**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
**REGION 8**
1595 Wynkoop Street
Denver, CO 80202-1129
Phone 800-227-8917
www.epa.gov/region08

SEP 16 2015

Ref: 8EPR-EP

Patrick Pfaltzgraff, Director
Water Quality Control Division
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

Re: TMDL Approvals Mainstem Left Hand Creek, COSPSV04a, for pH, Cu & Zn
James Creek, COSPSV04b, for Cd, Cu, Pb & Zn
Little James Creek, COSPSV04b, for pH, Cd, Cu, Pb & Zn
Left Hand Creek blw James Creek, COSPSV04c, for Cu

Dear Mr. Pfaltzgraff:

We have completed our review of the total maximum daily loads (TMDLs) as submitted by your office for the waterbodies listed in the enclosure to this letter. In accordance with the Clean Water Act (33 U.S.C. 1251 *et. seq.*), we approve all aspects of the TMDLs as developed for the water quality limited waterbodies as described in Section 303(d)(1). Based on our review, we feel the separate elements of the TMDLs listed in the enclosed table adequately address the pollutants of concern as given in the table, taking into consideration seasonal variation and a margin of safety.

Thank you for submitting these TMDLs for our review and approval. If you have any questions, the most knowledgeable person on my staff is Julie Kinsey and she may be reached at (303) 312-7065.

Sincerely,

Martin Hestmark
Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

Enclosures 1 & 2

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# TOTAL MAXIMUM DAILY LOAD (TMDL)ASSESSMENT
# Left Hand Creek Watershed
# Boulder County, Colorado

August 2015

Colorado Department of Public Health and Environment
Water Quality Control Division
4300 Cherry Creek Drive South
Denver, Colorado 80246

# TOTAL MAXIMUM DAILY LOAD (TMDL) ASSESSMENT
# Left Hand Creek Watershed
# Boulder County, Colorado
# July 2015

## TMDL SUMMARY

| | |
|---|---|
| Waterbody Names/Segment Numbers | Mainstem of Left Hand Creek and tributaries, from the source to immediately below the confluence with James Creek; COSPSV04a;<br>Mainstem of James and tributaries (including Little James Creek) from the source to Left Hand Creek; COSPSV04b<br>Mainstem of Left Hand Creek and tributaries, from immediately below the confluence with James Creek to Hwy 36; COSPSV04c |
| Pollutants/ Conditions Addressed | dissolved cadmium (Cd), dissolved copper (Cu), dissolved lead (Pb), dissolved zinc (Zn), pH |
| Affected Portions of Segments | COSPSV04a: pH, Cu, Zn (Highway 72 to James Creek)<br>COSPSV04b: Cu (James Creek above Little James Creek)<br>COSPSV04b: Cd, Cu, Pb, and Zn (Little James Creek)<br>COSPSV04b: Cd, Cu, Pb, and Zn (James Creek below Little James Creek)<br>COSPSV04c: Cu (James Creek to Highway 36) |
| Use Classifications (for all segments) | Aquatic Life Cold 1<br>Recreation E<br>Water Supply<br>Agriculture |
| Waterbody Designation | Reviewable |
| Water Quality Targets | Attainment of the Table Value Based Standards (TVS) for dissolved Cd, Cu, Pb, Zn, and pH. |

| WBID | Parameter | numeric criteria | |
|---|---|---|---|
| COSPSV04a | cadmium (µ/L)[1] | chronic | = (1.101672-[ln(hardness) x (0.041838)])*$e^{(0.7998[\ln(hardness)]-4.4451)}$ |
| | | acute | = (1.136672-[ln(hardness) x (0.041838)])*$e^{(0.9151[\ln(hardness)]-3.6236)}$ |
| | copper (µ/L) | chronic | = $e^{(0.8545[\ln(hardness)]-1.7428)}$ |
| | | acute | = $e^{(0.9422[\ln(hardness)]-1.7408)}$ |
| | zinc (µ/L) | chronic | = 0.986 $e^{(0.8525[\ln(hardness)]+0.9109)}$ |
| | | acute | = 0.978 $e^{(0.8525[\ln(hardness)]+1.0617)}$ |
| | pH (s.u.) | | 6.5 – 9.0 |
| COSPSV04b | cadmium (µ/L)[1] | chronic | = (1.101672-[ln(hardness) x (0.041838)])*$e^{(0.7998[\ln(hardness)]-4.4451)}$ |
| | | acute | = (1.136672-[ln(hardness) x (0.041838)])*$e^{(0.9151[\ln(hardness)]-3.6236)}$ |
| | copper (µ/L) | chronic | = $e^{(0.8545[\ln(hardness)]-1.7428)}$ |
| | | acute | = $e^{(0.9422[\ln(hardness)]-1.7408)}$ |
| | lead (µ/L) | chronic | = (1.46203-[(ln hardness)* (0.145712)])*$e^{(1.273[\ln(hardness)]-4.705)}$ |
| | | acute | = (1.46203-[ln(hardness)*(0.145712)])*$e^{(1.273[\ln(hardness)]-1.46)}$ |
| | zinc (µ/L) | chronic | = 0.986 $e^{(0.8525[\ln(hardness)]+0.9109)}$ |
| | | acute | = 0.978 $e^{(0.8525[\ln(hardness)]+1.0617)}$ |
| | pH (s.u.) | | 6.5 – 9.0 |
| COSPSV04c | copper (µ/L) | chronic | = $e^{(0.8545[\ln(hardness)]-1.7428)}$ |
| | | acute | = $e^{(0.9422[\ln(hardness)]-1.7408)}$ |

[1]acute cadmium standard adopted is intended to be protective of trout

| | |
|---|---|
| TMDL Goal | Protection of Aquatic Life Use through attainment of associated numeric water quality standards. |

## EXECUTIVE SUMMARY

This document presents Total Maximum Daily Loads (TMDLs) for three impaired segments of the Left Hand Creek Watershed near Jamestown, Colorado. The segments in the Left Hand Creek Watershed, Segments COSPSV04a, COSPSV04b, and COSPSV04c, are part of the Saint Vrain tributary system which is part of the South Platte River Basin. The Left Hand Creek Watershed is located northwest of the City of Boulder, Colorado within Boulder County. Little James Creek flows into James Creek which then flows into Left Hand Creek. This document was developed by the Water Quality Control Division, Colorado Department of Public Health and Environment and submitted to the U.S. Environmental Protection Agency (U.S. EPA) for approval. The Clean Water Act requires TMDLs for waterbodies that do not meet water quality standards. A TMDL is the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. The goal of the TMDL is to identify the pollutant reductions necessary for the waterbody to attain relevant water quality standards for those pollutants and to support designated uses.

These segments appeared on the 2010 and 2012 303(d) lists for non attainment of water quality standards. Segment COSPSV04a was listed for non-attainment of the Aquatic Life Use-based chronic standards for pH, dissolved copper, and dissolved zinc, as well as acute standards for dissolved copper and dissolved zinc. The pH standard also applies to the Recreation Use. Segment COSPSV04b is listed for non-attainment of Aquatic Life Use-based chronic standards for dissolved copper and dissolved lead. Due to changes to cadmium and zinc standards assigned to Segment COSPSV04b in 2010, TMDLs for these parameters have been revised. Segment COSPSV04c is listed for the non-attainment of Aquatic Life Use-based acute dissolved copper standards. The high concentration of metals, as well as low pH values, is primarily the result of historical mining activity and natural geologic conditions in the area. There are no active mines or mills currently operating in the Left Hand Creek Watershed. The Captain Jack Mine and Mill site within the Left Hand Watershed is listed on the Environmental Protection Agency's National Priorities List (NPL) for environmental clean-up.

TMDL

COSPSV04a

For COSPSV04a, the TMDLs require 67%-77% reduction in cadmium, 81%-98% reduction in copper, and 41%-88% reduction in zinc (Tables 11-13).

COSPSV04b

TMDLs were developed for three reaches in COSPSV04b: James Creek above Little James Creek (JC abv LJC), Little James Creek (LJC) and James Creek below Little James Creek (JC blw LJC).

For JC abv LJC, the TMDLs require 14%-50% reduction in cadmium, 35% to 41% reduction in copper, 62%-95% reduction in lead and 46%-90% reduction in zinc (Tables 14-17).

For LJC, the TMDLs require 72%-98% reduction in cadmium, 57%-99% reduction in copper, 54%-96% reduction in lead and 66%-99% reduction in zinc (Tables 18-21).

For JC blw LJC, the TMDLs require 21%-80% reduction in cadmium, 17%-90% reduction in copper, 37%-95% reduction in lead, and 47-88% reduction in zinc (Tables 22-25).

pH TMDL

Exceedances of the lower pH standard of 6.5 s.u. were observed in portions of Left Hand Creek, segment COSPSV04a, and Little James Creek, segment COSPSV04b. It is expected that remediation for the metals impairment (cadmium, copper, lead and zinc), by addressing sources of acid mine drainage, will result in attainment of the pH standard. Post-remediation monitoring can verify this assumption.

# 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 is a segment that does not meet the standards for its assigned use classification. The 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 (WQCC, 2012). For water bodies 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 TMDL is the sum of the Waste Load Allocation (WLA), which is the load from permitted and non-permitted 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

Alternatively, a segment or pollutant may be removed from the list if the applicable standard is attained, if implementation of clean-up activities via 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), or other EPA approved recalculation method.

Segments COSPSV04a, COSPSV04b and COSPSV04c of the Left Hand watershed were on the 2012 303(d) list for non-attainment of assigned water quality standards. The portion of Segment COSPSV04a from Highway 72 to James Creek originally was added to the 303(d) list in 2006 for non-attainment of pH, dissolved copper and zinc standards. Segment COSPSV04c, the portion of Left Hand Creek downstream of James Creek to Highway 36 was placed on the 2010 303(d) list for dissolved copper and arsenic. Arsenic will not be addressed in this TMDL assessment as there are insufficient data available to do a thorough analysis of this pollutant. A portion of Segment COSPSV04b, Little James Creek (tributary to James Creek), is listed due to non-attainment of copper and lead. TMDLs for cadmium, iron, manganese, zinc and pH were completed for Little James Creek in 2002. However, the standards for cadmium and zinc have been modified since 2002, therefore, TMDLs to address new cadmium and zinc standards for Little James Creek are included in this report. Although not identified on the 2010 or 2012 List, the portion of James Creek above its confluence with Little James Creek exceeds dissolved copper chronic standards. This portion also exceeds acute standards for dissolved copper, dissolved lead and dissolved zinc. Exceedances of cadmium, copper and zinc chronic standards and copper and zinc acute standards are documented in this analysis for James Creek within the reach from Little James Creek to Left Hand Creek.

The Environmental Protection Agency contracted with Tetra Tech, Inc. for the development of TMDLs for cadmium, copper, lead and zinc for those portions of the watershed not addressed in the previous TMDL document (2002). This report was

completed in 2008. EPA Region VIII has requested the Division to prepare this revision to the 2008 document so as to conform to current Region VIII guidelines.

## II. GEOGRAPHICAL EXTENT

The Left Hand Creek watershed lies northwest of the city of Boulder, Colorado, on the east slope of the Front Range of the Rocky Mountains. The watershed is a mixture of alpine and sub-alpine forest, agricultural land, and residential area. Most of the watershed lies within the Roosevelt National Forest. The water quality in Left Hand Creek, James Creek, and Little James Creek is affected by discharges from various mines, waste rock and mine tailings in the area. The drainage area encompasses the historical Captain Jack and Golden Age mining districts and receives runoff from a number of rock dumps, mill tailings, and abandoned mining sites. Figure 1 illustrates the relative locations of mining features in the upper watershed.

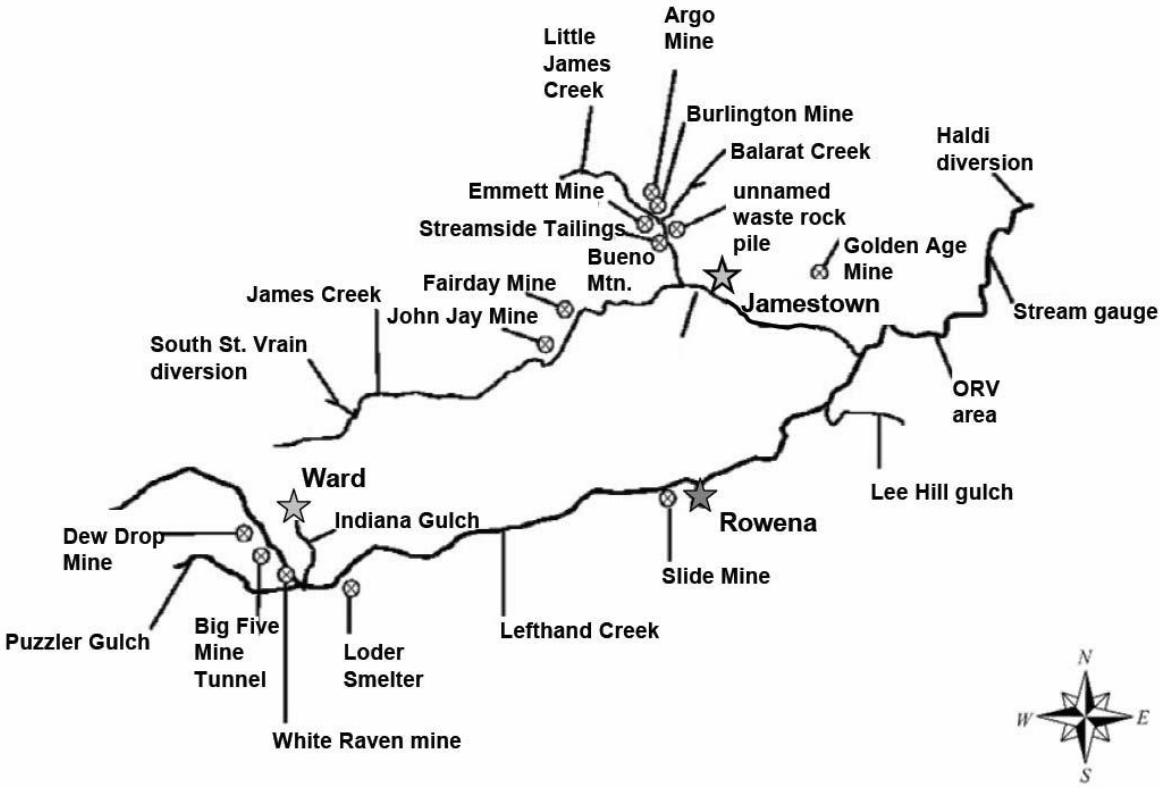


**Figure 1. Left Hand Creek Watershed Showing Significant Mining Features (source Bautts et.al., 2007)**

The Left Hand Creek watershed drains approximately 71.5 square miles and discharges to Saint Vrain Creek in Longmont, Colorado. The watershed area was delineated using the U.S. Geological Survey StreamStats program (U.S. Geological Survey, 2012). Left Hand Creek, James Creek, and Little James Creek are the only

perennial streams in the watershed. Little James Creek flows into James Creek, which flows into Left Hand Creek. The uppermost segment, COSPSV04a extends from the source of Left Hand Creek, north of Niwot Ridge, to a point immediately below the confluence with James Creek. There are a number of legacy mining features located along Left Hand Creek, most notably the Big Five Mine and Captain Jack Mill, a "Superfund" or "National Priorities List" (NPL) site. Note the absence of mining features below the Left Hand/James Creek confluence (Figure 1).

The James Creek watershed covers approximately 18.6 square miles from its source above the Peak-to-Peak Highway (Highway 72) near Ward, Colorado, to its confluence with Left Hand Creek (Figure 3). James Creek and its tributaries comprise segment COSPSV04b. The Golden Age Mining District contributes runoff to James Creek. James Creek and Little James Creek converge at the western edge of Jamestown. Jamestown's water supply intake is in James Creek upstream of the confluence with Little James Creek. The Little James Creek watershed area encompasses only about 3 square miles. Little James Creek is affected by abandoned mines (Evening Star, Argo, Burlington, and Emmit) and tailings sites (Streamside, Porphyry Mountain Waste Rock pile [formerly Joe Ryan Tailings (JRT)], and Bueno).

Left Hand Creek, James Creek, and Little James Creek are part of the St. Vrain Hydrologic Unit Code 10190005. The map below (Figure 2) illustrates the watersheds for each of the three segments addressed in this report.

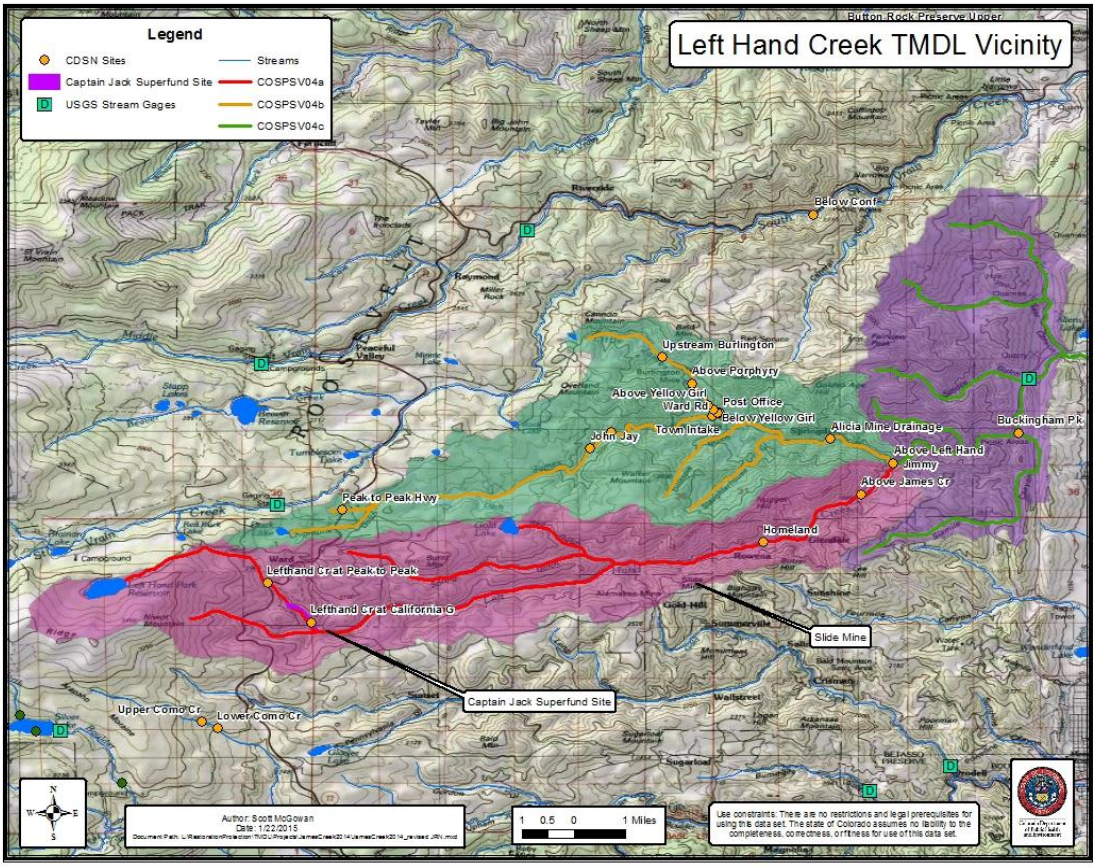


**Figure 2. Left Hand Creek (COSPSV04a, COSPSV04c) and James Creek (COSPSV04b) Watersheds**

The lowermost portion of the watershed extends from the James Creek confluence to the confluence with St. Vrain Creek. This reach is made up of two segments; COSPSV04c extends from the confluence with James Creek to Highway 36. At this point Left Hand Creek emerges from the mountainous topography of the eastern slope Rocky Mountains into the Great Plains. This transition is marked by the terminus between segment COSPSV04c and COSPSV05, which extends to the confluence with St. Vrain 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 2010), 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 water source 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 the "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*.

**Uses and Standards addressed in this TMDL**

The *Colorado Basic Standards and Methodologies for Surface Water*, Regulation 31, identifies water quality criteria potentially applicable for any surface water statewide (WQCC, 2013). The WQCC assigns specific numeric standards to a given water body based upon that water's classified uses. The segmentation of waters in the South Platte basin, and the relevant classified uses and assigned numeric standards, are detailed in *Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin and Smoky Hill River Basin*, Regulation 38 (WQCC, 2014). When the assigned standard is unchanged from the numeric criteria identified in the *Basic Standards and Methodologies for Surface Water* the standards are referred to as Table Value Standard (TVS). That is the case for the segments addressed in this TMDL report.

Table 1 identifies the classified uses and impairment status for each of the three segments addressed in this TMDL assessment.

| WBID | Segment Description | Aquatic Life cold 1 | Recreation E | Water Supply | Agriculture |
|---|---|---|---|---|---|
| COSPSV4a | Left Hand Creek, source to James Creek | impaired | impaired | attaining | attaining |
| COSPSV4b | James Creek, Little James Creek | impaired | attaining | attaining | attaining |

| | | | | | |
|---|---|---|---|---|---|
| COSPSV4c | Left Hand Creek, from confluence with James Creek to Highway 36 | impaired | attaining | attaining | attaining |

Table 1. Classified uses and impairment status for St. Vrain segments COSPSV04a, COSPSV04b, and COSPSV04c.

The pollutants of concern for the Left Hand Creek watershed include cadmium, copper, lead, zinc and pH. Several locations within the drainage exceed the Aquatic Life Use-based TVS for these pollutants. Aquatic Life Use-based standards for cadmium, copper, lead and zinc are expressed as the dissolved fraction of those metals.

Aquatic Life Use-based standards are two-part, and include both acute and chronic criteria. Chronic and acute standards are designed to protect against different ecological effects of pollutants (long term exposure to relatively lower pollutant concentrations vs. short term exposure to relatively higher pollutant concentrations). Chronic standards represent the level of pollutants that protect 95 percent of the genera from chronic toxic effects of metals. Chronic toxic effects include, but are not limited to, demonstrable abnormalities and adverse effects on survival, growth, or reproduction (WQCC 2014). Acute standards are intended to protect against outright mortality and represents one-half of the LC-50 that protects 95 percent of the genera in a waterbody from lethal effects.

The Aquatic Life Use-based metal standards included in this TMDL assessment are hardness-based. The toxicity of these metals decreases as hardness increases. The standards are calculated from hardness-based equations and the calculated standard for a particular metal is higher with higher hardness values. Attainment of Aquatic Life Use-based chronic metals standards is determined by comparing the existing or ambient quality (measured as the 85$^{th}$ percentile of the observed data) against the hardness-based standard calculated using the mean hardness. Attainment of Aquatic Life Use-based acute standards is evaluated by comparing the sample-specific acute standard against the observed sample value. The acute standard is calculated using sample-specific hardness. Data indicate non-attainment of an acute standard if the standard is exceeded more frequently than once in three years.

The Aquatic Life Use-based and Recreation Use-based standards for pH have the allowable range of values between 6.5 and 9.0 standard units (s.u.). Attainment of the pH standard is evaluated by comparing the existing or ambient quality as measure by the 15$^{th}$ and 85$^{th}$ percentiles of the observed data to the lower and upper pH standards of 6.5 and 9.0 s.u., respectively.

Table 2 lists the pollutants for which each segment is impaired, and the applicable numeric criteria. The listed segments are in attainment of numeric standards associated with the designated Water Supply and Agricultural Uses, as well as other numeric standards associated with Aquatic Life Uses.

| WBID | Parameter | numeric criteria | |
|---|---|---|---|
| COSPSV04a | cadmium (µ/L)[1] | chronic | = (1.101672-[ln(hardness) x (0.041838)])*$e^{(0.7998[\ln(hardness)]-4.4451)}$ |
| | | acute | = (1.136672-[ln(hardness) x (0.041838)])*$e^{(0.9151[\ln(hardness)]-3.6236)}$ |
| | copper (µ/L) | chronic | = $e^{(0.8545[\ln(hardness)]-1.7428)}$ |
| | | acute | = $e^{(0.9422[\ln(hardness)]-1.7408)}$ |
| | zinc (µ/L) | chronic | = 0.986 $e^{(0.8525[\ln(hardness)]+0.9109)}$ |
| | | acute | = 0.978 $e^{(0.8525[\ln(hardness)]+1.0617)}$ |
| | pH (s.u.) | | 6.5 – 9.0 |
| COSPSV04b | cadmium (µ/L)[1] | chronic | = (1.101672-[ln(hardness) x (0.041838)])*$e^{(0.7998[\ln(hardness)]-4.4451)}$ |
| | | acute | = (1.136672-[ln(hardness) x (0.041838)])*$e^{(0.9151[\ln(hardness)]-3.6236)}$ |
| | copper (µ/L) | chronic | = $e^{(0.8545[\ln(hardness)]-1.7428)}$ |
| | | acute | = $e^{(0.9422[\ln(hardness)]-1.7408)}$ |
| | lead (µ/L) | chronic | = (1.46203-[(ln hardness)* (0.145712)])*$e^{(1.273[\ln(hardness)]-4.705)}$ |
| | | acute | = (1.46203-[ln(hardness)*(0.145712)])*$e^{(1.273[\ln(hardness)]-1.46)}$ |
| | zinc (µ/L) | chronic | = 0.986 $e^{(0.8525[\ln(hardness)]+0.9109)}$ |
| | | acute | = 0.978 $e^{(0.8525[\ln(hardness)]+1.0617)}$ |
| | pH (s.u.) | | 6.5 – 9.0 |
| COSPSV04c | copper (µ/L) | chronic | = $e^{(0.8545[\ln(hardness)]-1.7428)}$ |
| | | acute | = $e^{(0.9422[\ln(hardness)]-1.7408)}$ |

[1]acute cadmium standard adopted is intended to be protective of trout

Table 2. Impaired parameters and relevant numeric standards for St. Vrain segments COSPSV04a, COSPSV04b, and COSPSV04c.

## IV. PROBLEM IDENTIFICATION

### Background

Located at the northern tip of the Colorado Mineral Belt, the watershed drains mainly Precambrian metamorphic and igneous formations and glacial and alluvial deposits. The watershed terrain is about one-half alpine and sub-alpine forest and one-half agricultural and urban on the high plains east of the Front Range of the Rocky Mountains. Metal loading and depressed pH within the Left Hand Creek Watershed result from both natural geologic conditions and historic (unpermitted) mining activities. Legacy mining features include draining mine adits, waste rock piles and tailing (fine waste material remaining after the processing of metals). Tailing materials were typically deposited adjacent to or directly down-gradient of milling operations. Although active mining ceased some time ago, the discharge of pollutants through the direct discharge of seepage from the mine workings and more diffuse transport via snowmelt or precipitation continue today.

There are a number of completed and on-going remedial efforts taking place within the watershed. The document *Assessment of Metal Contamination in Sediments and Waste Rock Piles in the Left Hand Creek Watershed, Northwestern Boulder County, Colorado, 2005-2007* (Bautts et.al., 2007) includes a comprehensive summary of work that had been undertaken prior to that point:

> *Remediation has been completed or is underway at a number abandoned mine sites in the watershed, including the Captain Jack Mine and Mill, the Burlington Mine, the Slide Mine, the "stream-side tailings," the Bueno Mine tailings, the Fairday Mine, the Golden Age Mine, the Evening Star Mine, the Argo Mine, and the Porphyry Mountain tailings.*
>
> *The Captain Jack Mine and Mill is an EPA Superfund site (includes the Big Five Tunnel drainage, the Blackjack Mine, the Captain Jack mill, and the White Raven Mine) located just south of the town of Ward along a segment of Left Hand Creek referred to locally as "California Gulch." The site was listed on the states National Priority List (NPL) in September, 2003. The draft remedial investigation and feasibility study was completed in April, 2006, and rehabilitation of the Big Five Tunnel was accomplished during the winter of 2006 and spring of 2007.*
>
> *The Burlington Mine is located along Little James Creek one mile north of Jamestown. This site was listed as a Voluntary Clean-Up Program (VCUP) site in April, 2002, and remediation of the Burlington Mine was completed in December, 2004. The remediation and VCUP listing was initiated by Honeywell, Inc., the private owner.*
>
> *The Bueno Mine tailings and the "stream-side tailings," located just west of Jamestown, were remediated by the U.S. Forest Service and the EPA's Emergency Response program. Jamestown is surrounded by steep eroding slopes and recently experienced mudslides in the early summer of 2005. Bueno Mountain resides just above Jamestown and the potential exists for the release of toxic metals during a rain storm or rapid snowmelt.*
>
> *The U.S. Forest Service has completed a reclamation project at the Fairday Mine on James Creek west of Jamestown and is restoring the Golden Age Mine, which is located northeast of Jamestown, during the summer of 2006.*
>
> *Boulder County has completed remediation of waste rock piles at the Evening Star and Argo Mine properties located on the Little James Creek just west of the Burlington Mine using an EPA Brownfields Cleanup Grant.*

Following is a summary of restoration projects completed, or in progress subsequent to the 2007 Bautts report summarized above:

The Slide Mine restoration was completed under VCUP in 2007 (G. Patterson, personal communication, May 2015).

With the assistance of Nonpoint Source Section 319 funds from the Colorado Nonpoint Source Program, the James Creek Watershed Initiative (JCWI), a stakeholder group, completed the remediation of a waste rock pile adjacent to Little James Creek below Porphyry Mountain during the fall of 2011.

The Town of Jamestown used a Brownfields grant to stabilize a tailings deposit in Jamestown on the west bank of James Creek. The tailings were capped, graded and revegetated, turning it into a city park (Elysian Park). This work was completed during 2011.

Under the oversight of CDPHE and EPA, a surface remediation of the Captain Jack site was completed in November 2012, including consolidation and stabilization of waste rock piles, diversion of surface runoff around waste rock piles, revegetation, and other actions. A subsurface remediation project on the Big Five tunnel is planned but has not been started (G. Patterson, personal communication, May 2015).

Although the VCUP at the Burlington site was completed as planned, the site has not been fully remediated. A pond on the site, filled with drainage water from an adit, was not part of the VCUP restoration plan and still discharges mine-related runoff to Little James Creek (G. Patterson, personal communication, May 2015).

In September 2013, extensive flooding occurred in many parts of the South Platte Basin, including the Left Hand watershed. Although the damage resulting from the flood was devastating, the effects on metals impairments are unknown at this time. The assessment in this report is based on data collected prior to the 2013 flood.

### Discharge Permits

The Captain Jack Mine site was the only permitted point source in the Left Hand Creek watershed, however the site is not currently permitted. The Captain Jack site and numerous other pollutant sources, such as waste rock piles, tailings and mine dumps, are considered to be non-permitted point sources. As such, Waste Load Allocations were developed for these sources. Other, diffuse sources and contributions of metals from upstream of the mining impacted areas are considered non-point or background sources and are addressed in the Load Allocation term of a TMDL.

## Water Quality Impairment

Colorado's 1998 Section 303(d) list indicated that the numeric water quality standards for cadmium, iron, manganese, zinc, and pH were not attained in Little James Creek. By 2002, the WQCD completed, and EPA approved, TMDLs addressing these pollutants. In 2006, Left Hand Creek, segment COSPSV04a, was added to the 303(d) list for impairments due to copper, zinc, and pH. Also in 2006, Little James Creek (COSPSV04b) was re-listed for impairments due to copper and lead. In 2010, Left Hand Creek, segment COSPSV04c, was added to the 303(d) list for impairments due to copper (acute) and arsenic (chronic). As previously stated, this report does not address a TMDL for arsenic. These listings remained unchanged on subsequent 303(d) lists.

In the development of the 303(d) lists, data from multiple sites within a reach were pooled for assessments. For Segment COSPSV04a, four reaches were assessed: Left Hand Creek from Highway 72 to the Captain Jack Mine, Left Hand Creek from the Captain Jack Mine to the Slide Mine, Left Hand Creek from the Slide Mine to James Creek. For segment COSPSV04b, the assessment was based on James Creek and Little James Creek combined data. However, the listing only identifies the portion of Little James Creek as impaired. For Segment COSPSV04c, sites from the reach from Left Hand Creek from James Creek to Highway 36 were pooled and assessed. Table 3 summarizes the assessments from the 2012 303(d) List. The hardness values shown are mean values for the entire dataset for each assessed reach. The period of record was from 2001-2004.

| **Segment** | **Assessed Reach** | **Hardness** mg/L (n) | **Cadmium** µg/l (n) | | **Copper** µg/l (n) | | **Lead** µg/l (n) | | **Zinc** µg/l (n) | | **pH** s.u. (n) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **std** | **amb** | **std** | **amb** | **std** | **Amb** | **Std** | **amb** | **std** | **amb** |
| COSPSV04a | Left Hand Creek from Hwy 72 to the Captain Jack Mine | 18.6 (3) | 0.6 | 0.0 (8) | **2.1** | **3.96 (18)** | 0.4 | 0.32 (16) | **28.4** | **37.8 (16)** | **6.5-9.0** | **5.3-6.0 (11)** |
| COSPSV04a | Left Hand Creek from the Captain Jack Mine to Slide Mine | 39.8 (35) | 1.1 | 0.97 (20) | **4.1** | **25.1 (125)** | 0.9 | 0.44 (118) | **54.1** | **256 (121)** | **6.5-9.0** | **5.0-6.0 (92)** |
| COSPSV04a | Left Hand Creek from Slide Mine to James Creek | 54.1 (22) | 1.4 | 0.06 (19) | **5.3** | **7.08 (57)** | 1.3 | 0.19 (56) | **70.2** | **36.8 (55)** | **6.5-9.0** | **6.2-7.5 (32)** |
| COSPSV04b | James Creek, Little James Creek | 61.53 (109) | **0.29** | **1.69 (105)** | **5.91** | **13.04 (99)** | **1.48** | **2.11 (107)** | **82.16** | **365.9 (105)** | 6.6 | 6.6-7.7 |
| COSPSV04c | Left Hand Creek from James Creek to Hwy 36 | 60.6 (23) | 0.29 | 0.0 (30) | 5.84 | 4.9 (114) | 1.45 | 0.3 (34) | 81.1 | 29.2 (37) | 6.5-9.0 | 7.2-8.2 (106) |

Table 3. Attainment Summary for Chronic Table Value Standards, 2012 303(d) List Rationales. Exceedances of standards are shown in bold-face type.

As shown in Table 3, segment COSPSV04a exhibited non-attainment of chronic water quality standards for pH, dissolved copper and dissolved zinc throughout the

segment, although the severity of the impairments varied. The reach of Left Hand Creek from the Captain Jack Mine to the Slide mine exhibited the greatest degree of impairment. The concentration of pollutants downstream from this reach shows some attenuation, either from dilution from inflowing waters or from the pollutants settling out of the water column. Segment COSPSV04b showed impairments for cadmium, copper, lead and zinc. The data for segment COSPSV04c, Left Hand Creek from James Creek to Highway 36 showed attainment of all chronic standards, however, this segment was listed as impaired for exceedances of the acute standards for copper.

## WATER QUALITY GOALS

Segment COSPSV04a, COSPSV04b, and COSPSV04c are classified for the Aquatic Life Cold 1, Recreation E, Water Supply and Agriculture uses. The goal of this TMDL is attainment of the standards for which the segments are impaired in order to attain of the assigned aquatic life use designations for these segments. Attainment of the numeric water quality standards that are protective of the aquatic life use designation should result in restoration of these waterbodies. Attainment of the table value based standards is protective of all assigned beneficial uses, including Aquatic Life Use.

POLLUTANT SOURCE ANALYSIS

## VII. SOURCE ANALYSIS

Numerous studies have been performed intending to identify and quantify the sources of metals loading within the Left Hand Creek watershed. In the 1980s, EPA site assessment activities revealed significant impacts to fisheries and wetlands from the discharges of metal-contaminated water from the major abandoned mining and milling areas of Captain Jack, adjacent to the town of Ward, the Slide Mine and Mill, downhill from Gold Hill and adjacent to Rowena and from the numerous abandoned mines and mills of the Jamestown area, on Little James and James Creeks, tributaries to Left Hand Creek.

The Division, in 1991, completed the *Little James Creek and James Creek Nonpoint Source Study* (WQCD, 1991). In addition to synoptic sampling performed by the Division the report also incorporated the results of ambient toxicity testing and fish population studies.

Subsequently, EPA contracted with URS Consultants, Inc. and Morrison Knudson Corporation to undertake a series of site evaluations within the watershed. These focused primarily on the Captain Jack Mill site located along upper Left Hand Creek and the Golden Age mine on James Creek.

On September 29, 2003 the Captain Jack Mill site (including the Big Five Tunnel drainage, the Blackjack Mine, the Captain Jack mill, and the White Raven Mine) was included on the National Priorities List for remediation under auspices of EPA's Superfund Program. Although the Captain Jack Mill site represented the largest potential source of metals loading within the watershed, there were a substantial number of additional sources not included in the NPL Listing.

Additional study reports include a thesis entitled *Characterization and prioritization of mining-related metals sources with metal loading tracer dilution tests, and a review of regulations and mine restoration funding resources, Left Hand Creek watershed, Northwestern Boulder County, Colorado* (Wood, 2004) and the document *Assessment of Metal Contamination in Sediments and Waste Rock Piles in the Left Hand Creek Watershed, Northwestern Boulder County, Colorado, 2005-2007* (Bautts et.al., 2007). These studies cumulatively demonstrate the wide scale nature of diffuse pollutant loading sources in the watershed.

## AMBIENT WATER QUALITY

### Data

The data used in development of this TMDL report included the data sets from the original 303(d) listing assessments as well as additional, more recently collected

data. These data were collected by the University of Colorado, EPA, Riverwatch and the Water Quality Control Division. Riverwatch data were obtained from the Colorado Data Sharing Network. The University of Colorado and EPA conducted synoptic sampling events in the watershed in 2003 and 2004. Riverwatch collected data from four sites on Left Hand Creek, five sites on James Creek, four sites on Little James Creek (2000-2013). The Water Quality Control Division collected data on Left Hand Creek, James Creek and Little James Creek during (2001, 2007-2008). The period of record for this extended data set was then limited to 2000-2013.

Data were assessed according to the methodology identified in the 303(d) Listing Methodology as described in the section on standards above. In addition, the data were assessed at a more refined spatial and temporal scale to identify the areas with the greatest degree of impairment as defined by the highest concentrations of pollutant, as well as the times when exceedances are observed. This ensures that the resulting TMDL is protective of the stream uses throughout the entire segment as well throughout the entire year. This refined scale of evaluation also informs future implementation.

Not all sites were sampled in all months and in all years. Some sample results were missing hardness values. In these cases, the average hardness value for the sample month was used. If no sample results for a particular month were available, the average for adjacent months was used.

In instances where analytical results were reported at less than detect, as with the cadmium, copper and lead datasets, the Water Quality Control Division typically assigns “0” for less than detection reports. This is the approach used in this report. The rationale for replacing “less than detects” with “0” is that the hardness values are so low that the hardness-based standards are below the detection limit, and in some cases below one-half the detection limit. Replacing the less than detects with the detection limit or one-half the detection limit would result in standards being exceeded, even at the background sites. While this might be more conservative, it probably is extremely over-protective. Therefore, the approach used in this TMDL is consistent with the division’s approach for assessing data.

Water quality data from sites upstream of mining impacts were evaluated to determine natural background conditions. Water quality data for the upper site on Left Hand Creek, Left Hand Creek at Peak to Peak, was used to represent background conditions. The 85$^{th}$ percentile was less than detect for cadmium, copper and lead. The 85$^{th}$ percentile for zinc was 6.52 µg/L.

Table 4 summarizes the assessment of the dataset for attainment of the chronic standards. In following sections, each segment or portion of the segment is evaluated in greater detail. The reaches assessed for Segment COSPSV04a were described slightly differently than in the 303(d) listing assessment. These reaches were Left Hand Creek at the Peak to Peak Highway, Left Hand Creek upstream of California Gulch, Left Hand Creek from California Gulch to the Slide mine, and Left

Hand Creek from the Slide Mine to James Creek. For segment COSPSV04b, the Division noted that portions of James Creek were also impaired. Therefore, segment COSPSV04b was divided into three specific reaches: Little James Creek (LJC), James Creek above the confluence with Little James Creek (JC abv LJC), and James Creek below the confluence with Little James Creek (JC blw LJC). The data for segment COSPSV04c showed attainment of the chronic standard for cadmium, copper, lead, and zinc.

| Segment | Assessed Reach | Hardness mg/L (n) | Cadmium µg/l (n) | | Copper µg/l (n) | | Lead µg/l (n) | | Zinc µg/l (n) | | pH s.u. (n) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | std | amb | std | amb | std | amb | Std | amb | std | amb |
| COSPSV04a | Left Hand Creek at Peak to Peak Highway | 14 (12) | 0.095 | 0 (12) | 1.64 | 0 (12) | 0.28 | 0 (12) | 22.9 | 7 (12) | 6.5-9.0 | **6.2**-7.1 (4) |
| COSPSV04a | Left Hand Creek upstream California Gulch | 19 (19) | 0.120 | 0 (8) | 2.15 | **4** (18) | 0.40 | 0 (8) | 30 | **38** (16) | 6.5-9.0 | **5.3-6.0** (11) |
| COSPSV04a | Left Hand Creek from California Gulch to Slide Mine | 30 (143) | 0.171 | **0.974** (32) | 3.2 | **32** (137) | 0.66 | 0 | 44.6 | **257** (133) | 6.5-9.0 | **5.0-6.0** (96) |
| COSPSV04a | Left Hand Creek from Slide Mine to James Creek | 41 (88) | 0.214 | 0.097 (32) | 4.1 | **8** (83) | 0.94 | 0 (4) | 57.6 | 35 (81) | 6.5-9.0 | **6.2**-7.5 (52) |
| COSPSV04b | James Creek above Little James Creek | 14.2 (167) | 0.10 | 0.0 (4162) | 1.69 | **1.79** (162) | 0.28 | 0.0 (162) | 23.49 | 12.3 (159) | 6.5-9.0 | 7.3-7.7 (154) |
| COSPSV04b | Little James Creek | 177 (197) | 0.65 | **3.79** (188) | 14.61 | **34.1** (190) | 4.67 | **13.3** (190) | 202.5 | **874.8** (189) | 6.5-9.0 | **5.7**-6.7 (159) |
| COSPSV04b | James Creek below Little James Creek | 21.6 (49) | 0.13 | **0.23** (40) | 2.42 | **5.23** (43) | 0.46 | 0.0 (45) | 33.7 | **36.95** (43) | 6.5-9.0 | 6.7 (43) |
| COSPSV04c | Left Hand Creek from James Creek to Hwy 36 | 75 (61) | 0.34 | 0.0 (29) | 5.7 | 2.7 (57) | 1.84 | 0.0 (28) | 97.6 | 47.56 (29) | 6.5-9.0 | 7.0-7.4 (47) |

Table 4. Attainment Summary for Chronic Table Value Standards. (POR=2001-2013) Exceedances are shown in bold type.

## Acute Standards

Table 5 identifies attainment status for acute standards for the waterbodies in this TMDL report. Attainment of Aquatic Life Use-based acute standards is evaluated by comparing the sample specific acute standard against the sample value. In other words, the acute standard is calculated for each individual sample and the sample result is compared to the calculated acute standard. According to the *Section 303(d) Listing Methodology, 2012 Listing Cycle* multiple exceedances of acute standards (for a given parameter) within a three year period are evidence of impairment. Exceedance of acute standards also triggered more detailed evaluation of the data.

| WBID | Segment | cadmium | copper | lead | Zinc |
|---|---|---|---|---|---|
| COSPSV04a | Left Hand Creek, Hwy 72 to James Creek | attain | 170/250 | attain | 103/242 |
| COSPSV04b | James Creek, source to Little James Creek | attain | 25/162 | 3/162 | 17/159 |
| COSPSV04b | Little James Creek, source to James Creek | 41/188 | 83/190 | 13/190 | 131/189 |
| COSPSV04b | James Creek, Little James Creek to Left Hand Creek | attain | 13/43 | attain | 5/43 |
| COSPSV04c | Left Hand Creek, from confluence with James Creek to Highway 36 | attain | attain | attain | Attain |

Table 5. Summary of Aquatic Life Use-based Acute Standard Attainment, no. exceedances/no. samples

## COSPSV04a

Left Hand Creek at Peak to Peak Highway is upstream from known mining influences. This site showed attainment of the dissolved cadmium, dissolved copper, dissolved lead and dissolved zinc standards. However, the lower pH standard of 6.5 was exceeded (Table 4). Data from this site was used for the purpose of establishing a background condition for calculating pollutant loads for metals.

With respect to Aquatic Life Use-based chronic TVS, Segment COSPSV04a Left Hand Creek did not attain cadmium, copper, and zinc standards in the reaches below the Peak to Peak Highway. The lower pH standard of 6.5 s.u. also was exceeded. The creek exceeded the chronic cadmium standard from California Gulch to the Slide mine, but showed attainment from the Slide mine to James Creek. Copper, as well as pH were exceeded as far downstream as the confluence with James Creek. The creek exceeded the zinc standard in the two reaches below the Peak to Peak Highway, but in the lower reach, from the Slide Mine to James Creek, Left Hand Creek zinc concentrations decreased dramatically and attained the standards. Figures 3, 4 and 5 illustrate the spatial patterns for cadmium, copper and zinc, respectively. The figures show the sites in an upstream to downstream order. The reach from California Gulch to the Slide mine exhibited the greatest impairment for all four pollutants.

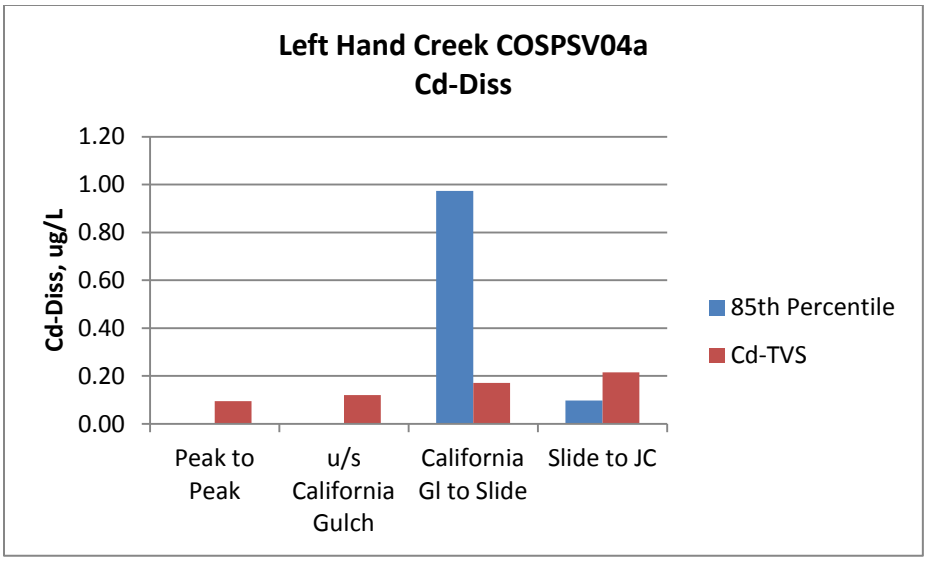


Figure 3. Left Hand Creek dissolved cadmium by reach. Ambient data represented as 85th percentiles.

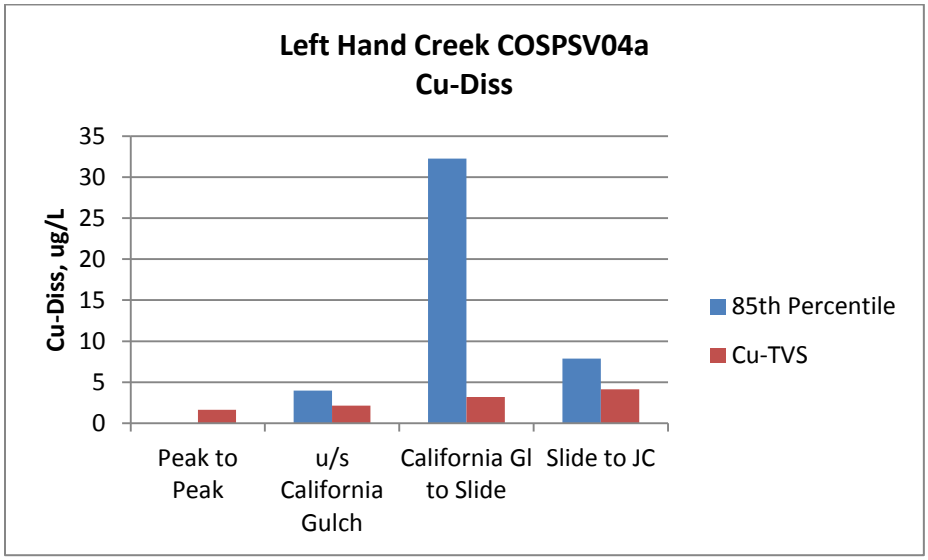


Figure 4. Left Hand Creek dissolved copper by reach. Ambient data represented as 85th percentiles.

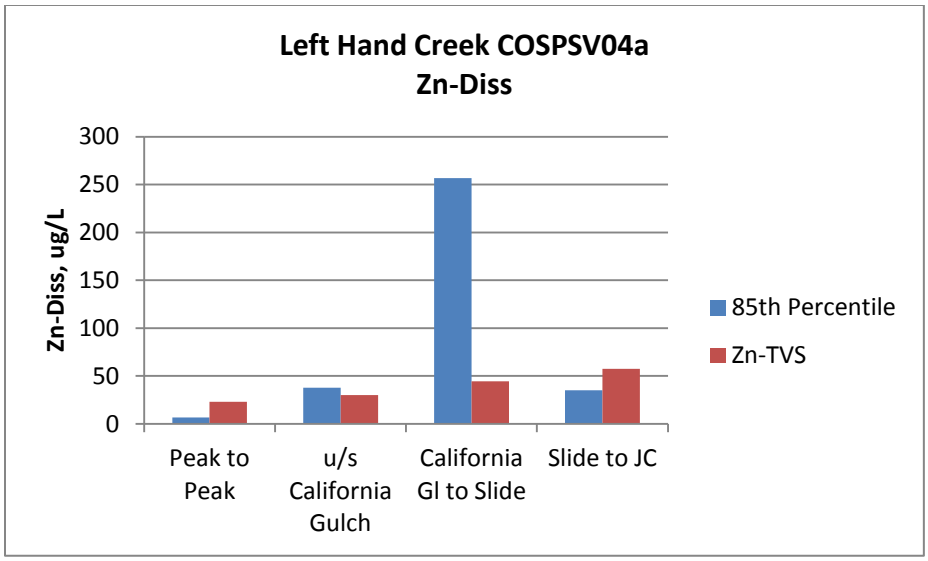


Figure 5. Left Hand Creek dissolved zinc by reach. Ambient data represented as 85th percentiles.

Because the reach from California Gulch to the Slide mine showed the highest concentrations for cadmium, copper and zinc, this reach was examined in more detail temporally (Figures 6-8). When evaluated on a monthly basis, exceedances of copper were observed in all months. Cadmium and zinc standards were exceeded in all months except October.

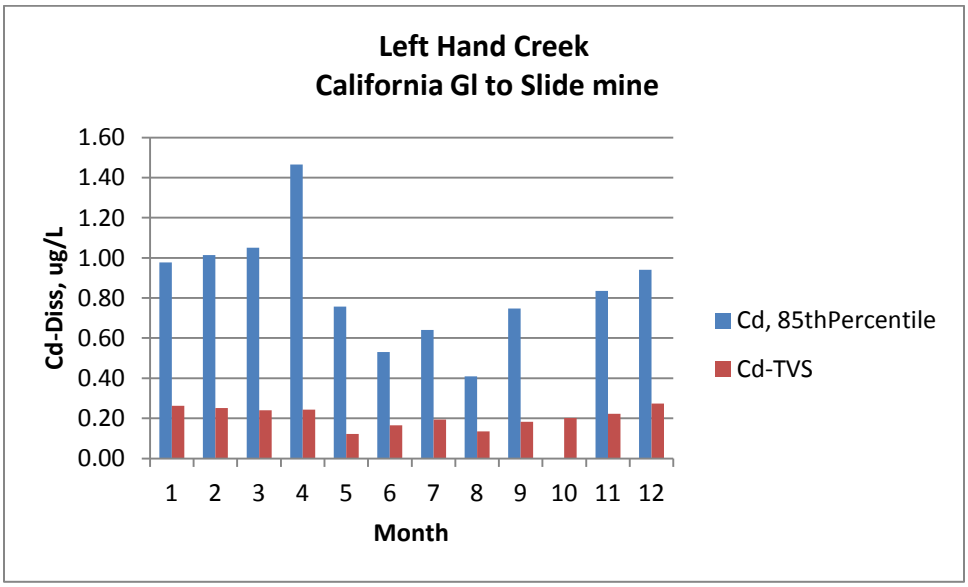


Figure 6. Left Hand Creek, California Gl to Slide mine dissolved cadmium by month. Ambient data represented as 85th percentiles.

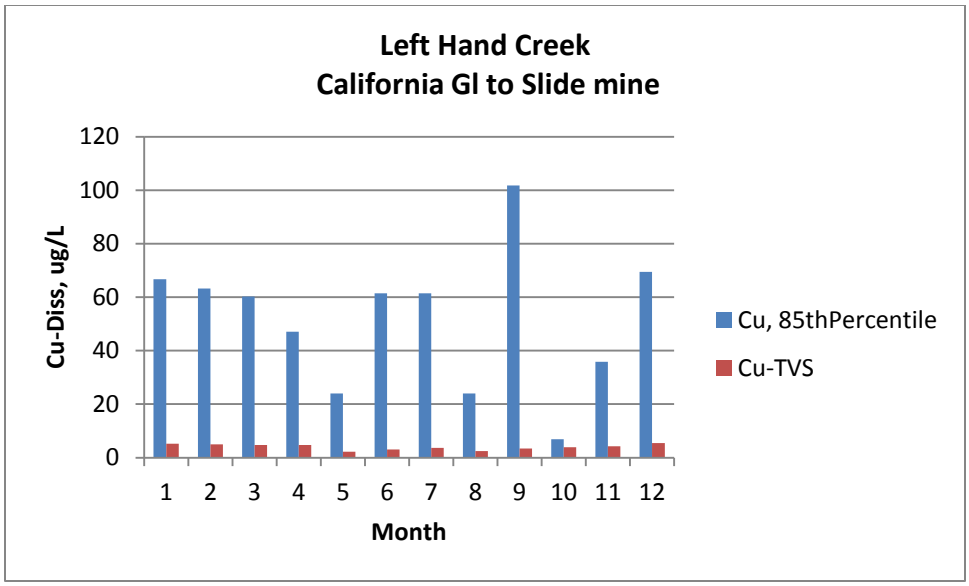


Figure 7. Left Hand Creek, California Gl to Slide mine dissolved copper by month. Ambient data represented as 85th percentiles.

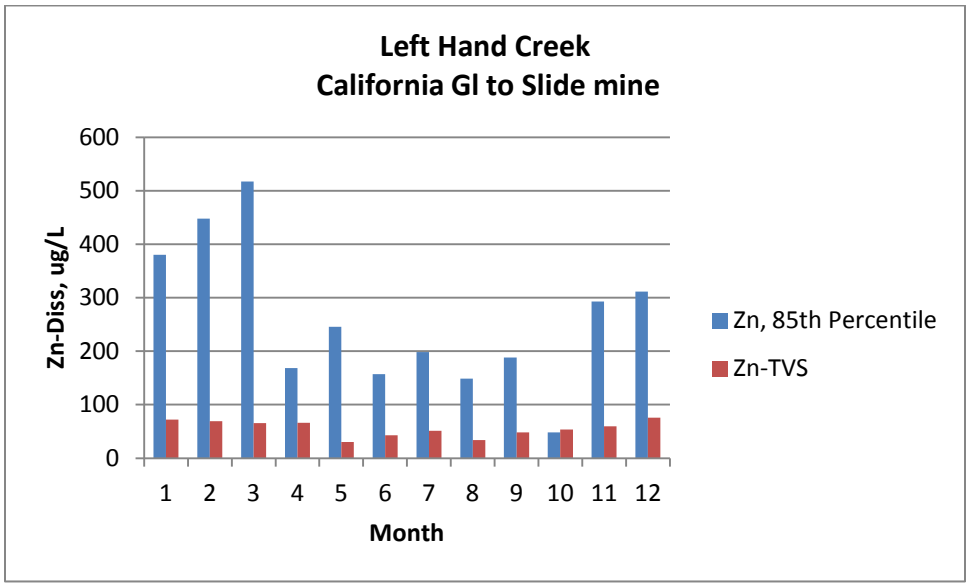


Figure 8. Left Hand Creek, California Gl to Slide mine dissolved zinc by month. Ambient data represented as 85th percentiles.

Acute Standards

In addition to exceedances of the chronic standards for copper and zinc, segment COSPSV04a exceeds acute standards for these pollutants (Table 5).

Development of the TMDL for this segment is focused on the reach from California Gulch to the Slide mine because this reach showed the greatest degree of impairment. The water quality characteristics for the pollutants of concern for this reach are presented in tabular form in Table 6. In addition to the exceedances of the

metals standards, the pH standard was exceeded for all months for which data were available.

| Month | Hardness Mean (mg/L) | n= | Cd, 85th Percentile (ug/L) | Cd-TVS | n= | Cu, 85th Percentile (ug/L) | Cu-TVS | n= | Zn, 85th Percentile (ug/L) | Zn-TVS | pH 15th Percentile (s.u.) | pH TVS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 53* | 0 | **0.98*** | **0.26** | 0 | **67*** | **5.21** | 0 | **380.3*** | **72.3** | | 6.5 |
| Feb | 50* | 0 | **1.01*** | **0.25** | 0 | **63*** | **4.95** | 0 | **448.0*** | **68.8** | | 6.5 |
| Mar | 47 | 10 | **1.05** | **0.24** | 11 | **60** | **4.70** | 11 | **517.0** | **65.3** | **5.8** | 6.5 |
| Apr | 48 | 2 | **1.47** | **0.24** | 9 | **47** | **4.76** | 9 | **168.5** | **66.1** | **6.2** | 6.5 |
| May | 19 | 7 | **0.76** | **0.12** | 74 | **24** | **2.19** | 73 | **245.6** | **30.5** | **5.7** | 6.5 |
| Jun | 29 | 1 | **0.53** | **0.17** | 1 | **61** | **3.09** | 1 | **156.8** | **43.0** | | 6.5 |
| Jul | 35 | 1 | **0.64** | **0.19** | 1 | **62** | **3.68** | 1 | **198.4** | **51.2** | | 6.5 |
| Aug | 22 | 1 | **0.41** | **0.13** | 1 | **24** | **2.44** | 1 | **148.9** | **34.0** | | 6.5 |
| Sept | 33 | 2 | **0.75** | **0.18** | 2 | **102** | **3.45** | 2 | **188.3** | **47.9** | | 6.5 |
| Oct | 37 | 1 | 0.00 | 0.20 | 14 | **7** | **3.86** | 11 | 48.2 | 53.7 | **4.7** | 6.5 |
| Nov | 42 | 6 | **0.84** | **0.22** | 23 | **36** | **4.30** | 23 | **292.7** | **59.7** | **4.9** | 6.5 |
| Dec | 56 | 1 | **0.94** | **0.27** | 1 | **70** | **5.46** | 1 | **312** | **75.8** | **6.3** | 6.5 |

Table 6. Ambient water quality (denoted as "85th percentile") and TVS in COSPSV04a, California Gl to Slide mine.
*No data, used average of adjacent months
**Bold type indicates exceedances**

COSPSV04b

The James Creek portion of segment COSPSV04b was not identified as impaired on the Colorado 2010 and 2012 303(d) Lists, although its tributary, Little James Creek, was identified as impaired. In the development of this TMDL report, data for segment COSPSV04b were examined for discrete reaches: Little James Creek (LJC), James Creek above the confluence with Little James Creek (JC abv LJC), and James Creek below the confluence with Little James Creek (JC blw LJC).

<u>James Creek above the confluence with Little James Creek (JC abv LJC)</u>

James Creek above the confluence with Little James Creek was not included on the 2012 Section 303(d) List. When data from all sites from this portion of James Creek are pooled and assessed, the creek exceeded the chronic standard for dissolved copper. This portion of James Creek also exceeded the acute standards for dissolved copper, dissolved lead and dissolved zinc. Data for these pollutants were evaluated spatially by calculating the ambient water quality for each pollutant at each site. Figures 9-11 illustrate the spatial patterns for these pollutants. The figures show the sites in an upstream to downstream order. Although the stream as a whole only

showed impairments for chronic standards for copper, when evaluated spatially, chronic impairments for both copper and zinc were observed at the site named Cushman Bark. The data for lead did not show a spatial pattern of exceedances of the chronic standards.

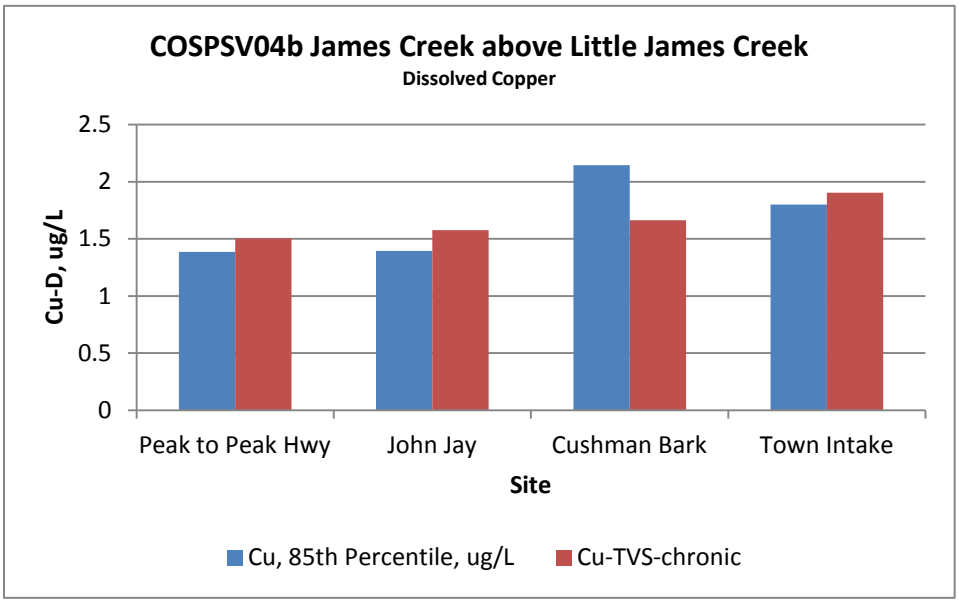


Figure 9. JC abv LJC dissolved copper by site. Ambient data represented as 85th percentiles.

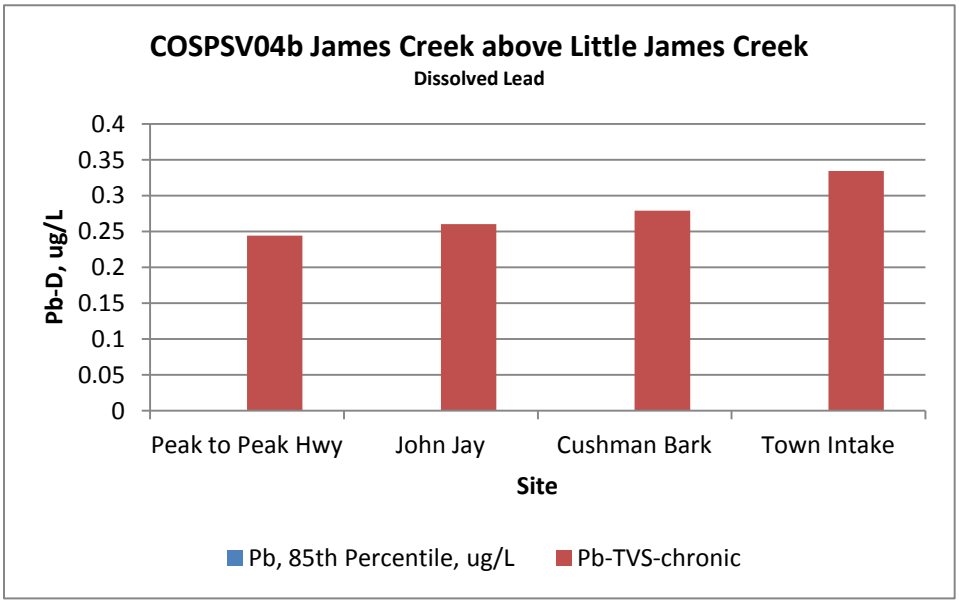


Figure 10. JC abv LJC dissolved lead by site. Ambient data represented as 85th percentiles.

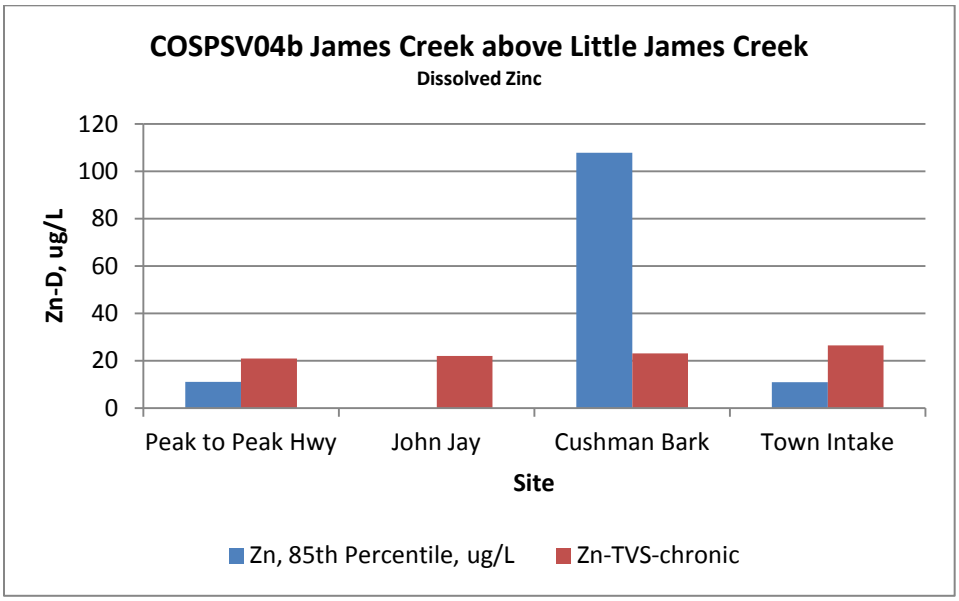


Figure 11. JC abv LJC dissolved zinc by site. Ambient data represented as 85th percentiles.

When the data were examined on a monthly basis, exceedances of the Aquatic Life Use-based chronic standards for copper, lead and zinc were observed (Table 7). Because the stream also showed exceedances of the acute standards for these pollutants, the data were evaluated on a seasonal basis by comparing the monthly ambient quality (85th percentile) to the monthly standard for each pollutant. The monthly water quality and associated chronic standards for each pollutant are presented in Table 7. For the monthly analysis of copper and zinc, the data from Cushman Bark were used because this site showed the greatest impairment. For the monthly analysis of lead, data from Town Intake were used because this site showed the most monthly exceedances of the chronic lead standard.

| Month | n= | Hardness mean, (mg/L) | n= | Cu, 85th Percent-ile, ug/L | Cu-TVS-chronic | n= | Zn, 85th Percent-ile, ug/L | Zn-TVS-chronic | n= | Pb, 85th Percent-ile, ug/L | Pb-TVS-chronic |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 3 | 19.3 | 3 | 1.5 | 2.2 | 3 | **259.1** | **30.6** | 5 | **2.4** | **0.44** |
| Feb | 2 | 20.0 | 2 | 0.0 | 2.3 | 2 | 9.4 | 31.5 | 4 | **1.2** | **0.46** |
| Mar | 1 | 16.0 | 1 | 0.0 | 1.9 | 0 | 18.6 | 26.1 | 4 | 0.0 | 0.51 |
| Apr | 7 | 19.7 | 7 | **2.5** | **2.2** | 7 | **146.9** | **31.1** | 7 | **7.3** | **0.54** |
| May | 5 | 10.6 | 5 | **2.6** | **1.3** | 4 | **99.7** | **18.3** | 6 | **0.7** | **0.21** |
| Jun | 3 | 7.3 | 3 | **1.3** | **1.0** | 3 | 2.5 | 13.4 | 5 | **3.1** | **0.14** |
| Jul | 3 | 7.3 | 3 | 0.9 | 1.0 | 3 | **68.5** | **13.4** | 3 | 0 | 0.15 |
| Aug | 5 | 10.0 | 4 | **1.5** | **1.3** | 4 | **40.4** | **17.5** | 5 | 0 | 0.18 |
| Sept | 4 | 12.5 | 4 | 0.0 | 1.5 | 4 | **119.6** | **21.1** | 4 | 0 | 0.27 |
| Oct | 4 | 15.0 | 4 | 0.0 | 1.8 | 4 | **37.0** | **24.7** | 3 | 0 | 0.33 |
| Nov | 4 | 15.5 | 4 | 0.0 | 1.8 | 3 | 19.5 | 25.4 | 5 | 0 | 0.35 |
| Dec | 0 | 17.4* | 0 | 0.7* | 2.0* | 0 | 139.3* | 28.0* | 1 | 0 | 0.52 |

Table 7. Ambient water quality (denoted as "85th Percentile") and TVS in COSPSV04b, JC abv LJC.
*No data, used average of adjacent months
**Bold type indicates exceedances**

## Little James Creek (LJC)

LJC was identified on the 2012 303(d) list for impairments due to copper and lead. The tributary also exceeded the chronic standards for cadmium and zinc, for which a TMDL had bene completed in 2002. Although hardness levels, and consequently metal standards, in LJC were considerably higher than within other portions of the watershed, concentrations of these four metals exceed standards. The lower limit pH standard of 6.5 also is not attained. In addition, the tributary exceeded acute standards for cadmium, copper, lead and zinc.

The data for LJC were evaluated in more detail spatially and temporally. The data for individual sites were assessed to determine the area exhibiting the greatest degree of impairment (Figures 12-15). The figures show the sites in an upstream to downstream order. The site on Little James Creek named Ward Road exhibited the highest concentrations of cadmium and zinc, while the highest concentration of copper and lead were observed at the site Above Porphyry.

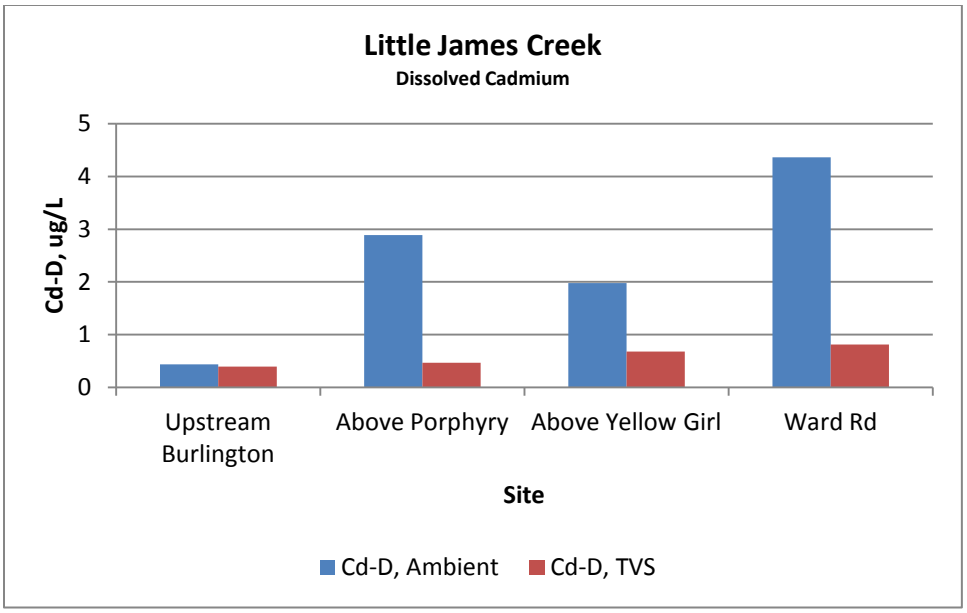


Figure 12. LJC dissolved cadmium by site. Ambient data represented as 85th percentiles.

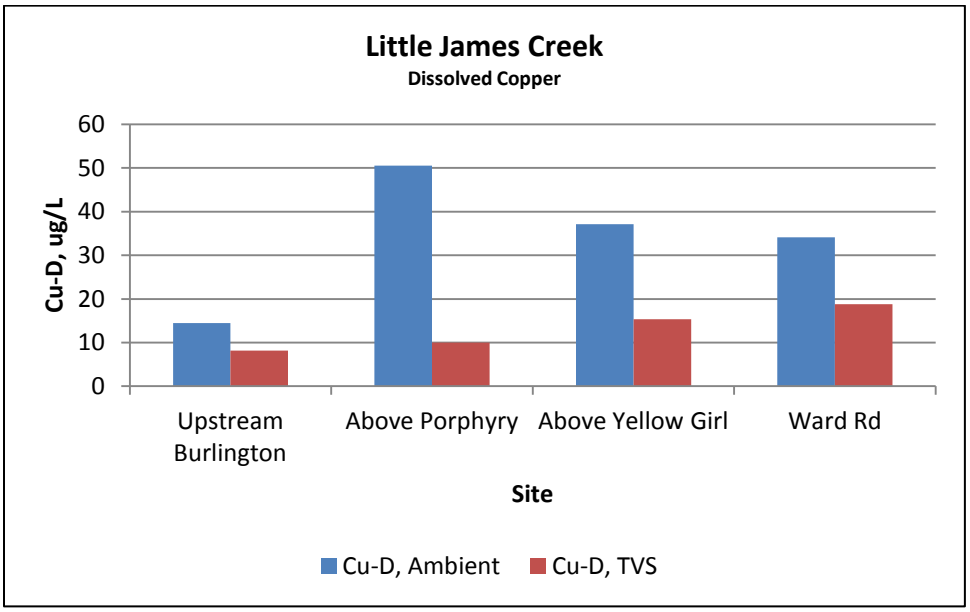


Figure 13. LJC dissolved copper by site. Ambient data represented as 85th percentiles.

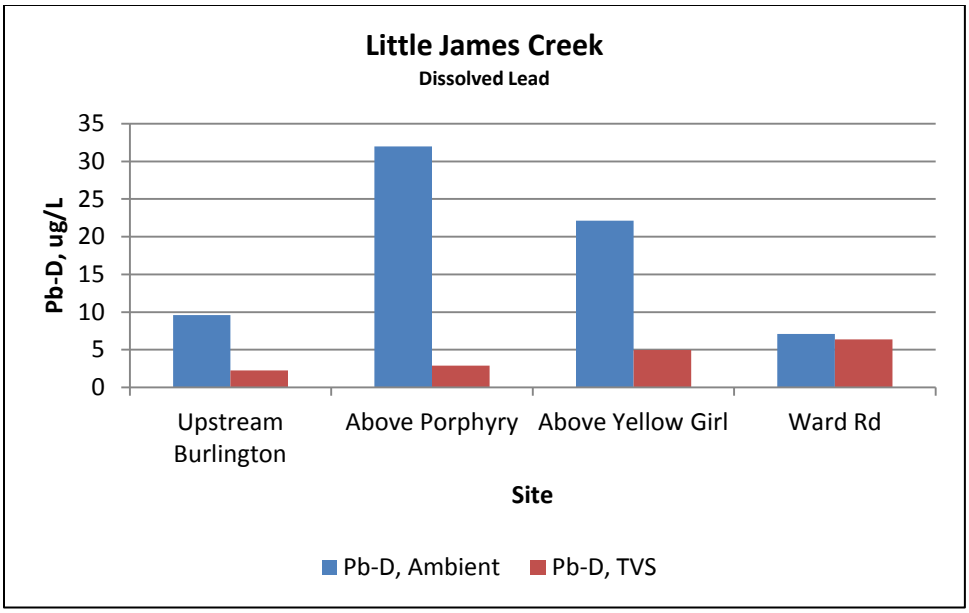


Figure 14. LJC dissolved lead by site. Ambient data represented as 85th percentiles.

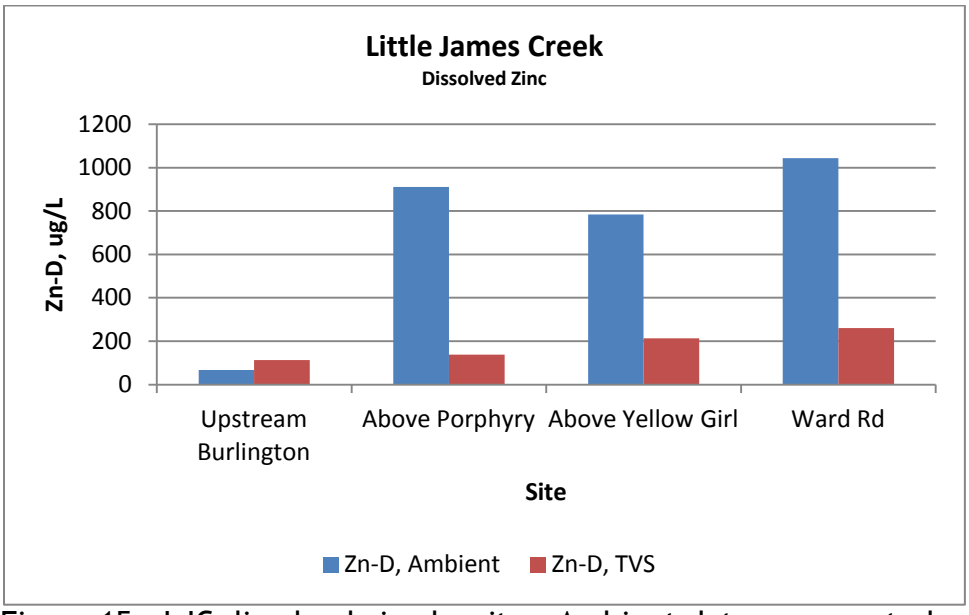


Figure 15. LJC dissolved zinc by site. Ambient data represented as 85th percentiles.

The stream also exceeded the acute standards for these pollutants. The data were evaluated on a seasonal basis by comparing the monthly ambient quality for each pollutant to the monthly standard. This additional monthly analysis focused on the sites noted above that showed the highest concentrations for each pollutant. These also are the sites for which TMDLs were developed. The monthly water quality and associated chronic standards for each pollutant are presented in Table 8. Exceedances of cadmium, copper, zinc, and lead were observed in all months. The pH standard also was exceeded in all months.

| month | n = | Hardness mean, (mg/L) | n = | Cd, 85th Percentile, ug/L | Cd-TVS-chronic | | Cu, 85th Percentile, ug/L | Cu-TVS-chronic | n = | Zn, 85th Percentile, ug/L | Zn-TVS-chronic | n = | Pb, 85th Percentile, ug/L | Pb-TVS-chronic | pH 15th Per (s.u.) | pH TVS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 5 | 368 | 5 | **5.52** | **1.13** | 1 | **27.5** | **11.9** | 5 | **1305** | **377** | 1 | **7.9** | **3.6** | **5.4** | 6.5 |
| Feb | 5 | 299 | 5 | **4.52** | **0.97** | 1 | **33.2*** | **9.1** | 4 | **1244** | **303** | 0 | **15.8*** | **2.6** | **5.5** | 6.5 |
| Mar | 4 | 340 | 4 | **6.43** | **1.07** | 3 | **38.9** | **6.0** | 4 | **1504** | **353** | 4 | **23.7** | **1.5** | **5.5** | 6.5 |
| Apr | 10 | 144 | 9 | **3.48** | **0.56** | 3 | **32.0** | **7.4** | 6 | **554** | **158** | 7 | **16.6** | **2.0** | **5.4** | 6.5 |
| May | 7 | 149 | 8 | **2.28** | **0.57** | 5 | **25.8** | **5.5** | 4 | **663** | **184** | 7 | **16.8** | **1.4** | **5.8** | 6.5 |
| Jun | 10 | 177 | 9 | **2.12** | **0.65** | 3 | **26.7** | **4.6** | 6 | **557** | **207** | 5 | **16.6** | **1.1** | **5.8** | 6.5 |
| Jul | 7 | 227 | 7 | **4.22** | **0.79** | 4 | **64.2** | **9.9** | 6 | **847** | **243** | 5 | **72.7** | **2.8** | **5.4** | 6.5 |
| Aug | 8 | 271 | 8 | **6.56** | **0.90** | 3 | **44.3** | **12.8** | 8 | **1024** | **291** | 4 | **29.8** | **4.0** | **5.6** | 6.5 |
| Sept | 8 | 293 | 9 | **4.37** | **0.95** | 2 | **47.4*** | **10.9** | 8 | **811** | **311** | 0 | **39.7*** | **3.2** | **5.7** | 6.5 |
| Oct | 6 | 238 | 5 | **3.74** | **0.81** | 1 | **50.5** | **9.0** | 5 | **843** | **260** | 1 | **49.6** | **2.5** | **5.5** | 6.5 |
| Nov | 7 | 292 | 7 | **4.75** | **0.95** | 1 | **42.83*** | **10.0** | 5 | **1420** | **377** | 1 | **28.8*** | **2.9** | **5.3** | 6.5 |
| Dec | 2 | 400 | 2 | **4.23** | **1.20** | 1 | **35.17*** | **11.0** | 2 | **1201** | **405** | 0 | **22.3*** | **3.3** | **5.4** | 6.5 |

Table 8. Ambient water quality (denoted as the "85th Percentile") and TVS in COSPSV04b, LJC.

*No data, used average of adjacent months

**Bold type indicates exceedances**

## James Creek below Little James Creek (JC blw LJC)

JC blw LJC showed the influence of metals loading from LJC. Chronic standards for cadmium, copper, lead and zinc were not attained, but because LJC drains a much smaller area than upper JC, instream concentrations were somewhat attenuated, probably due to dilution. For this portion of James Creek, data were available from one site, James Creek at Post Office. Figures 16-19 illustrate the exceedances of the chronic standards for the pollutants of concern.

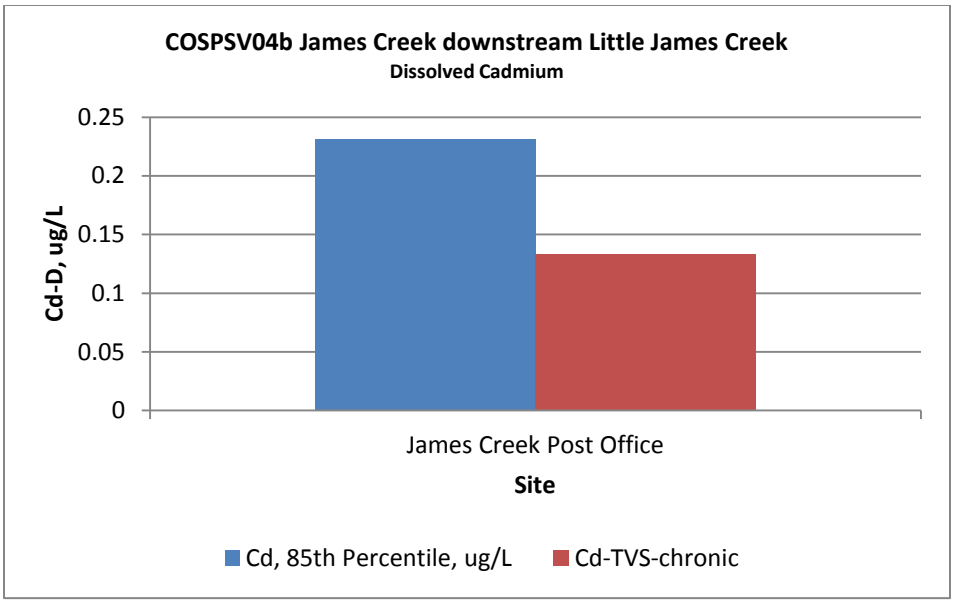


Figure 16. JC blw LJC dissolved cadmium. Ambient data represented as 85th percentiles.

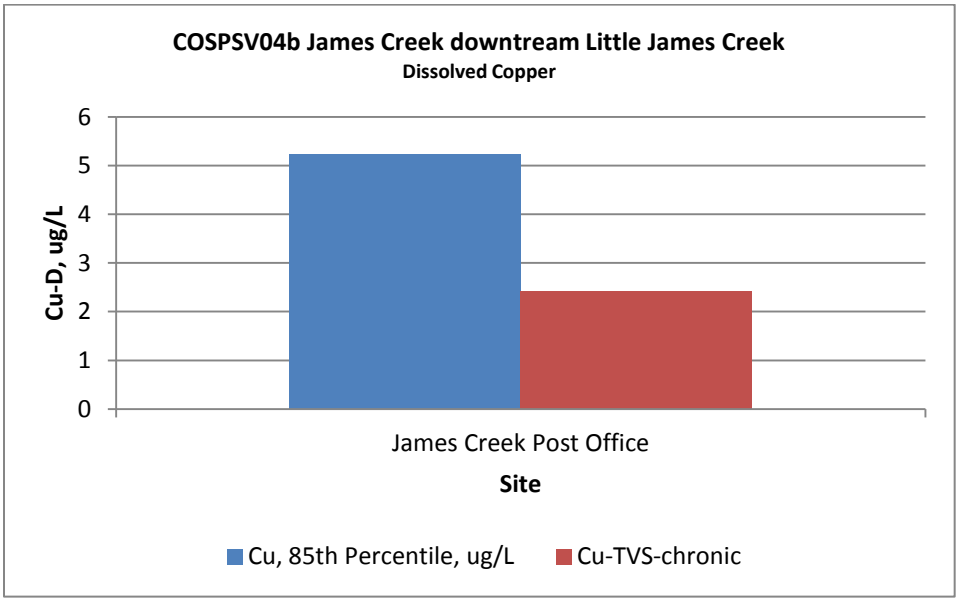


Figure 17. JC blw LJC dissolved copper. Ambient data represented as 85th percentiles.

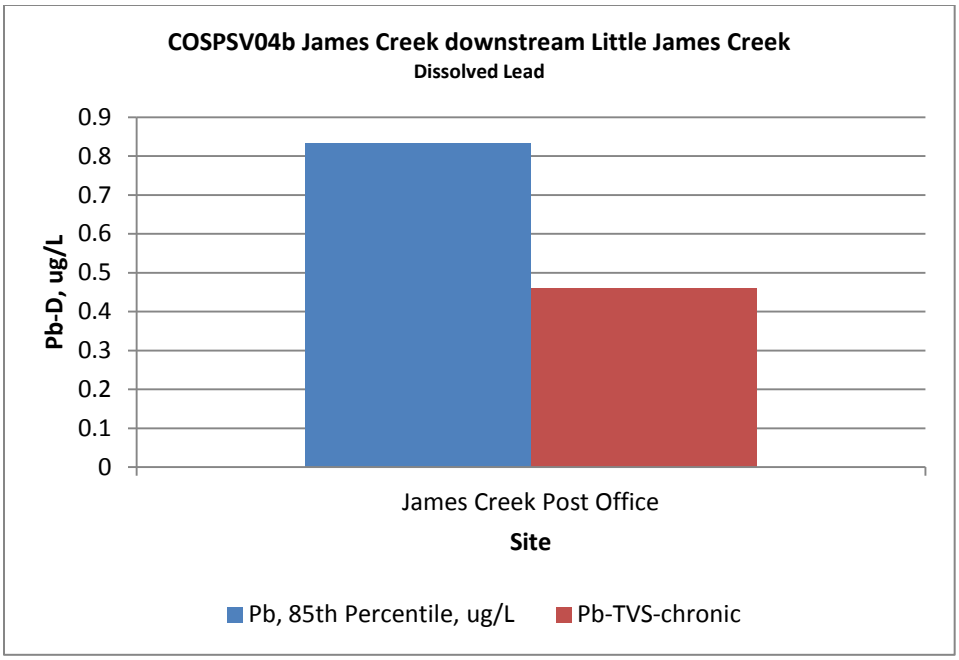


Figure 18. JC blw LJC dissolved lead. Ambient data represented as 85th percentiles.

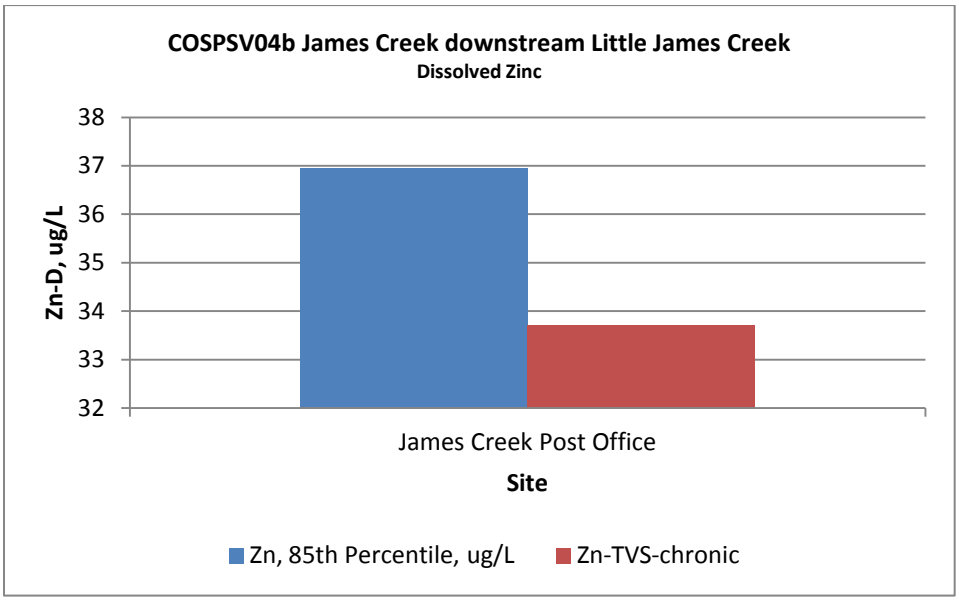


Figure 19. JC blw LJC dissolved zinc. Ambient data represented as 85th percentiles.

This portion of James Creek also showed exceedances of acute standards. The data were evaluated on a seasonal basis by comparing the monthly ambient quality for each pollutant against the monthly standard. Acute exceedances were observed for all metals. However, for cadmium and lead, the age or number of exceedances did not meet the requirements for being identified as non-attaining for acute standards. In the case of cadmium, there were two acute exceedances, but these were from 2004. The division's assessment methodology would use only the most recent five years of data, so these exceedances would not be included. For lead,

there was only one exceedance observed. Non-attainment of acute exceedances is found if there is more than one exceedance in three years. This additional monthly analysis focused on the sites that showed the highest concentrations for each pollutant. The monthly water quality and associated chronic standards for each pollutant are presented in Table 9.

| Month | n = | Hardness mean, (mg/L) | n = | n = | Cd, 85th Percentile, ug/L | Cd-TVS-chronic | n = | Cu, 85th Percentile, ug/L | Cu-TVS-chronic | n = | Pb, 85th Percentile, ug/L | Pb-TVS-chronic | n = | Zn, 85th Percentile, ug/L | Zn-TVS-chronic | pH, 15th percentile, s.u. | TVS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 3 | 28 | 3 | 3 | 0.00 | 0.16 | 3 | 0.8 | 3.0 | 3 | **2.45** | **0.61** | 3 | 24.3 | 42.0 | 7.4 | 6.5 |
| Feb | 2 | 30 | 2 | 2 | **0.24** | **0.17** | 2 | 2.3 | 3.2 | 2 | 0.00 | 0.66 | 2 | 38.0 | 44.5 | 7.2 | 6.5 |
| Mar | 3 | 36 | 2 | 3 | **0.64** | **0.19** | 3 | **32.3** | **3.7** | 3 | 0.50 | 0.80 | 3 | **348.7** | **51.5** | 7.0 | 6.5 |
| Apr | 7 | 33 | 7 | 7 | **0.34** | **0.18** | 7 | **6.0** | **3.5** | 7 | **3.73** | **0.73** | 7 | 43.4 | 48.1 | 6.5 | 6.5 |
| May | 6 | 17 | 3 | 4 | 0.00 | 0.11 | 4 | **14.4** | **2.0** | 5 | **0.57** | **0.36** | 5 | **105.5** | **28.1** | **6.2** | **6.5** |
| Jun | 4 | 12 | 3 | 4 | **0.10** | **0.08** | 3 | **3.0** | **1.4** | 4 | **2.42** | **0.23** | 4 | 0.0 | 19.7 | 7.1 | 6.5 |
| Jul | 3 | 9 | 3 | 2 | 0.00 | 0.07 | 3 | **1.4** | **1.1** | 3 | 0.00 | 0.17 | 3 | 4.8 | 15.7 | 6.8 | 6.5 |
| Aug | 4 | 12 | 4 | 3 | **0.41** | **0.08** | 3 | **4.6** | **1.4** | 3 | **4.97** | **0.22** | 3 | **38.5** | **19.7** | 7.2 | 6.5 |
| Sept | 4 | 14 | 1 | 3 | 0.00 | 0.10 | 3 | 0.7 | 1.7 | 3 | 0.00 | 0.29 | 3 | 9.7 | 23.7 | 7.7 | 6.5 |
| Oct | 5 | 19 | 5 | 3 | 0.00 | 0.12 | 4 | **3.2** | **2.1** | 4 | 0.23 | 0.39 | 4 | 26.3 | 29.6 | **5.7** | **6.5** |
| Nov | 7 | 26 | 4 | 5 | 0.00 | 0.15 | 7 | **5.3** | **2.8** | 7 | 0.53 | 0.56 | 5 | **128.3** | **39.1** | 6.1 | 6.5 |
| Dec | 1 | 26 | 1 | 1 | 0.00 | 0.15 | 1 | 2.8* | 2.8 | 1 | 0.00* | 0.57 | 1 | 21.4* | 39.4 | 7.7 | 6.5 |

Table 9. Ambient water quality (denoted as "85th Percentile") and TVS in COSPSV04b, JC blw LJC.
*No data, used average of adjacent months
**Bold type indicates exceedances**

COSPSV04c Left Hand Creek below James Creek

Left Hand Creek below the confluence of James Creek and Left Hand Creek, Segment COSPSV04c, was listed for copper and arsenic. As stated in a previous section, this report does not address arsenic. Although Segment COSPSV04c, attains all chronic Aquatic Life Use-based standards, an assessment for attainment of acute standards identified an exceedance. However, only one exceedance was observed in the data set, so according to the listing methodology, this segment does not exceed the acute copper standards. Therefore, this report concludes that COSPSV04c attains the chronic and acute standards for copper. Because the segment currently is on the 303(d) List, a protective TMDL is presented in this report. It is anticipated that this segment will be reviewed during the next 303(d) listing cycle.

## VI. INSTREAM CONDITIONS

### Climate

Climate data for the area was collected at the Allenspark weather station to provide a general idea about weather conditions in the area. The weather station is

located near the Left Hand Creek and James Creek watersheds. The data for this station was collected from January 1994 through June 2004. A summary of the climate data is provided below:

Average annual precipitation (in.): 25.8
Month of highest precipitation: April (4.2 in.)
Month of lowest precipitation: December (0.8 in.)
Average annual snowfall (in.): 175.2
Average annual temperature: 39.8°F
Month of lowest average temperature: February (14.3°F)
Month of highest average temperature: July (76.0°F)
(source: www.wrcc.dri.edu )

**Hydrology**

The hydrology of a system is an important component for calculating loads. The quantity of water in a system can be obtained from stream gages in the reaches of interest or through other means of estimating or modeling the system. Although Figure 1 shows a gaging station located approximately midway between James Creek and the Haldi Diversion, the station, which was operated by the U.S.G.S. from 1929 to 1980, is no longer in service. Several gages became active on April 1, 2015, immediately prior to the April 3, 2015 public notice of the TMDL. However, for the period of record for which TMDL data were assessed, only one stream gage operated in the impaired segments that are the subject of this TMDL. Therefore, stream flow was estimated using a watershed area ratio approach. The gages that became active in April, 2015, and that are within the impaired segments addressed by the TMDL, will provide useful data for future water quality assessments.

The hydrograph of the Left Hand Creek watershed is expected to be typical of other high mountain streams on the Colorado east slope. Low flows occur in the late fall to early spring, followed by large increases in flow during the annual snowmelt period. The snowmelt period starts in late spring, usually May, and tails off through the summer. Smaller tributaries show the same pattern, but tend to show greater influences from summer rain events. The hydrograph of Middle Boulder Creek (Figure 20) approximates the pattern of the Left Hand Creek hydrograph, as both are Colorado Front Range drainages located in the same area and of similar aspect.

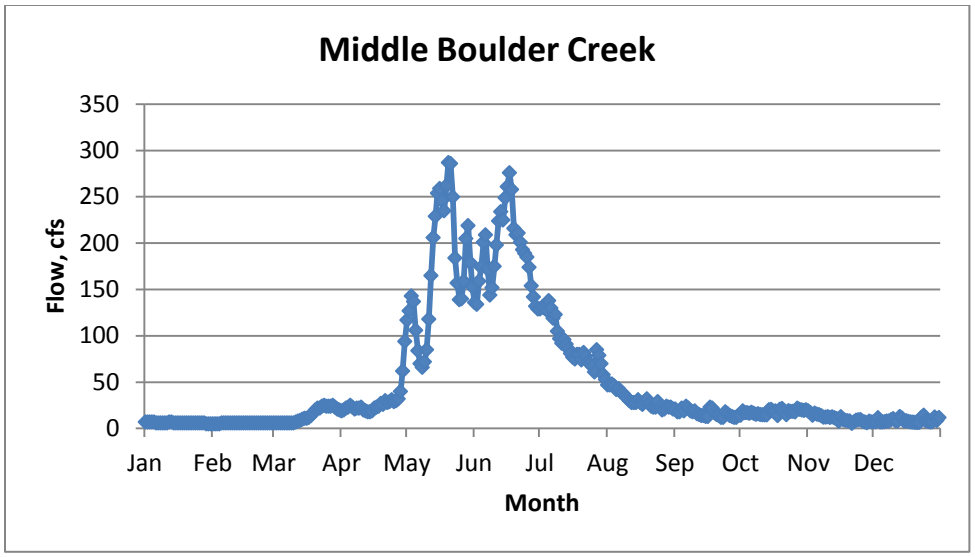


**Figure 20. Hydrograph of Middle Boulder Creek near Nederland, USGS gage 06725500.**

Flows for Middle Boulder Creek were obtained from USGS gage #6725500 near Nederland, Colorado, which operated during the years 1907 through 2007 and from Colorado Division of Water Resources (gage renamed BOCMIDCO), which operated the gage since 2007. The period of record for the data obtained from the BOCMIDCO gage was from 1995-2013. Daily flows at several locations within the Left Hand Creek and James Creek watersheds were estimated using a watershed area ratio. The U.S.G.S. StreamStats program (U.S. Geological Survey, 2012) was used to estimate watershed areas for locations on Left Hand Creek, James Creek, and Little James Creek. These watershed areas were divided by the watershed area for the Middle Boulder Creek gage (36.2 $mi^2$). This ratio was applied to the daily flows for the BOCMIDCO gage . The Left Hand Water District (LHWD), which has senior water rights on South Saint Vrain Creek, diverts water (typically from June through October) from the South Saint Vrain above the Peak-to-Peak Highway via James Creek to Left Hand Creek. The diversion structure is at an elevation of about 9,400 feet and is within the Roosevelt National Forest (Wood and Russell 2005). Flow estimates for sites on James Creek were adjusted to reflect these additional flows. Daily flows from the Left Hand Diversion near Ward for the gage named LEFTHDCO were added to the daily flow estimates for each site on James Creek. Monthly median flows were calculated from the daily flow estimates for the sites for which loads were calculated (Table 10).

| Month | Middle Boulder Creek (36.2 $mi^2$) | Left Hand Creek at Slide Mine (18.1 $mi^2$) | James Creek @ Cushman Bark (7.8 $mi^2$) | JC @ Town Intake (8.98 $mi^2$) | LJC abv JC (12.1 $mi^2$) |
|---|---|---|---|---|---|
| Jan | 6.0 | 3.0 | 1.3 | 1.5 | 0.5 |
| Feb | 5.1 | 2.6 | 1.1 | 1.3 | 0.4 |
| Mar | 6.1 | 3.1 | 1.3 | 1.5 | 0.5 |
| Apr | 21.3 | 10.7 | 4.6 | 5.3 | 1.8 |
| May | 104.0 | 52.0 | 33.9 | 38.3 | 8.8 |
| Jun | 239.5 | 119.8 | 139.2 | 146.4 | 20.2 |
| Jul | 109.0 | 54.5 | 85.8 | 89.4 | 9.2 |
| Aug | 39.2 | 19.6 | 41.1 | 42.4 | 3.3 |
| Sep | 24.0 | 12.0 | 17.9 | 18.7 | 2.0 |
| Oct | 18.0 | 9.0 | 10.7 | 11.3 | 1.5 |
| Nov | 11.0 | 5.5 | 2.6 | 3.0 | 0.9 |
| Dec | 7.8 | 3.9 | 1.7 | 2.0 | 0.7 |

**Table 10. Monthly median flows (cfs) for Middle Boulder Creek and estimated monthly median flows (cfs) for select sites on Left Hand Creek, James Creek and Little James Creek (1995-2013)**

The distribution of flows for Left Hand Creek, James Creek and Little James Creek are illustrated in "box and whiskers" plots (Figures 21-23). The boxes show the 25th and 75th percentiles, while the bars or whiskers show the 5th and 95th percentiles for the flow estimates. Medians are shown as markers in the boxes. The period of record from 1995 through 2013 was used.

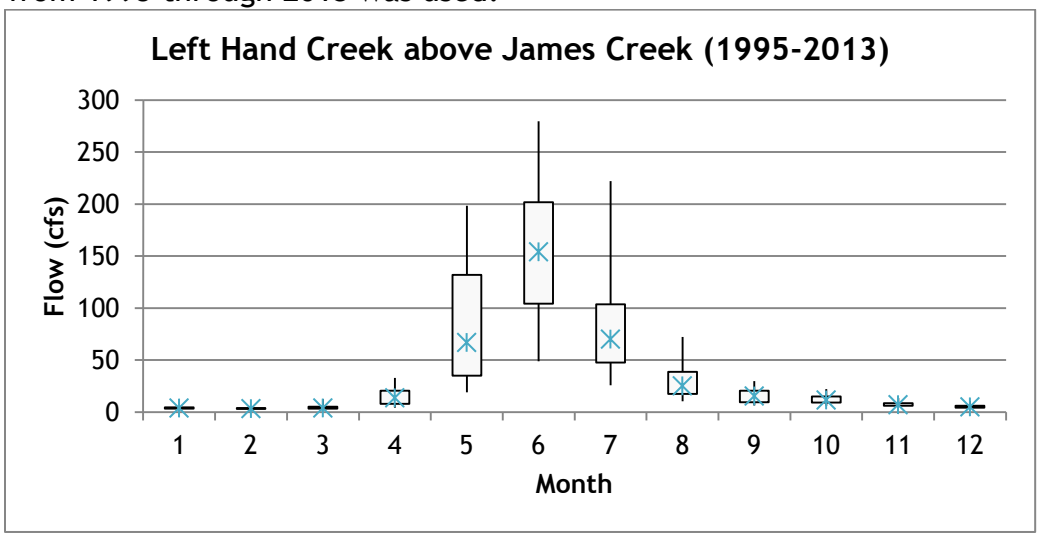


**Figure 21. Distribution of flows in Left Hand Creek**

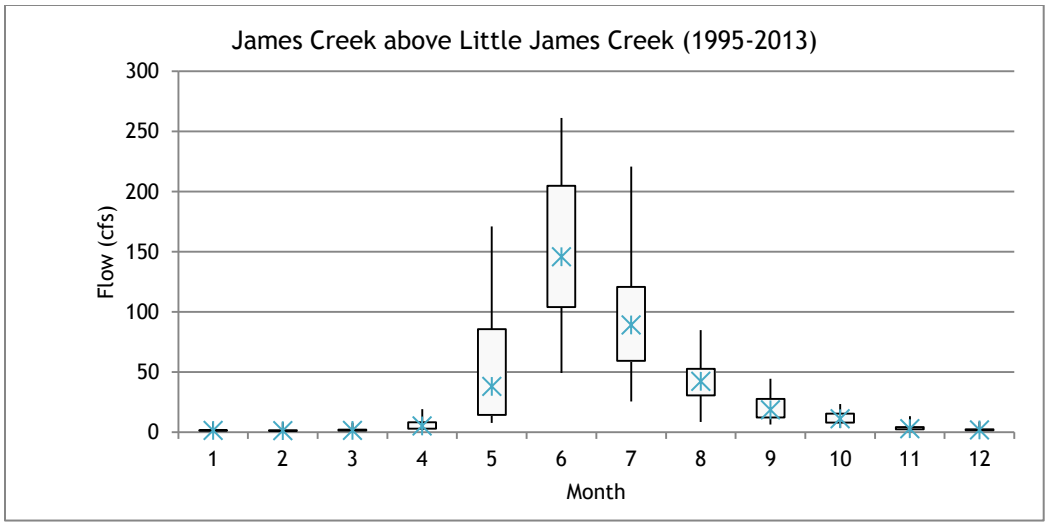


**Figure 22. Distribution of flows in James Creek**

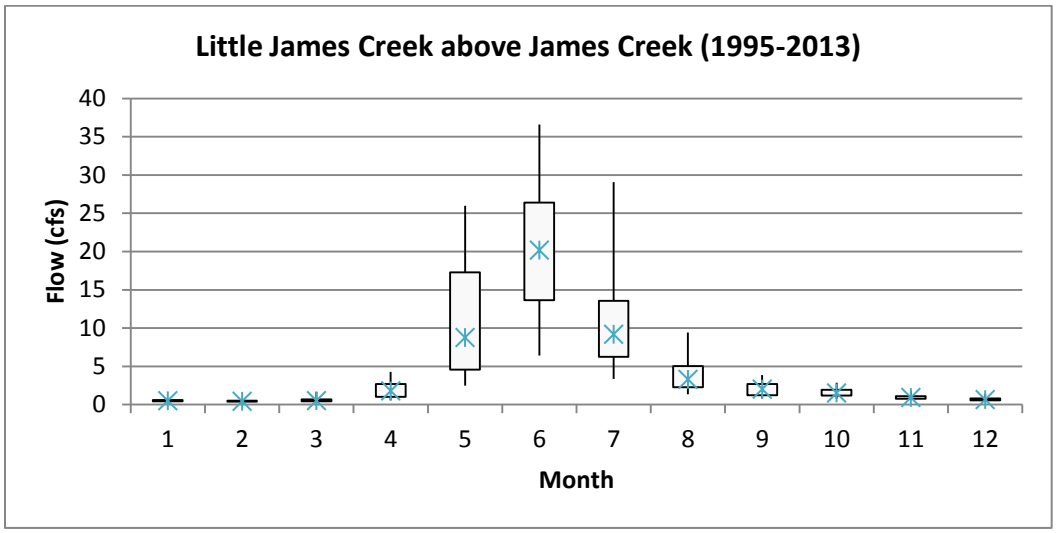


**Figure 23. Distribution of flows in Little James Creek**

## VIII. TMDL ALLOCATION

### Total Maximum Daily Loads

A TMDL is comprised of the sum of the Waste Load Allocation (WLA), Load Allocation (LA), and a Margin of Safety (MOS). The Waste Load Allocation consists of the permitted and non-permitted point sources within the segment. The Load Allocation is the pollutant load attributed to natural background, also referred to as non-point sources.

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

**Waste Load Allocations "(WLA)"**

There are no permitted dischargers actively discharging to listed segments in the Left Hand Creek watershed. However, despite the lack of permitted facilities, pollutant loading associated with abandoned, or legacy mining operations is considered to be a point source contribution. Therefore these pollutant loads are treated as non-permitted point sources and are included in the WLA portion of the TMDLs. A portion of the WLA, the reserve capacity (RC) is reserved for future development.

**Load Allocations "(LA)"**

Background or natural sources are considered non-point sources and are accounted for in the LA term of a TMDL.

Water quality data from sites upstream of mining impacts were evaluated to determine natural background conditions. The ambient water quality, as defined by the 85$^{th}$ percentile, for the upper site on Left Hand Creek, Left Hand Creek at Peak to Peak, was used to represent background conditions. The 85$^{th}$ percentile was less than detect for cadmium, copper and lead. The 85$^{th}$ percentile for zinc was 6.52 µg/L. The Water Quality Control Division typically assigns "0" for less than detection reports. Therefore, the background concentrations for cadmium, copper and lead were assigned 0 ug/L, and 6.52 ug/L was used for zinc. These values were used to characterize background loads for these pollutants.

**Margin of Safety "(MOS)"**

The Federal Clean Water Act requires TMDLs to incorporate a margin of safety (MOS) component that accounts for the uncertainty about the relationship between the pollutant loads and the receiving waterbody. The MOS can be implicit (included in factors determining the TMDL) or explicit (a separate value in the TMDL). An explicit 10% MOS was included to allow for uncertainty in load calculations.

There are a number of abandoned mine land reclamation projects that have been completed or are underway within the Left Hand Creek watershed. The datasets utilized in this TMDL assessment span a period of record that includes sample results that precede many of the remedial projects. Consequently the characterization of existing water quality in this report may reflect a greater degree of impairment than may actually exist.

## Load Calculations

The previous section in this TMDL document, which addressed ambient water quality, identified specific reaches or sites within each segment that showed the greatest degree of impairment for each pollutant. Pollutant loads for these segments or sites were calculated for each month to address seasonal variation. Loads, as pounds per day, were calculated for each month by multiplying the monthly median flows in cubic feet per second (cfs) by the standard or the ambient concentration and by a conversion factor of 0.0054. The allowable load is that load based on the standard, while the ambient load was that load based on the ambient concentration. The allowable load was compared to the ambient load. Load reductions, as percentages of the ambient loads, were calculated for those months during which the ambient load exceeded the allowable load. The reductions necessary to attain chronic standards were applied to individual sampling event results to determine if acute standards would also be attained. In instances when the chronic reductions were inadequate to ensure attainment of acute standards, the calculated acute reductions were applied during the corresponding months to determine a revised allowable load. This ensures that the TMDLs will attain both chronic and acute standards.

## COSPSV04a

TMDLs for COSPSV04a were developed from data for the reach from California Gulch to the Slide Mine. As stated above, TMDLs were developed to attain both chronic and acute standards. The monthly TMDLs for cadmium, copper and zinc are presented in Tables 11-13.

| Month | Flow (cfs) | Ambient Load (#/D) | Allowable load (#/D) | 10% MOS (#/D) | WLA (#/D) | (10%)Reserve Capacity | LA (#/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 3.0 | 0.016 | 0.004 | 0.000 | 0.003 | 0.0004 | 0.000 | 73 |
| Feb | 2.6 | 0.014 | 0.003 | 0.000 | 0.003 | 0.0003 | 0.000 | 75 |
| Mar | 3.1 | 0.017 | 0.004 | 0.000 | 0.003 | 0.0004 | 0.000 | 77 |
| Apr | 10.7 | 0.084 | 0.084 | 0.008 | 0.067 | 0.0084 | 0.000 | 0 |
| May | 52.0 | 0.213 | 0.213 | 0.021 | 0.170 | 0.0213 | 0.000 | 0 |
| Jun | 119.8 | 0.343 | 0.107 | 0.011 | 0.086 | 0.0107 | 0.000 | 69 |
| Jul | 54.5 | 0.188 | 0.057 | 0.006 | 0.046 | 0.0057 | 0.000 | 70 |
| Aug | 19.6 | 0.043 | 0.014 | 0.001 | 0.011 | 0.0014 | 0.000 | 67 |
| Sept | 12.0 | 0.048 | 0.012 | 0.001 | 0.009 | 0.0012 | 0.000 | 76 |
| Oct | 9.0 | 0.039 | 0.010 | 0.001 | 0.008 | 0.0010 | 0.000 | 75 |
| Nov | 5.5 | 0.025 | 0.025 | 0.002 | 0.020 | 0.0025 | 0.000 | 0 |
| Dec | 3.9 | 0.020 | 0.006 | 0.001 | 0.005 | 0.0006 | 0.000 | 71 |

Table 11. COSPSV04a TMDL for cadmium.

| Month | Flow (cfs) | Ambient Load (#/D) | Allowable load (#/D) | 10% MOS (#/D) | WLA (#/D) | (10%)Reserve Capacity | LA (#/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 3.0 | 1.08 | 0.08 | 0.008 | 0.067 | 0.008 | 0.00 | 92 |
| Feb | 2.6 | 0.87 | 0.07 | 0.007 | 0.055 | 0.007 | 0.00 | 92 |
| Mar | 3.1 | 0.99 | 0.08 | 0.008 | 0.062 | 0.008 | 0.00 | 92 |
| Apr | 10.7 | 2.71 | 0.26 | 0.026 | 0.207 | 0.026 | 0.00 | 90 |
| May | 52.0 | 6.73 | 0.17 | 0.017 | 0.134 | 0.017 | 0.00 | 98 |
| Jun | 119.8 | 39.70 | 2.00 | 0.200 | 1.597 | 0.200 | 0.00 | 95 |
| Jul | 54.5 | 18.10 | 1.08 | 0.108 | 0.866 | 0.108 | 0.00 | 94 |
| Aug | 19.6 | 2.54 | 0.26 | 0.026 | 0.207 | 0.026 | 0.00 | 90 |
| Sept | 12.0 | 6.60 | 0.22 | 0.022 | 0.179 | 0.022 | 0.00 | 97 |
| Oct | 9.0 | 0.34 | 0.06 | 0.006 | 0.051 | 0.006 | 0.00 | 81 |
| Nov | 5.5 | 1.06 | 0.11 | 0.011 | 0.087 | 0.011 | 0.00 | 90 |
| Dec | 3.9 | 1.45 | 0.11 | 0.011 | 0.091 | 0.011 | 0.00 | 92 |

Table 12. COSPSV04a TMDL for copper.

| Month | Flow (cfs) | Ambient Load (#/D) | Allowable load (#/D) | 10% MOS (#/D) | WLA (#/D) | (10%)Reserve Capacity | LA (#/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 3.0 | 6.161 | 1.172 | 0.117 | 0.832 | 0.117 | 0.106 | 81 |
| Feb | 2.6 | 6.169 | 0.948 | 0.095 | 0.669 | 0.095 | 0.090 | 85 |
| Mar | 3.1 | 8.515 | 1.076 | 0.108 | 0.754 | 0.108 | 0.107 | 87 |
| Apr | 10.7 | 9.689 | 1.598 | 0.160 | 0.904 | 0.160 | 0.375 | 84 |
| May | 52.0 | 68.976 | 8.210 | 0.821 | 4.737 | 0.821 | 1.831 | 88 |
| Jun | 119.8 | 101.395 | 27.783 | 2.778 | 18.010 | 2.778 | 4.216 | 73 |
| Jul | 54.5 | 58.389 | 15.055 | 1.506 | 10.125 | 1.506 | 1.919 | 74 |
| Aug | 19.6 | 15.739 | 3.596 | 0.360 | 2.188 | 0.360 | 0.689 | 77 |
| Sept | 12.0 | 12.203 | 3.107 | 0.311 | 2.063 | 0.311 | 0.422 | 75 |
| Oct | 9.0 | 2.344 | 1.381 | 0.138 | 0.788 | 0.138 | 0.317 | 41 |
| Nov | 5.5 | 8.693 | 1.454 | 0.145 | 0.970 | 0.145 | 0.194 | 83 |
| Dec | 3.9 | 6.522 | 1.587 | 0.159 | 1.133 | 0.159 | 0.136 | 76 |

Table 13. COSPSV04a TMDL for zinc

## COSPSV04b JC abv LJC

TMDLs for COSPSV04b JC abv LJC were developed for cadmium, copper, lead and zinc. TMDLs were developed to attain both chronic and acute standards. The monthly TMDLs for cadmium were based on data from the John Jay site. Copper and zinc TMDLS were calculated from data from the Cushman Bark site. Lead TMDLs were calculated from the Town Intake site. The monthly TMDLs are presented in Tables 14-17.

| Month | Flow (cfs) | Ambient or Observed Load (lbs/D) | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (WLA) Reserve Capacity (lbs/D) | LA (Background Load) (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 1.3 | 0.010 | 0.016 | 0.002 | 0.013 | 0.002 | 0.000 | 0 |
| Feb | 1.1 | 0.000 | 0.014 | 0.001 | 0.011 | 0.001 | 0.000 | 0 |
| Mar | 1.3 | 0.000 | 0.014 | 0.001 | 0.011 | 0.001 | 0.000 | 0 |
| Apr | 4.6 | 0.062 | 0.054 | 0.005 | 0.043 | 0.005 | 0.000 | 14 |
| May | 33.9 | 0.473 | 0.241 | 0.024 | 0.193 | 0.024 | 0.000 | 49 |
| Jun | 139.2 | 0.947 | 0.473 | 0.047 | 0.378 | 0.047 | 0.000 | 50 |
| Jul | 85.8 | 0.422 | 0.308 | 0.031 | 0.246 | 0.031 | 0.000 | 27 |
| Aug | 41.1 | 0.323 | 0.268 | 0.027 | 0.214 | 0.027 | 0.000 | 17 |
| Sept | 17.9 | 0.070 | 0.147 | 0.015 | 0.117 | 0.015 | 0.000 | 0 |
| Oct | 10.7 | 0.000 | 0.103 | 0.010 | 0.082 | 0.010 | 0.000 | 0 |
| Nov | 2.6 | 0.000 | 0.025 | 0.003 | 0.020 | 0.003 | 0.000 | 0 |
| Dec | 1.7 | 0.007 | 0.019 | 0.002 | 0.015 | 0.002 | 0.000 | 0 |

Table 14. COSPSV04b JC abv LJC TMDL for cadmium

| Month | Flow (cfs) | Ambient or Observed Load (lbs/D) | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (WLA) Reserve Capacity (lbs/D) | LA Background Load (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 1.1 | 0.0000 | 0.0006 | 0.0001 | 0.0005 | 0.0001 | 0.0000 | 0 |
| Feb | 0.9 | 0.0000 | 0.0006 | 0.0001 | 0.0005 | 0.0001 | 0.0000 | 0 |
| Mar | 1.1 | 0.0000 | 0.0006 | 0.0001 | 0.0005 | 0.0001 | 0.0000 | 0 |
| Apr | 3.7 | 0.0019 | 0.0024 | 0.0002 | 0.0019 | 0.0002 | 0.0000 | 0 |
| May | 29.2 | 0.0210 | 0.0123 | 0.0012 | 0.0099 | 0.0012 | 0.0000 | 41 |
| Jun | 129.8 | 0.0000 | 0.0383 | 0.0038 | 0.0307 | 0.0038 | 0.0000 | 0 |
| Jul | 80.7 | 0.0000 | 0.0247 | 0.0025 | 0.0198 | 0.0025 | 0.0000 | 0 |
| Aug | 39.3 | 0.0000 | 0.0152 | 0.0015 | 0.0121 | 0.0015 | 0.0000 | 0 |
| Sept | 17.0 | 0.0000 | 0.0079 | 0.0008 | 0.0063 | 0.0008 | 0.0000 | 0 |
| Oct | 10.0 | 0.0083 | 0.0054 | 0.0005 | 0.0043 | 0.0005 | 0.0000 | 35 |
| Nov | 2.1 | 0.0000 | 0.0012 | 0.0001 | 0.0009 | 0.0001 | 0.0000 | 0 |
| Dec | 1.4 | 0.0000 | 0.0008 | 0.0001 | 0.0006 | 0.0001 | 0.0000 | 0 |

Table 15. COSPSV04b JC abv LJC TMDL for copper

| Month | Flow (cfs) | Ambient or Observed Load (lbs/D) | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (WLA) Reserve Capacity (lbs/D) | Background Load (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 1.5 | 0.0193 | 0.0036 | 0.0004 | 0.0029 | 0.0004 | 0.0000 | 81 |
| Feb | 1.3 | 0.0086 | 0.0032 | 0.0003 | 0.0026 | 0.0003 | 0.0000 | 62 |
| Mar | 1.5 | 0.0000 | 0.0042 | 0.0004 | 0.0034 | 0.0004 | 0.0000 | 0 |
| Apr | 5.3 | 0.2083 | 0.0155 | 0.0016 | 0.0124 | 0.0016 | 0.0000 | 93 |
| May | 38.3 | 0.1395 | 0.0433 | 0.0043 | 0.0346 | 0.0043 | 0.0000 | 69 |
| Jun | 146.4 | 2.4500 | 0.1103 | 0.0110 | 0.0882 | 0.0110 | 0.0000 | 95 |
| Jul | 89.4 | 0.0000 | 0.0715 | 0.0071 | 0.0572 | 0.0071 | 0.0000 | 0 |
| Aug | 42.4 | 0.0000 | 0.0421 | 0.0042 | 0.0337 | 0.0042 | 0.0000 | 0 |
| Sept | 18.7 | 0.0000 | 0.0277 | 0.0028 | 0.0222 | 0.0028 | 0.0000 | 0 |
| Oct | 11.3 | 0.0000 | 0.0199 | 0.0020 | 0.0159 | 0.0020 | 0.0000 | 0 |
| Nov | 3.0 | 0.0000 | 0.0057 | 0.0006 | 0.0046 | 0.0006 | 0.0000 | 0 |
| Dec | 2.0 | 0.0000 | 0.0055 | 0.0005 | 0.0044 | 0.0005 | 0.0000 | 0 |

Table 16. COSPSV04b JC abv LJC TMDL for lead.

| Month | Flow (cfs) | Ambient or Observed Load (lbs/D) | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (WLA) Reserve Capacity (lbs/D) | Background Load (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 1.3 | 1.844 | 0.183 | 0.018 | 0.100 | 0.018 | 0.046 | 90 |
| Feb | 1.1 | 0.058 | 0.195 | 0.019 | 0.116 | 0.019 | 0.040 | 0 |
| Mar | 1.3 | 0.134 | 0.189 | 0.019 | 0.104 | 0.019 | 0.047 | 0 |
| Apr | 4.6 | 3.652 | 0.506 | 0.051 | 0.243 | 0.051 | 0.162 | 86 |
| May | 33.9 | 18.271 | 2.266 | 0.227 | 0.619 | 0.227 | 1.194 | 88 |
| Jun | 139.2 | 1.895 | 10.075 | 1.008 | 3.158 | 1.008 | 4.902 | 0 |
| Jul | 85.8 | 31.755 | 5.399 | 0.540 | 1.298 | 0.540 | 3.021 | 83 |
| Aug | 41.1 | 8.967 | 2.031 | 0.203 | 0.178 | 0.203 | 1.446 | 77 |
| Sept | 17.9 | 11.582 | 1.678 | 0.168 | 0.711 | 0.168 | 0.631 | 86 |
| Oct | 10.7 | 2.144 | 1.159 | 0.116 | 0.549 | 0.116 | 0.378 | 46 |
| Nov | 2.6 | 0.272 | 0.263 | 0.026 | 0.119 | 0.026 | 0.091 | 4 |
| Dec | 1.7 | 1.284 | 0.258 | 0.026 | 0.146 | 0.026 | 0.060 | 80 |

Table 17. COSPSV04b JC abv LJC TMDL for zinc

## COSPSV04b LJC

TMDLs for COSPSV04b LJC were developed for cadmium, copper, lead and zinc. TMDLs were developed to attain both chronic and acute standards. The monthly TMDLs for cadmium and zinc were calculated from data from the Ward Road site. Copper and lead TMDLS were calculated from data from the Above Porphyry site. The monthly TMDLs are presented in Tables 18-21.

| Month | Flow (cfs) | Ambient or Observed Load | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (10%) Reserve Capacity (WLA) | LA (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 0.5 | 0.0150 | 0.0031 | 0.0003 | 0.0025 | 0.0003 | 0.0000 | 80 |
| Feb | 0.4 | 0.0105 | 0.0022 | 0.0002 | 0.0018 | 0.0002 | 0.0000 | 79 |
| Mar | 0.5 | 0.0178 | 0.0029 | 0.0003 | 0.0024 | 0.0003 | 0.0000 | 83 |
| Apr | 1.8 | 0.0336 | 0.0029 | 0.0003 | 0.0023 | 0.0003 | 0.0000 | 91 |
| May | 8.7 | 0.1073 | 0.0243 | 0.0024 | 0.0194 | 0.0024 | 0.0000 | 77 |
| Jun | 20.1 | 0.2307 | 0.0167 | 0.0017 | 0.0133 | 0.0017 | 0.0000 | 93 |
| Jul | 9.2 | 0.2085 | 0.0052 | 0.0005 | 0.0042 | 0.0005 | 0.0000 | 97 |
| Aug | 3.3 | 0.1160 | 0.0022 | 0.0002 | 0.0018 | 0.0002 | 0.0000 | 98 |
| Sept | 2.0 | 0.0476 | 0.0010 | 0.0001 | 0.0008 | 0.0001 | 0.0000 | 98 |
| Oct | 1.5 | 0.0305 | 0.0013 | 0.0001 | 0.0010 | 0.0001 | 0.0000 | 96 |
| Nov | 0.9 | 0.0237 | 0.0047 | 0.0005 | 0.0038 | 0.0005 | 0.0000 | 80 |
| Dec | 0.7 | 0.0149 | 0.0042 | 0.0004 | 0.0034 | 0.0004 | 0.0000 | 72 |

Table 18. COSPSV04b LJC TMDL for cadmium

| Month | Flow (cfs) | Ambient or Observed Load | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (10%) Reserve Capacity (WLA) | LA (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 0.4 | 0.060 | 0.026 | 0.003 | 0.021 | 0.003 | 0.000 | 57 |
| Feb | 0.3 | 0.061 | 0.017 | 0.002 | 0.013 | 0.002 | 0.000 | 73 |
| Mar | 0.4 | 0.086 | 0.011 | 0.001 | 0.009 | 0.001 | 0.000 | 87 |
| Apr | 1.4 | 0.246 | 0.009 | 0.001 | 0.007 | 0.001 | 0.000 | 97 |
| May | 7.0 | 0.969 | 0.072 | 0.007 | 0.057 | 0.007 | 0.000 | 93 |
| Jun | 16.0 | 2.310 | 0.108 | 0.011 | 0.086 | 0.011 | 0.000 | 95 |
| Jul | 7.3 | 2.528 | 0.076 | 0.008 | 0.061 | 0.008 | 0.000 | 97 |
| Aug | 2.6 | 0.624 | 0.008 | 0.001 | 0.006 | 0.001 | 0.000 | 99 |
| Sept | 1.6 | 0.411 | 0.011 | 0.001 | 0.009 | 0.001 | 0.000 | 97 |
| Oct | 1.2 | 0.328 | 0.009 | 0.001 | 0.007 | 0.001 | 0.000 | 97 |
| Nov | 0.7 | 0.170 | 0.040 | 0.004 | 0.032 | 0.004 | 0.000 | 77 |
| Dec | 0.5 | 0.098 | 0.031 | 0.003 | 0.025 | 0.003 | 0.000 | 69 |

Table 19. COSPSV04b LJC TMDL for copper

| Month | Flow (cfs) | Ambient or Observed Load | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (10%) Reserve Capacity (WLA) | LA (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 0.4 | 0.017 | 0.008 | 0.001 | 0.006 | 0.001 | 0.000 | 54 |
| Feb | 0.3 | 0.029 | 0.005 | 0.000 | 0.004 | 0.000 | 0.000 | 84 |
| Mar | 0.4 | 0.052 | 0.003 | 0.000 | 0.003 | 0.000 | 0.000 | 94 |
| Apr | 1.4 | 0.127 | 0.015 | 0.002 | 0.012 | 0.002 | 0.000 | 88 |
| May | 7.0 | 0.630 | 0.051 | 0.005 | 0.041 | 0.005 | 0.000 | 92 |
| Jun | 16.0 | 1.433 | 0.092 | 0.009 | 0.074 | 0.009 | 0.000 | 94 |
| Jul | 7.3 | 2.859 | 0.112 | 0.011 | 0.090 | 0.011 | 0.000 | 96 |
| Aug | 2.6 | 0.419 | 0.031 | 0.003 | 0.025 | 0.003 | 0.000 | 93 |
| Sept | 1.6 | 0.344 | 0.028 | 0.003 | 0.023 | 0.003 | 0.000 | 92 |
| Oct | 1.2 | 0.322 | 0.016 | 0.002 | 0.013 | 0.002 | 0.000 | 95 |
| Nov | 0.7 | 0.114 | 0.012 | 0.001 | 0.010 | 0.001 | 0.000 | 89 |
| Dec | 0.5 | 0.062 | 0.008 | 0.001 | 0.006 | 0.001 | 0.000 | 87 |

Table 20. COSPSV04b LJC TMDL for lead

| Month | Flow (cfs) | Ambient or Observed Load | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (10%) Reserve Capacity (WLA) | LA (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 0.5 | 3.6 | 1.030 | 0.103 | 0.807 | 0.103 | 0.018 | 71 |
| Feb | 0.4 | 2.8 | 0.734 | 0.073 | 0.572 | 0.073 | 0.015 | 74 |
| Mar | 0.5 | 4.2 | 0.353 | 0.035 | 0.264 | 0.035 | 0.018 | 92 |
| Apr | 1.8 | 8.7 | 0.219 | 0.022 | 0.112 | 0.022 | 0.063 | 97 |
| May | 8.8 | 24.2 | 2.327 | 0.233 | 1.553 | 0.233 | 0.309 | 90 |
| Jun | 20.2 | 56.7 | 1.467 | 0.147 | 0.463 | 0.147 | 0.710 | 97 |
| Jul | 9.2 | 37.3 | 0.499 | 0.050 | 0.076 | 0.050 | 0.323 | 99 |
| Aug | 3.3 | 18.2 | 0.547 | 0.055 | 0.322 | 0.055 | 0.116 | 97 |
| Sept | 2.0 | 8.6 | 0.122 | 0.012 | 0.026 | 0.012 | 0.071 | 99 |
| Oct | 1.5 | 6.9 | 0.101 | 0.010 | 0.027 | 0.010 | 0.053 | 99 |
| Nov | 0.9 | 6.9 | 1.552 | 0.155 | 1.209 | 0.155 | 0.033 | 78 |
| Dec | 0.7 | 4.2 | 1.429 | 0.143 | 1.120 | 0.143 | 0.023 | 66 |

Table 21. COSPSV04b LJC TMDL for zinc

## COSPSV04b JC blw LJC

TMDLs for COSPSV04b JC blw LJC were developed for cadmium, copper, lead and zinc. TMDLs were developed to attain both chronic and acute standards. The monthly TMDLs were based on data from the Post Office site. The monthly TMDLs are presented in Tables 22-25.

| Month | Flow (cfs) | Ambient or Observed Load (lbs/D) | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (WLA) Reserve Capacity (lbs/D) | Background Load (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 2.0 | 0.0000 | 0.0018 | 0.0002 | 0.0014 | 0.0002 | 0.0000 | 0 |
| Feb | 1.8 | 0.0023 | 0.0016 | 0.0002 | 0.0013 | 0.0002 | 0.0000 | 28 |
| Mar | 2.1 | 0.0071 | 0.0022 | 0.0002 | 0.0017 | 0.0002 | 0.0000 | 69 |
| Apr | 7.1 | 0.0130 | 0.0070 | 0.0007 | 0.0056 | 0.0007 | 0.0000 | 46 |
| May | 47.4 | 0.0000 | 0.0290 | 0.0029 | 0.0232 | 0.0029 | 0.0000 | 0 |
| Jun | 166.6 | 0.0940 | 0.0747 | 0.0075 | 0.0598 | 0.0075 | 0.0000 | 21 |
| Jul | 98.8 | 0.0000 | 0.0361 | 0.0036 | 0.0289 | 0.0036 | 0.0000 | 0 |
| Aug | 46.0 | 0.1008 | 0.0205 | 0.0021 | 0.0164 | 0.0021 | 0.0000 | 80 |
| Sept | 20.7 | 0.0000 | 0.0109 | 0.0011 | 0.0087 | 0.0011 | 0.0000 | 0 |
| Oct | 12.8 | 0.0000 | 0.0082 | 0.0008 | 0.0066 | 0.0008 | 0.0000 | 0 |
| Nov | 4.0 | 0.0000 | 0.0033 | 0.0003 | 0.0026 | 0.0003 | 0.0000 | 0 |
| Dec | 2.6 | 0.0000 | 0.0022 | 0.0002 | 0.0017 | 0.0002 | 0.0000 | 0 |

Table 22. COSPSV04b JC blw LJC TMDL for cadmium

| Month | Flow (cfs) | Ambient or Observed Load (lbs/D) | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (WLA) Reserve Capacity (lbs/D) | LA (Background Load) (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 2.0 | 0.009 | 0.033 | 0.003 | 0.027 | 0.003 | 0.000 | 0 |
| Feb | 1.8 | 0.022 | 0.031 | 0.003 | 0.024 | 0.003 | 0.000 | 0 |
| Mar | 2.1 | 0.360 | 0.037 | 0.004 | 0.030 | 0.004 | 0.000 | 90 |
| Apr | 7.1 | 0.230 | 0.132 | 0.013 | 0.106 | 0.013 | 0.000 | 43 |
| May | 47.4 | 3.690 | 0.502 | 0.050 | 0.402 | 0.050 | 0.000 | 86 |
| Jun | 166.6 | 2.682 | 1.274 | 0.127 | 1.019 | 0.127 | 0.000 | 52 |
| Jul | 98.8 | 0.726 | 0.601 | 0.060 | 0.481 | 0.060 | 0.000 | 17 |
| Aug | 46.0 | 1.138 | 0.350 | 0.035 | 0.280 | 0.035 | 0.000 | 69 |
| Sept | 20.7 | 0.078 | 0.190 | 0.019 | 0.152 | 0.019 | 0.000 | 0 |
| Oct | 12.8 | 0.219 | 0.106 | 0.011 | 0.085 | 0.011 | 0.000 | 52 |
| Nov | 4.0 | 0.114 | 0.026 | 0.003 | 0.021 | 0.003 | 0.000 | 77 |
| Dec | 2.6 | 0.000 | 0.040 | 0.004 | 0.032 | 0.004 | 0.000 | 0 |

Table 23. COSPSV04b JC blw LJC TMDL for copper

| Month | Flow (cfs) | Ambient or Observed Load (lbs/D) | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (WLA) Reserve Capacity (lbs/D) | Background Load (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 2.0 | 0.027 | 0.007 | 0.001 | 0.005 | 0.001 | 0.000 | 75 |
| Feb | 1.8 | 0.000 | 0.006 | 0.001 | 0.005 | 0.001 | 0.000 | 0 |
| Mar | 2.1 | 0.006 | 0.009 | 0.001 | 0.007 | 0.001 | 0.000 | 0 |
| Apr | 7.1 | 0.143 | 0.028 | 0.003 | 0.023 | 0.003 | 0.000 | 80 |
| May | 47.4 | 0.145 | 0.092 | 0.009 | 0.074 | 0.009 | 0.000 | 37 |
| Jun | 166.6 | 2.178 | 0.203 | 0.020 | 0.162 | 0.020 | 0.000 | 91 |
| Jul | 98.8 | 0.000 | 0.089 | 0.009 | 0.071 | 0.009 | 0.000 | 0 |
| Aug | 46.0 | 1.234 | 0.056 | 0.006 | 0.045 | 0.006 | 0.000 | 95 |
| Sept | 20.7 | 0.000 | 0.032 | 0.003 | 0.026 | 0.003 | 0.000 | 0 |
| Oct | 12.8 | 0.016 | 0.027 | 0.003 | 0.021 | 0.003 | 0.000 | 0 |
| Nov | 4.0 | 0.012 | 0.012 | 0.001 | 0.010 | 0.001 | 0.000 | 0 |
| Dec | 2.6 | 0.000 | 0.008 | 0.001 | 0.006 | 0.001 | 0.000 | 0 |

Table 24. COSPSV04b JC blw LJC TMDL for lead

| Month | Flow (cfs) | Ambient or Observed Load (lbs/D) | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (WLA) Reserve Capacity (lbs/D) | Background Load (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 2.0 | 0.267 | 0.461 | 0.046 | 0.297 | 0.046 | 0.072 | 0 |
| Feb | 1.8 | 0.362 | 0.425 | 0.042 | 0.278 | 0.042 | 0.062 | 0 |
| Mar | 2.1 | 3.891 | 0.448 | 0.045 | 0.285 | 0.045 | 0.073 | 88 |
| Apr | 7.1 | 1.664 | 0.887 | 0.089 | 0.459 | 0.089 | 0.250 | 47 |
| May | 47.4 | 27.023 | 4.149 | 0.415 | 1.650 | 0.415 | 1.670 | 85 |
| Jun | 166.6 | 0.000 | 17.763 | 1.776 | 8.343 | 1.776 | 5.867 | 0 |
| Jul | 98.8 | 2.560 | 8.381 | 0.838 | 3.226 | 0.838 | 3.479 | 0 |
| Aug | 46.0 | 9.563 | 4.885 | 0.488 | 2.288 | 0.488 | 1.619 | 49 |
| Sept | 20.7 | 1.087 | 2.653 | 0.265 | 1.393 | 0.265 | 0.730 | 0 |
| Oct | 12.8 | 1.818 | 1.788 | 0.179 | 0.979 | 0.179 | 0.451 | 2 |
| Nov | 4.0 | 2.771 | 0.664 | 0.066 | 0.390 | 0.066 | 0.141 | 76 |
| Dec | 2.6 | 0.304 | 0.560 | 0.056 | 0.356 | 0.056 | 0.093 | 0 |

Table 25. COSPSV04b JC blw LJC TMDL for zinc

## COSPSV04c LHC blwJC

A TMDL for COSPSV04c LHC blw JC was developed for copper. The TMDL was developed to attain both chronic and acute standards. The monthly TMDL was based on data from the Buckingham Park Site. The monthly TMDLs are presented in Table 26.

| Month | Flow (cfs) | Ambient or Observed Load (lbs/D) | Allowable Load TMDL (lbs/D) | 10% MOS (lbs/D) | WLA (lbs/D) | (WLA) Reserve Capacity (lbs/D) | Background Load (lbs/D) | % Reduction |
|---|---|---|---|---|---|---|---|---|
| Jan | 7.3 | 0.01 | 0.26 | 0.026 | 0.212 | 0.026 | 0.0 | 0 |
| Feb | 6.2 | 0.02 | 0.21 | 0.021 | 0.169 | 0.021 | 0.0 | 0 |
| Mar | 7.5 | 0.11 | 0.33 | 0.033 | 0.260 | 0.033 | 0.0 | 0 |
| Apr | 26.1 | 0.84 | 0.96 | 0.096 | 0.768 | 0.096 | 0.0 | 0 |
| May | 129.7 | 3.19 | 3.56 | 0.356 | 2.847 | 0.356 | 0.0 | 0 |
| Jun | 375.9 | 0.00 | 4.79 | 0.479 | 3.833 | 0.479 | 0.0 | 0 |
| Jul | 187.2 | 0.00 | 1.94 | 0.194 | 1.554 | 0.194 | 0.0 | 0 |
| Aug | 80.4 | 0.00 | 0.70 | 0.070 | 0.562 | 0.070 | 0.0 | 0 |
| Sept | 40.0 | 0.22 | 0.71 | 0.071 | 0.569 | 0.071 | 0.0 | 0 |
| Oct | 28.1 | 0.14 | 0.68 | 0.068 | 0.541 | 0.068 | 0.0 | 0 |
| Nov | 13.5 | 0.08 | 0.45 | 0.045 | 0.358 | 0.045 | 0.0 | 0 |
| Dec | 9.5 | 0.00 | 0.36 | 0.036 | 0.291 | 0.036 | 0.0 | 0 |

Table 26. COSPSV04c LHC blw JC TMDL for copper

pH TMDL

Exceedances of the lower pH standard of 6.5 s.u. were observed in portions of Left Hand Creek, segment COSPSV04a, and Little James Creek, segment COSPSV04b. In the upper reaches of COSPSV04a, both the fifteenth and eighty-fifth percentiles of the observed data were below the lower pH standard of 6.5. It is expected that remediation for the metals impairment (cadmium, copper, lead and zinc), by addressing sources of acid mine drainage, will result in attainment of the pH standard. Post-remediation monitoring can verify this assumption.

## IX. RESTORATION PLANNING AND IMPLEMENTATION PROCESS

### Water Quality Improvements in the Watershed

Work has been done recently to identify problem areas, assess the issues contributing to the metals loading and resulting acidic pH, and remediate identified spots contributing to the degradation of the water quality in the watershed. Multiple agencies and stakeholders have been involved in cleanup efforts during this time. In 2001, the Boulder County Board of Health established the Left Hand Watershed Task Force. The Task Force was established to assess the existing environmental and health data pertinent to the Left Hand Creek Watershed. The Task Force released the Final Report to the Boulder County Board of Health in March of 2002. This report found that the water in the Left Hand Creek watershed has environmental degradation and posed a risk to public health due to the historic mining activity in the area.

One of the recommendations of the Task Force was to establish a Watershed Oversight Group. In response to the recommendation, the Left Hand Watershed Oversight Group (LWOG) was formed to develop a watershed plan and help direct future remediation efforts. LWOG created a watershed management plan for Left Hand Creek in August 2005. In addition, Source Water Protection Plans were developed for the Left Hand Water District in 2010 (Colorado Rural Water Association, 2010) and for the Town of Jamestown in 2011(Colorado Rural Water Association, 2011). Prior to the formation of the LWOG, the James Creek Watershed Initiative was formed in 1997 to engage the engage the local community in protecting James Creek and the forest surrounding it. Both groups are active in the watershed in terms of remediation and protection efforts as well as representing the local communities in matters involving the watershed. Additional metals contamination research was performed by the University of Colorado's Outreach Extension for LWOG.

Several remediation projects have been conducted recently or are underway in the Left Hand watershed. As mentioned earlier, the Captain Jack site is listed on the Environmental Protection Agency's National Priorities List for cleanup and preliminary work has begun. Remediation work was performed at the Burlington Mine site under

the State of Colorado's Voluntary Cleanup Program (VCUP) by the land owner, Honeywell, Inc. Remediation work was performed at the Slide Mine under VCUP by the land owner, Golden Reef Mining, Inc. Boulder County utilized Brownfields grant money for remediation work at the Evening Star and Argo mine sites. The U.S. Forest Service has done cleanup work at the Bueno Mine, Fairday Mine, and Golden Age Mine sites. In addition, remediation work was completed on Little James Creek near Porphyry Mountain using State of Colorado 319 (Nonpoint Source) Program grant money.

**Monitoring**

In order to ensure that this TMDL is adequately protective of the segment, additional monitoring is necessary. LWOG continues to monitor sites on James Creek, Little James Creek and Left Hand Creek. It is expected that this monitoring is ongoing and will continue into the future.

## X. PUBLIC INVOLVEMENT

The public has had the opportunity to be involved in the Water Quality Control Commission (WQCC) hearings since 1996 when the WQCC adopted ambient-based standards. Opportunities for public involvement have also been available through the 303(d) listing process.

The TMDL is the subject of an independent public process. In February 2015, the Colorado Water Quality Control Division (division) Restoration and Protection Unit staff met with LWOG to discuss the TMDL. The division met with LWOG again on March 25, 2015. A draft of the TMDL report was made available for public review and comment during a 30 day public notice period April 3, 2015 through May 3, 2015.

The division received two comment letters from the public notice period. Only one letter offered comments and information that resulted in revisions to the TMDL report. After the public notice period, the division prepared responses to the comments and revised the report accordingly. Appendix A is a summary of the comments received during public notice period and the division's responses to those comments.

The final TMDL report was published in the Water Quality Bulletin for public review during a 30 day public notice period in June 2015, as required by Regulation 21(WQCC, 2015). Following this public notice period, the report was submitted to EPA.

After TMDL submittal to EPA in July 2015, an error in the zinc TMDL was identified. Specifically, there was an error in how the acute zinc standard was calculated. Correction of the error resulted in slight changes to the zinc TMDLs for COSPSV04a and COSPSV04b. Although the correction did not result in significant

changes to the TMDL and no permittees were impacted, in order to maintain transparency, the division decided to make the corrected report available for public review for two weeks in August 2015. Following this public review period, the corrected report was re-submitted to EPA.

## XI. REFERENCES


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**Appendix A**
**Summary of Comments received at Public Notice and Water Quality Control Division Reponses**

The Left Hand Creek Watershed TMDL report was made available for public review and comment during a 30 day public notice period in April 2015. The Division received two comment letters. One letter, from Mr. Glenn Patterson, offered comments and information resulting in revisions to the report. The second letter, from the U.S. Forest Service, offered useful perspectives and input about TMDL program aspects rather than specifics of this TMDL.

Mr. Patterson's comments provided clarification of the text including correction of the applicable HUC name, updates on restoration projects in the watershed, as well as substantive information on the data used for the COSPSV04b Little James Creek TMDLs. Mr. Patterson also commented the statement in the TMDL report that there were no stream gages in the impaired segments was inaccurate. Mr. Patterson provided a list of stream gages. Based on the comments received from Mr. Patterson, appropriate revisions were made to the text and the data assessments and the TMDLs for Little James Creek were revised. Following are Mr. Patterson's comments and the Division's responses to the comments.

Mr. Patterson: Page 7: While the HUC number, 10190005, is the correct code for Left Hand Creek, this is not the Colorado Headwaters HUC; it is the St. Vrain HUC.

*Division Response: This correction was made to the document text.*

Mr. Patterson: Page 12: The information about the Captain Jack-White Raven-Big Five Superfund site is correct but incomplete. Under the oversight of CDPHE and EPA, a surface remediation of the site was completed in November 2012, including consolidation and stabilization of waste rock piles, diversion of surface runoff around waste rock piles, revegetation, and other actions. A subsurface remediation project on the Big Five tunnel is planned but has not been started.
The VCUP at the Burlington site was completed as far as the plans went, but the site has not been fully remediated. A pond on the site, filled with drainage water from an adit, was not part of the VCUP restoration plan, and still discharges mine-related runoff to Little James Creek.
As mentioned at the top of the page, the Slide Mine has undergone a VCUP. In the middle of the page, this project is mentioned as though it were in the planning stages.

*Division Response: This section summarized a report from Bautts, et. al. 2007. The Division appreciates Mr. Patterson's additional information on projects subsequent to*

*the 2007 report. The additional information provided by Mr. Patterson was included in the document in paragraphs following this section.*

Mr. Patterson: Page 21: Based on the distribution of data among the months in figure 6, I suspect that most of the water quality data for the reach of Left Hand Creek from California Gulch to Slide Mine were collected prior to the surface restoration project referenced above. Perhaps more weight should be given to River Watch data collected after November 2012, which probably show improved water quality in this reach.

*Division Response: While developing this TMDL, the division recognized that, because of the long period of record, the TMDLs included some conservative assumptions. The Margin of Safety section of the report includes the following statement:*

> *"The datasets utilized in this TMDL assessment span a period of record that includes sample results that precede many of the remedial projects. Consequently the characterization of existing water quality in this report may reflect a greater degree of impairment than may actually exist."*

*Because of the September 2013 flood, the division decided to limit the data used for the TMDL to sampling events prior to the flood. The amount of post-2012 data available for this TMDL report was not adequate to draw conclusions about post restoration water quality.*

*Assessing effectiveness of restoration efforts is beyond the scope of this TMDL.*

Mr. Patterson: Page 26: The River Watch site (577) known as Little James Creek below Yellow Girl is actually located at a seep from the Yellow Girl adit, which flows into Little James Creek. It is not on the creek proper.

*Division Response: In the public notice version of the report, the copper and cadmium TMDLs for COSPSV04b, Little James Creek above James Creek were based on the site Little James Creek Below Yellow Girl. Based on the information provided by Mr. Patterson stating that the site Below Yellow Girl wasn't on Little James Creek, the division revised the assessments and the copper and cadmium TMDLs. The assessments and the text were revised to reflect the revised TMDLs.*

Mr. Patterson: Page 32: The statement about the lack of streamgages in the watershed is not exactly correct. Here is a list of active streamgages in the watershed:

1. Left Hand Creek at Hover Road near Longmont. Operated by the U.S. Geological Survey, in cooperation with the City of Longmont, since March 2015. Link:
http://waterdata.usgs.gov/co/nwis/uv?site_no=06724970

2. Lower Left Hand Creek (formerly USGS Left Hand Creek near Boulder). Located downstream of Geer Canyon and upstream of the Haldi Intake, where Left Hand Creek emerges from the mountains. Operated/data provided by OneRain, Inc, of Longmont, under contract with Urban Drainage and Flood Control District and Boulder County, and also Left Hand Ditch Company. Link:
https://udfcd.onerain.com/sensor.php?site_id=15854&device_id=2&view_id=296
This station is also known as LEFCRECO in the Division of Water Resources database, and is available at this link:
http://www.dwr.state.co.us/Surfacewater/data/detail_graph.aspx?ID=LEFCRECO

3. Left Hand Creek near Rowena. Located upstream of Rowena and downstream of Lickskillet Road. Operated by OneRain, Inc, of Longmont, under contract with Urban Drainage and Flood Control District and Boulder County. Link:
https://udfcd.onerain.com/sensor.php?site_id=15860&device_id=2&view_id=296

4. James Creek at Jamestown. Located on the Main Street bridge. Operated by OneRain, Inc, of Longmont, under contract with Urban Drainage and Flood Control District and Boulder County.
Link: https://udfcd.onerain.com/sensor.php?site_id=15861&device_id=2&view_id=296

The three gauges available from Urban Drainage, along with many others, are shown on an interactive map at this site:
onerain.com/map.php?&map_id=360&view_id=296&sensor_class=20&mode=sensor&interval=0&rainfall_enabled=&type=Radar%20Rainfall&overlay_index=0

5. Left Hand Ditch Diversion from South St. Vrain Creek to James Creek. Operated by Colo. Division of Water Resources, with station ID LEFTHDCO. Link:
http://www.dwr.state.co.us/Surfacewater/data/detail_graph.aspx?ID=LEFTHDCO

*Division Response: The draft TMDL stated there were no gages in the segments addressed in the TMDL. The division was aware of stream gages in lower segments but determined that the flow characteristics of those segments represent plains-types of streams, rather than high elevation streams. While the new gages within the area of concern for the TMDL will provide stream flow data in the future, because these gages came on-line immediately prior to the public notice of this TMDL report, the data were not included in the TMDL.*

*The LEFTHDCO gage was active during the applicable period of record and data from that gage were used in the TMDL.*

*The division is confident that the approach used in the TMDL is representative of the flow conditions for the stream segments in the TMDL. This approach has been used in several approved TMDLs in Colorado.*

Mr. Patterson: Page 35: In figure 23, the monthly distribution of flow in Little James Creek is assumed to follow the same pattern as Middle Boulder Creek. In actuality, Little James Creek peaks about a month earlier, in May. This is because its headwaters are located at a lower elevation than those of Middle Boulder Creek (or James Creek, with its diversion from S. St. Vrain Creek, or Left Hand Creek).

*Division Response: The division appreciates the observation, but had no alternative data to support a change in the hydrology used in the TMDL.*

Mr. Patterson: Page 47: The pH TMDL will be difficult to attain as background pH values in the watershed are usually below 6.5.

*Division Response: The division appreciates the perspective of and knowledge about the watershed provided by local groups and citizens, especially as they relate to potential restoration activities and the potential limitations faced in trying to reach the TMDL targets.*