent reduction was calculated as the difference between the existing stream load (lbs/day) and the calculated TMDL (lbs/day) divided by the existing stream load. It should be noted that POTW WLAs are not subject to the instream load reductions. Since they account for less than 5% of the metals load, they are not considered major contributors to impairment of the mainstem of Clear Creek.

Since the TMDL is based on the critical condition, in this case, chronic low flows, the largest reductions in metals loads are clustered during the rising and falling limbs of the hydrograph. In the case of Segment 2, the annual percent contribution from mines was approximately 90% for copper. Copper load reductions needed to achieve TMDL goals are greatest in May-July, with load reductions ranging from 80% in July to 91% in June. Load reductions would also be required for the remainder of the year, ranging from 28% in December to 59% In August in order to attain current stream standards. The calculated WLA for abandoned mines is approximately 36% of the TMDL for lead. However, load reductions for lead are only required during high flow months of May-July. The remaining nine months are currently in attainment of the TMDL. Since lead is attaining its chronic standard, it was removed from the 2008 303(d) listed parameters following the February rulemaking hearing. The WLA for abandoned mines is approximately 94% of the TMDL for zinc. Loading reductions for zinc are needed year round, with the highest required reductions occurring in months of higher flow,

April-July. The lowest reduction is required in September (18%) while the largest reduction is required in June (68%) loading.

When median flows are used to calculate allowable stream loads, load reductions are considerably decreased. The months of July, August, and December are in attainment of chronic copper standards. Additionally, in the high flow months of May and June, reductions in copper load decrease from 86% to 34% and 91% to 42%, respectively. In the case of lead loads, no reductions are required when median flows are used to calculate the TMDL. When median flows are used to calculate the zinc TMDL, Segment 2 is in attainment of its chronic standard from May through November. The range of remaining reductions ranges between 26% and 41%.

Chronic load reductions were applied to instream concentrations in order to assess attainment of the acute stream standards. It is assumed that if the chronic load reductions are attained, Segment 2 will be in attainment of its acute copper and lead standards. An additional 11% reduction would be required for the mainstem Clear Creek, Segment 2, to be in attainment of its acute zinc standard.

TMDL for Segment 3a

Similar to Segment 2, a 10% explicit Margin of Safety was included in the dissolved zinc TMDL. Table 19 lists the TMDL for South Clear Creek. There are no dischargers that currently discharge into Segment 3a. All waste load allocations are considered to be from historic mining activity while all load allocations are considered to be from non-point sources. The waste load allocation for the abandoned mines was determined first by calculating a background, or upstream concentration from one sampling date from South Clear Creek in which the dissolved zinc concentration was less than the detection level and was therefore set to the detection limit (10 ug/L). A concentration for downstream of the mine influence, South Fork Clear Creek above Leavenworth Creek near Georgetown (CC-10), was similarly calculated. The difference in upstream and downstream concentrations was attributed to mine influence. An annual average of the monthly contribution was then multiplied by the calculated TMDL to generate a WLA for abandoned mines. In the case of Segment 3a, the annual percent contribution from abandoned mines was approximately 89%. The percent reduction was calculated as the difference between the existing stream load (lbs/day) and the calculated TMDL (lbs/day) divided by the existing stream load.

The load reductions needed to attain TMDL goals range from 6% in February to as much as 95% in June. Load reductions are highest in the months of May-July correlating with the period of increased flow. Similar to Segment 2, load reductions are greatest during periods of high flow when metal-laden water is flushed out of shallow aquifers into adjacent streams. Like Segment 2, the critical condition is considered to be chronic low flows, which have the greatest effect during months of expected higher flows. The largest reductions in metals loads are therefore clustered during the rising and falling limbs of the hydrograph.

When median flows are used to calculate allowable stream loads, load reductions are decreased. The highest required load reduction decreases from 95% to 71%. Zinc reductions in the remaining months range between 12% and 62%.

Chronic load reductions were applied to instream zinc concentrations in order to assess attainment of the acute stream standards. It is assumed that if the chronic load reductions are attained, Segment 3a will be in attainment of its acute zinc standard.

TMDL for Segment 3b

Similar to Segment 3a, dissolved lead load reductions are highest during months of high flow, i.e. runoff. Table 21 lists the TMDL for Leavenworth Creek for lead. There are no permitted dischargers to Segment 3b, thus no waste load allocations are given to permitted dischargers. Loading reductions are considered to be from non-point sources and non-permitted abandoned mine sources. The waste load allocation for the abandoned mines was determined first by generating a background, or upstream concentration. Since abandoned mines exist at the headwaters of Leavenworth Creek, the entire load reductions were given to the non-permitted mine discharges as a waste load allocation. The increase in lead and zinc concentrations was attributed to mine influence. An annual average of the monthly contribution was then multiplied by the calculated TMDL to generate a WLA for abandoned mines. Therefore, in the case of Segment 3b, the annual percent contribution from abandoned mines was considered to be 100%. The percent reduction was calculated as the difference between the existing stream load (lbs/day) and the calculated TMDL (lbs/day) divided by the existing stream load.

The TMDL calculated load reductions for lead range from 3% in December to as much as 98% in June (Table 21). Load reductions during the rising and falling limbs of the hydrograph (May-July) are greater than 90%. Months of December and January require the lowest reductions at 3% and 8%, respectively. The remaining months would require between 19% and 81% reductions in order to attain chronic dissolved lead standards.

Load reductions for zinc are steadier year round (685-98%) with the highest loading reductions occurring in May-June at 97% and 98%, respectively. Table 22 lists the TMDL for zinc for Segment 3b, Leavenworth Creek. During months of lower flow (i.e. September-April, zinc loading reductions fluctuate from 68% and 88%. The lowest reduction in zinc loading is required in March at 68% and the highest is in June at 98%.

Allowable stream loads were also calculated using median flows. January through March and November-December would be in attainment of their lead TMDL. Load reductions of dissolved lead decreased from a maximum of 98% to a maximum of 76%. Chronic zinc standards are still not in attainment when median flows are used to calculate the TMDL. Monthly zinc load reductions continue to range between 67% and 78%.

Chronic lead and zinc load reductions were applied to instream concentrations in order to assess attainment of the acute stream standards. It is assumed that if the chronic load reductions are attained, Segment 3b will be in attainment of its acute lead, and zinc standards.

TMDL for Segment 9a

Not unlike zinc in South Clear Creek and lead in Leavenworth Creek, dissolved copper follows the same loading pattern, such that the highest load reductions occur during months of high flow, i.e. runoff. Table 23 lists the TMDL for the Fall River for copper. The TMDL is divided into Waste Load and Load Allocations. There is one discharger that currently discharges into Segment 9a, and a waste load allocation was calculated. The remaining load allocations were divided between non-permitted mine discharge (WLA) and non-point sources (LA). The waste load allocation for the abandoned mines was determined first by assuming a background, or upstream concentration, unaffected by heavy metal contamination. Since the headwaters of the Fall River originate at an elevation greater than 12,000 feet above sea level, it is assumed that

the abandoned mine influence originates at a lower elevation near the confluence with Silver Creek and the town of Alice. An eighty-fifth percentile concentration for downstream of the mine influence, Fall River near confluence (CC-30), was also calculated. The percent contribution attributed to mine influence was estimated to be approximately 90% (similar to Clear Creek Segment 2 and the South Fork Clear Creek). This 90% was multiplied by the TMDL to calculate the WLA attributed to abandoned mines. The percent reduction was calculated as the difference between the existing stream load (lbs/day) and the calculated TMDL (lbs/day) divided by the existing stream load. It should be noted that the discharger WLA is not subject to the instream load reductions. Since the discharge accounts for an average of 15% of the metals load, it is not considered to be a major contributor to impairment of the Fall River.

Similar to the previous listed segments, the critical condition is assumed to be during chronic low flows (30E3). Since the difference between median flows and chronic low flows is greatest during months of assumed higher flow, the largest reductions in metals loads are clustered during the rising and falling limbs of the hydrograph. Load reductions from non-point sources and abandoned mine discharges are required year round (Table 23). However, during months of high flow, copper load reductions increase to as much as 99% in May and 97% in June. In the remaining months, copper load reductions range from 48% in January to 91% in July. During periods of low flow (October-April), load reductions remain steady between 48% and 68%.

When median flows are used to calculate allowable stream loads, load reductions are decreased. Copper load reductions are still required in all months of the year, although they decrease to between 14% and 90%.

Chronic lead and zinc load reductions were applied to instream concentrations in order to assess attainment of the acute stream standards. It is assumed that if the chronic load reductions are attained, Segment 3b will be in attainment of its acute lead, and zinc standards.

TMDL for Segment 9b

Dissolved cadmium follows similar loading patterns to that of Fall River, South Clear Creek, and Leavenworth Creek, such that the highest load reductions needed for Trail Creek occur during months of high flow, i.e. runoff. Tables 24 through 27 list the TMDLs and current metals loads for cadmium, copper, lead, and zinc, respectively. The TMDL is divided into both Waste Load and Load Allocations. Separate waste load allocations are given for both the non-permitted mine discharges (WLAs) and non-point sources (LAs). The waste load allocation for the mine discharge was determined first by calculating a background, or upstream eighty-fifth percentile concentration from the UCCWA sampling site Trail Creek above Freeland/Lamartine Mine (CC-31A). A concentration for downstream of the mine influence, Trail Creek near confluence with Clear Creek (CC-31), was also calculated. The difference in upstream and downstream concentrations was attributed to mine influence. An annual average of the monthly contribution was then multiplied by the calculated TMDL to generate a WLA for abandoned mines. The annual percent contribution from abandoned mines differs between metals. The percent reduction was calculated as the difference between the existing stream load (lbs/day) and the calculated TMDL (lbs/day) divided by the existing stream load.

Table 24 lists the TMDL for Trail Creek for cadmium. There is no applicable discharger Waste Load Allocation for Trail Creek. Load reductions are required from abandoned mine discharge and non-point sources year round for cadmium, copper, and zinc. The WLA for

abandoned mine discharge is approximately 95% of the TMDL for cadmium. Cadmium load reductions are highest in April and May with reductions of 72% and 68%, respectively. In the remaining months, cadmium load reductions range from 21% in November to 55% in August. Chronic cadmium load reductions were applied to instream concentrations in order to assess attainment of the acute stream standard. An additional 17% reduction in the cadmium load would be required in order to attain the acute cadmium trout standard. Therefore, during this acute critical condition, it is assumed that if the chronic load reductions are met in addition to an overall 17% reduction in cadmium load, Segment 9b will be in attainment of its acute cadmium trout standard.

The WLA for abandoned mine discharge is approximately 99% of the TMDL for copper. Copper load reductions remain steady between 82% and 96%. Similar to cadmium, the highest loading reductions occur in April and May at 94% and 96%, respectively. Chronic copper load reductions were applied to instream concentrations in order to assess attainment of the acute stream standard. It is assumed that if the chronic load reductions are attained, Segment 9b will be in attainment of its acute copper standard.

The WLA for abandoned mine discharge is approximately 91% of the TMDL for lead. Reductions in lead are required for nine months of the year. Load reductions range from 8% in March to 74% in October. The months of July and August, and November require no load reductions. In order to assess attainment of the acute stream standard, chronic lead load reductions were applied to instream concentrations. It is assumed that if the chronic load reductions are attained, Segment 9b will be in attainment of its acute lead standard.

The WLA for abandoned mine discharge is approximately 99% of the TMDL for zinc. Zinc loading reductions remain elevated year round with reductions of 82% to 92% required year round. Similar to cadmium and copper, the highest loading reductions are required in April and May. In the remaining months, load reductions remain between 80% and 90%. Chronic zinc load reductions were applied to instream concentrations in order to assess attainment of the acute stream standard. It is assumed that if the chronic load reductions are attained, Segment 9b will be in attainment of its acute zinc standard.

TMDL for Segment 11

The TMDL is divided into both Waste Load and Load Allocations. Separate waste load allocations are given for both the dischargers and the discharge from abandoned mine sites. The waste load allocation for the mines was determined first by calculating a background, or upstream concentration from the UCCWA sampling site Clear Creek Mainstem below Idaho Springs, Kermit Gage (CC-40). A concentration for downstream of the mine influence, Clear Creek above Church Ditch Headgate at Golden (CC-60), was also calculated. The difference in upstream and downstream concentrations was attributed to mine influence in Segment 11. In the case of Segment 11, upstream concentrations are greater than downstream concentrations. Metals attenuation occurs throughout Segment 11. Since mining activity occurred in the more upstream portion of Segment 11, this difference in concentration is still, however, attributed to mine influence. An annual average of the monthly contribution was then multiplied by the calculated TMDL to generate a WLA for abandoned mines. The percent reduction was calculated as the difference between the existing stream load (lbs/day) and the calculated TMDL (lbs/day) divided by the existing stream load. It should be noted that discharger WLAs are not

subject to the instream load reductions. Since they account for less than 5% of the metals load, they are not considered major contributors to impairment of the mainstem of Clear Creek. Tables 28 through 30 list the TMDLs for cadmium, lead, and zinc, respectively.

For the TMDL for mainstem Clear Creek Segment 11, an explicit 10% Margin of Safety was included. In the case of Segment 11, WLAs are superseded by Type iii Temporary Modifications (31.14(15)(b))). The WLA for abandoned mine discharge is approximately 46% of the TMDL for cadmium. Cadmium load reductions are required year round, with maximum load reductions of 90% in May and 88% in June, required. The remaining load reductions range from 15% in February to 71% in July. It is assumed that if the chronic load reductions are attained, Segment 11 will be in attainment of its acute cadmium standard.

The WLA for abandoned mine discharge is approximately 21% of the TMDL for lead. Load reductions for lead are not required in any month of the year. All months are currently in attainment of the TMDL. Lead did, however, remain on the 2008 303(d) listed parameters due to an abnormally high lead value of 62 ug/L in 1994. It is assumed that if the chronic load reductions are attained, Segment 11 will be in attainment of its acute lead standard.

The WLA for abandoned mine discharge is approximately 60% of the TMDL for zinc. Loading reductions for zinc occur year round, with the highest required load reductions occurring in May and June (81%). Remaining load reductions remain steady between 56% in October to 72% in November and December. If the chronic load reductions are attained, Segment 11 will require further reductions in order to attain its acute zinc standard. An additional 23% reduction is required in order to attain the acute standard.

When median flows are used to calculate allowable stream loads, load reductions are considerably decreased. The months of January through April and July through December would be in attainment of its chronic cadmium standard. May and June would be the only months requiring cadmium load reductions at 40% and 7%, respectively. When median flows were used to calculate both the TMDL and ambient stream load, no load reductions are required. Zinc would be in attainment during the months of May through September. Remaining reductions in zinc loading range between 4% and 46%.

Previous Water Quality Improvements in the Watershed

There has been extensive water quality studies and data collection efforts focused on nutrients and metals in the Clear Creek watershed. In 1983, because of mining-related water quality problems, the US Environmental Protection Agency (USEPA) established the Clear Creek/Central City Superfund Study Area and placed it on the National Priority clean-up list. In 1987, EPA completed a study of mine tunnel drainages, and many more studies followed. This began remediation efforts on the mine sites in the area, including an extensive network of water quality monitoring (http://www.clearcreekwater.org).

Continuing to address abandoned mine discharge and the ongoing path to remediation, the Clear Creek Watershed Forum was established in 1990 as an organization which transcended the boundaries of any one agency, community, industry, or organization within the watershed. The role of the Forum was to bring people together from throughout the watershed to share knowledge, attitudes and values and thus develop cooperative water quality improvement strategies and projects. Through numerous gatherings, stakeholder input on projects has been

obtained and incorporated to define watershed priorities and establish project partners, thus creating a watershed-wide "culture of cooperation" (http://www.clearcreekwater.org).

This led to the establishment of the Clear Creek Watershed Initiative (WIIN) in 1991 as a joint project between Coors Brewing Company and the Center for Resource Management to provide leadership and coordination of ecological and recreational improvements in the Clear Creek Basin. With recognition of and respect for the fact that many individuals, communities, organizations and agencies had been focusing for years on the well-being of the complex Clear Creek Watershed, the WIIN program encouraged collaboration and cooperation among these groups. Their goal was to enhance, not duplicate, the resources and efforts that had already been dedicated to the basin. Long-term improvement programs focused on four critical areas: water quality, fish and wildlife, public utilization and stream flow augmentation (http://www.clearcreekwater.org).

In 1997, the Clear Creek Watershed Foundation (CCWF) was founded. The CCWF is a non-profit organization dedicated to improving the ecological, aesthetic, recreational and economic conditions in the Clear Creek Watershed through comprehensive and cooperative efforts with watershed stakeholders. This includes, but is not limited to, improving the water quality of Clear Creek and its tributaries. In addition to remediation work, CCWF now promotes and facilitates improved water quality through sustainable watershed management, which integrates ecological, economic and social perspectives. In 2006, CCWF was awarded an EPA Region 8 Regional Priorities Grant to research and develop a sustainable watershed management strategy for the Clear Creek Watershed. The Stakeholder and Technical Advisory Committees formed for this effort are instrumental in refining and implementing the strategy (http://www.clearcreekwater.org).

The Argo Tunnel, in Idaho Springs, was the largest single source of metals contamination to the mainstem of Clear Creek. Construction of a 700 gallon per minute treatment facility was completed in 1998, and full time operation of the treatment plant began in April 1998. Consequently, approximately 1200 pounds of metals are prevented from entering Clear Creek each day due to treatment of the Argo Tunnel (http://www.cdphe.state.co.us).

Most of the OU3 work on the mainstem of Clear Creek has been completed; the bulk of the Superfund work to date has primarily improved water quality in the mainstem of Clear Creek. Continuing efforts on OU4 focus on North Clear Creek. Components of the OU 4 ROD include: capping/removal of priority tailings/waste rock piles in the North Fork of Clear Creek drainage; treatment of discharges from the Gregory Incline and National Tunnels; collection and treatment of the drainage/ground water in Gregory Gulch; and sediment control to North Clear Creek and its tributaries.

The Castleton Mine Dump remediation, with the use of non-point source funds and funds from the Department of Mining Reclamation and Safety, is currently scheduled for 2008. This project targets metal laden acidic runoff from one of the highest ranked polluting mine waste sites within the Virginia Canyon watershed. The project includes removing mine waste from drainages and consolidating the waste in on-site disposal areas. The disturbed areas will then be seeded and re-vegetated.

The Clear Creek Watershed Foundation has sponsored the Gilson Gulch Orphan Mine remediation project. The project intends to install sediment traps, run-on/run-off controls, and remove waste piles from the drainage. Originally scheduled for 2007, this project was also delayed until 2008 due to administrative issues.

Rehabilitation of the Clear Creek Watershed

The goal of the Clear Creek Watershed Association is to promote sustainable natural resource management throughout the entire Clear Creek Watershed and serve as a model for the arid mountain west. In addition to treatment of acid mine discharge, the Upper Clear Creek Watershed Association is drafting a proposal for changes to ambient water-quality standards in both the North Fork Clear Creek and mainstem Clear Creek for the Temporary Modification Hearing in December 2008. If the standards were adjusted, and treatment of discharge from mine tunnels and surrounding adits ensued, Clear Creek would be much closer to meeting its assigned water-quality standards.

Tributaries to the mainstem of Clear Creek continue to suffer impacts from historic mining activity in the watershed. Without further remediation, there is little hope for meeting TMDL goals. The mainstem of Clear Creek is much closer to meeting TMDL goals, but in order to achieve these goals, there must continue to be remediation of historic mine impacts.

This TMDL supports a "staged" implementation concept for the remediation of Clear Creek and its tributaries. This is a TMDL that anticipates implementation in several distinct stages, and it is anticipated that the load and waste load allocations will not require any significant adjustments. Instead, implementation actions will be staged over a period of time (i.e., ongoing CERCLA remediation). In this case, the WLA to point sources (which would be implemented through the NPDES process and alternate underlying standards) would be predicated on continued remediation in both the mainstem and North Clear Creek.

VIII. PUBLIC INVOLVEMENT

There has been a strong public participation in protecting and enhancing water quality of the Clear Creek Basin since the early 1980's. Many organizations have been extensively involved including, the Upper Clear Creek Watershed Association (UCCWA), Colorado Department of Public Health and Environment Hazardous Materials and Waste Management, and Water Quality Control Divisions, Environmental Protection Agency, Colorado Division of Wildlife, Colorado Division of Reclamation and Mine Safety and numerous downstream entities that are involved in the Clear Creek Watershed Forum. The public has openly participated in the UCCWA since the early 1990's and held public monthly meetings since that time. The UCCWA and other entities have and will continue to participate in WQCC hearings on water quality classifications and standards in the basin. The public has also participated in EPA/Hazardous Materials Division Technical Advisory Groups and Watershed Advisory Groups evaluating mine cleanup alternatives in the basin.

The TMDL itself is the subject of an independent public process. The TMDL was made available for public review and comment during a 30 day public notice period in September, 2006. Notice was provided in the Colorado Water Quality Information Bulletin. Public comments were received, and the response to comments is included at the end of this document. Subsequently the U.S. Environmental Protection Agency has also provided comment. The TMDL has been revised per those comments, and will be submitted to EPA for final approval.

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X. ADDITIONAL SOURCES

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XIII. RESPONSE TO COMMENTS

Issue: Assigned Waste Load Allocations in TMDL

Several commenters objected to the wasteload allocations (WLAs) assigned to individual treatment plants and the relative "insignificance" of these point sources to the overall load.

The City of Idaho Springs objects to the current version of the TMDL as it is written stating "Everyone involved agrees that the wastewater treatment plants in this basin are insignificant sources. The combined contribution from all of the wastewater plants is less than 3% of the load…With over 800 abandoned mines in the watershed, and the acknowledgement that regulating wastewater treatment plants will not improve water quality, imposing new permit standards on these small plants would be pointless."

*The City of Golden believes "the point sources that face additional regulation as a result of this draft TMDL are small domestic plants serving populations of less than 2,000. These communities and wastewater treatment plants are insignificant contributors of metal loading to Clear Creek. This TMDL, as written, would have the likely consequence of diverting limited resources available to make plant improvements away from treating pollutants that the plants **do** contribute."*

Upper Clear Creek Watershed Association (UCCWA) noted "The proposed TMDL would needlessly and illogically impose substantial costs on these insignificant dischargers, with no real water quality benefit."

*The City of Westminster stated "The metals from the wastewater treatment plants in the upper Clear Creek watershed should be viewed as insignificant sources for the purposes of development of the TMDL. The overall effect of imposing waste load allocations for metals on the wastewater entities will result in an insignificant improvement in water quality." They went on to add that, similar to the Alamosa TMDL, "…a TMDL does not have to provide a specific load allocation to each and every source within a watershed, it must identify specific load allocations for each **significant** pollutant source that needs to be controlled to achieve water quality standards."*

*The Blackhawk/Central City Sanitation District noted "It is **not**, however, appropriate to adopt a TMDL which would require point source dischargers, who are an insignificant portion of the total load, to implement expensive treatment controls designed to meet effluent limits set equal to the underlying standards, when the 319 study found that several of these underlying standards cannot be met due to natural or irreversible human-induced conditions."*

The Town of Georgetown stated "The Town of Georgetown's wastewater treatment plant is, as are other point source dischargers on Clear Creek, an insignificant source of copper, lead, and zinc…very little of the metals problem in Clear Creek can be solved by

a TMDL waste load allocation to Georgetown which will result in new discharge permit limits."

The City of Arvada states "The paradox we see in the proposed TMDL is the effort to regulate the sources that contribute less than 5% of the metal loading and not addressing the other 95% …The metals contributions from the wastewater treatment plants in the upper Clear Creek watershed should be viewed as what they are, insignificant sources for the purpose of development of the TMDL. The overall effect of imposing waste load allocations for metals on the wastewater entities will result in an insignificant improvement in water quality."

Division Response:

The Division concurs that "The vast majority of the metals load into Clear Creek are from historic and present day mining activities." The permitted dischargers do, in fact, contribute less than 5% of the metals load to Clear Creek. However, as stated in EPA Guidance, "a TMDL or Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and non-point sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality." This TMDL definition can be illustrated by the equation: Waste Load Allocation (WLA) + Load Allocation (LA) + Margin of Safety (MOS) = TMDL.

The WLA is assigned to permitted dischargers. These wastewater entities, although seemingly insignificant sources, must be assigned a WLA, since they are both man-made and controllable sources. It should be noted, however, that POTW WLAs are not subject to the instream load reductions. Since they account for less than 5% of the metals load, they are not considered major contributors to impairment of the mainstem of Clear Creek. Historic mine impacts, the largest contributors to instream metals concentrations were also given a WLA based on their annual percent contribution to elevated metals levels. Because the non-point sources are so diffuse in nature, they were given a single load allocation.

Given the extent of the metals load coming into individual treatment plants, the Division believes that the Type iii temporary modification that is in place on Clear Creek, (Segments 2, 3a, 3b, 6, 9a, 9b and 11), supersedes the waste load allocations developed in this TMDL. Per the EPA, new language in 31.14(16) of the Basic Standards allows the WQCD to impose effluent limits based on what the discharger is capable of achieving (reasonably) with existing treatment facilities. This allows for existing point sources to be regulated with attainable interim limits while the temporary modifications are in effect and the mining related sources in the watershed are being remediated. In the interim, permit limits shall be based on temporary modifications until they expire in February 2010, or until the underlying standards are revised in July 2009 or earlier. In this instance

when the standards are revised, the TMDL waste load allocations will be recalculated as needed.

In reference to the Alamosa TMDL, the point sources referred to that did not require a waste load allocation, were not NPDES permitted dischargers, but draining mine sites. Despite their "insignificant" contribution, water being discharged from permitted wastewater treatment plants on Clear Creek, is higher in metals concentration than that of the source water. In accordance with the provisions of subsection 31.14(15)(b), "no permit shall be issued which allows a discharge that by itself or in combination with other pollution will result in pollution of the receiving waters in excess of the pollution permitted by an applicable water quality standard or applicable antidegradation requirement unless the permit contains effluent limitations and a schedule of compliance specifying treatment requirements or the Division has granted a variance from the water quality standard." Consequently, permitted dischargers on Clear Creek receive a Waste Load allocation set to the existing stream standard multiplied by their design capacity.

Issue: Development of Underlying Standards through a Use Attainability Analysis (UAA)

The City of Golden believes "that instead of issuing the TMDL, the Division should be developing a Use Attainability Analysis (UAA) for these segments with a goal of developing new water quality standards for Clear Creek."

UCCWA states that "the draft TMDL identifies the need to consider the development of a Use Attainability Analysis (UAA) for these segments, and provides the opportunity to coordinate the UAA process with TMDL development."

Blackhawk/Central City Sanitation District noted "…it is now appropriate to next revisit the water quality standard, conduct a Use Attainability Analysis (UAA) as appropriate, and potentially propose revised water quality standards at the next triennial review if needed and justified."

The Town of Georgetown suggested "…the ultimate solution for Clear Creek wastewater dischargers might be a UAA that could lead to revised underlying metals standards on Clear Creek…and allow us time to commence a Clear Creek UAA."

Division Response:

The Division agrees with the Clear Creek stakeholders that a Use Attainability Analysis (UAA) is required in order to modify current water quality standards to better reflect ambient, achievable standards for Clear Creek. Clear Creek has been listed on Colorado's 303(d) List since 1992 (Segments 2, 3b, 9, 11, and 13) for elevated levels of heavy metals. Additionally, water quality monitoring has been ongoing in the watershed since its NPL Listing in 1983. The Upper Clear Creek Watershed Association (UCCWA), created in 1990, is one of Colorado's oldest watershed groups and has worked with EPA and HMWMD in the

effort to remediate the Clear Creek basin to the extent possible. Since clean-up efforts have largely been completed in the mainstem, UCCWA can move forward to develop achievable underlying standards.

UCCWA began writing a proposal for recalculated standards in 2006 with the expectation that it would be completed in time for the December 2007 Temporary Modification hearing. However, the proposal was not completed in time for that hearing, and as of this date, UCCWA, EPA, and WQCD have agreed that the site-specific standards proposal will be completed in time to propose alternate standards (July 2008) for the December 2008 Temporary Modification hearing. UCCWA, EPA, and WQCD also agreed that the TMDL would be submitted to EPA before June 2008 with an amendment that acknowledges that type iii Temporary Modifications take precedence over the WLA allocations outlined in the TMDL. Therefore, it is the Division's belief that the TMDL be submitted to EPA in its current form with underlying table value standards.

Issue: Phased TMDL

Blackhawk/Central City Sanitation District "supports the use of a phased TMDL for these Clear Creek segments…This is despite the significant uncertainty in the underlying standards upon which the TMDL draft is based."

The City of Georgetown added "I would suggest… from the WQCD's own statements in the September, 2006 public notice document demonstrate that there is sufficient evidence of the need for more study, more information, and more data on the sources of copper, lead, and zinc in Clear Creek. This situation appears to be a textbook case for phased TMDLs."

Division response:

The Division disagrees with the request for a "phased" TMDL. Per the 2006 EPA memorandum entitled Clarification Regarding "Phased" Total Maximum Daily Loads, "The phased TMDL approach would be used in situations where limited existing data are used to develop a TMDL and the State believes that the use of additional data or data based on better analytical techniques would likely increase the accuracy of the TMDL load calculation and merit development of a second phase TMDL."

The Clear Creek basin has historically been one of the most well studied and documented basins in Colorado. Extensive data collection, monitoring, and analyses have been undertaken since the 1980's, and Clear Creek represents one of the most data rich basins in Colorado. In accordance with this vast collection of historic and realtime data, the Division believes a "phased" TMDL is not warranted.

Due to the abundance of data collected, the Division does, however, support a TMDL with a "staged" implementation. This is a TMDL that anticipates implementation in several distinct stages, and it is anticipated that the load and waste load allocations will not require any significant adjustments. Instead, implementation actions will be staged over a period of time

(i.e., ongoing CERCLA remediation). In this case, the WLA to point sources (which would be implemented through the NPDES process and alternate underlying standards) would be predicated on continued remediation in both the mainstem and North Clear Creek.

Issue: Remediation of Remaining Non-Point Sources

The City of Golden expressed their concern that "The remaining contributions of metals to Clear Creek are either natural or irreversible human-induced sources. Without continued federal funding, and in the absence of Good Samaritan legislation, these remaining sources are unlikely to be targeted for other remedial activities."

UCCWA believes it is also worth noting that "there are no plans for additional remediation under CERCLA for the three draining adits listed in Table 13 and, in the absence of Good Samaritan legislation, they are unlikely to be targeted for other remedial activities."

Division response:

The Division suggests the Clear Creek stakeholders continue to seek out alternate pathways to remediation of remaining mine waste. Remediation of mine waste can be accomplished through funding opportunities such as non-point source grants, assessment and watershed protection grants available through EPA, loans from the Water Pollution Control Revolving Fund, the Colorado Watershed Protection Fund and CERCLA. Through these and other opportunities throughout the state, the Upper Clear Creek Watershed Association should actively seek out continued, innovative ways to remediate the remaining non-point sources. In addition, if there are no current plans for continued CERCLA remediation, there is no need for a "phased" TMDL, since load allocations would be unlikely to change significantly in the future.

Issue: Monthly Loading Allocations

UCCWA "believes that a TMDL should only be established for each metal in each month where the water quality standard is not being met…The TMDL should acknowledge this seasonality and only establish TMDLs during those seasons when the standard is exceeded."

Division response:

The Division disagrees with this approach. They believe that the TMDL is an inherent property of the waterbody itself (in this case, its natural capacity to assimilate metals) and should therefore encompass the temporal variation utilized by monthly load allocations. The more comprehensive the TMDL load allocations are, the more the loading sources can be understood in the watershed. By allocating waste loads and non-point loads on a monthly basis, it provides a more in-depth look at the potential loading sources. EPA in its draft version of "Options for Expressing Daily Loads in TMDLs" states that "allocations based on monthly, seasonal, or annual timeframes are valuable components to guide management measures and implementation plans because they are related to the overall capacity of the

waterbody, while the daily expressions represent day to day snapshots of the total loading capacity." Additionally, by incorporating the months that are in attainment as well as those months that are exceeding their load allocations, one can get a better estimate of seasonal loading reductions and can better postulate as to why some months are in attainment while others are not.

Issue: Segment 2 Lead and Segment 11 Cadmium and Lead

UCCWA observed in their comments for public notice that the TMDL suggests the lead standard in Segment 2 is attained throughout the entire year. "If this is the case, lead should be eliminated from the 303(d) listing for Segment 2 and a TMDL should ***NOT*** *be developed…TMDL calculations for cadmium and lead in Segment 11 suggest a similar situation."*

Division response:

The Division has investigated the 2006 listing and loading allocations for lead in Segment 2, and cadmium and lead in Segment 11. Due to these findings, Segment 2 is not on the proposed 2008 303(d) List for non-attainment of the chronic lead standard. Segment 11 is in attainment of the cadmium standard year round and the lead standard on an annual basis (based on 85th % concentrations). Nevertheless, since it exceeds the lead standard by greater than 50% during runoff, Segment 11 remains on the 2008 303(d) List for lead, while cadmium was removed. However, since the TMDL was being completed for other parameters and segments, the loading allocations will remain to illustrate the segments' compliance with the underlying table value standards.

Issue: Non-Point Source Contributions

UCCWA believes that "Table 13, which lists non-point source contributions, is highly misleading. There is much more data on non-point source contributions to all of the stream segments and certainly there is data more recent than 17 years ago…To list 11 wastewater treatment plants and only three non-point sources is misleading."

Division response:

The Division acknowledges the fact that non-point source contributions may be misrepresented in the draft TMDL. Therefore, an appendix will be included comprised of a detailed list of potential non-point sources of contamination highlighting those five that have the most significant impact to the water quality of Clear Creek. Additionally, the Division would like to note, that before the TMDL was drafted, recent data was solicited from all concerned parties. The revised TMDL has incorporated more recent Hazardous Materials sampling events into the data analysis.

Issue: Metals Trading

UCCWA believes that "the TMDL document should have provisions to allow trading between point sources and even with some of the non-point sources. There is not enough water quality data to decide if trading would be advantageous to the different plants, but the TMDL needs to allow trading in the future."

***Division response**:*

The Division disagrees with the idea of metals trading on Clear Creek. The book Water-Quality Trading: A Guide for the Wastewater Community; indicates that ideal tradable pollutants would "not exert toxic effects or be bioaccumulative". Additionally, in conjunction with the USEPA Water Quality Trading Assessment Handbook and the Division's Colorado Pollutant Trading Policy, the Division will generally not approve the trade of credits for bioaccumulative toxic pollutants. Therefore, metals trading is not allowable as an alternative to TMDL load allocations.

Issue: Town of Georgetown plant design capacity

The Town of Georgetown's wastewater treatment plant design and permitted capacity at 580,000 gallons per day or 0.58 mgd.

Division response:

The Division accepts this correction to the design capacity, and the appropriate tables will be adjusted.