Middle Fork of the South Platte
9 Element Watershed-based Plan

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January 31, 2020

EXECUTIVE SUMMARY

The Coalition for the Upper South Platte (CUSP) is a nonprofit watershed group formed in 1998 that works *to protect the water quality and ecological health of the Upper South Platte Watershed through the cooperative efforts of stakeholders with emphasis on community values and economic sustainability.* CUSP brings together stakeholders, ranging from local government to Front Range water providers, state and federal agencies, other nonprofit groups, and interested citizens, to implement projects and programs that further our mission.

Water quality impacts from abandoned mines was identified in CUSP's original strategic plan (2001) as a critical issue for watershed protection. In 2008, CUSP applied to the Office of Surface Mining/VISTA Western Hardrock Watershed Team for a VISTA volunteer, with additional funding support from the Colorado Division of Reclamation, Mining and Safety. Our first VISTA volunteer, Sara Lykens, spent her year of community service pulling together information on mines and mine issues across the watershed.

In 2009, Jara Johnson joined our crew to spearhead our Mines program. Jara, and several interns, spent the next few years performing extensive monitoring of mine areas within the watershed. This process led us to identify the upper Middle Fork area around Fairplay and Alma as the highest priority for us to move forward on projects. Over the next five years, we performed some "low-hanging fruit" projects, but also knew we needed to develop a more comprehensive plan to address mines in the region.

We recruited a stakeholder team (see acknowledgements, next page), and in 2017 received a Water Resources and Power Development Authority grant through the Nonpoint Source Program to develop a an EPA "9-Element Watershed-based Plan". This plan outlines our current state of understanding about water quality impacts from mines in the study area, and a proposed series of next steps to address these issues, to achieve the Clean Water Act goal of fishable/swimmable water quality.

ACKNOWLEDGEMENTS

This project is only possible through the collaboration of the agencies and entities who participated in the Stakeholder Committee include:

- Colorado Department of Public Health and Environment (CDPHE),
- Colorado Division of Reclamation, Mining, & Safety (DRMS),
- Colorado Division of Water Resources,
- Colorado Geologic Survey,
- Denver Water,
- Park County,
- Town of Alma,
- Town of Fairplay,
- Trout Unlimited (TU),
- US Environmental Protection Agency (USEPA),
- US Fish & Wildlife Service (USFWS),
- US Forest Service.

Special thanks go to the Colorado Water Resources and Power Development Authority and the Park County Land & Water Trust Fund for their funding support of this project, and to the CDPHE 319 Colorado Nonpoint Source Grant Program for their oversight of the grant and review of this watershed-based plan.

Special thanks also go to Sara Lykens and Jara Johnson for their early work on CUSP's mines initiative.

ACRONYMS

Al- Aluminum
BMPs- Best Management Practices
Cd- Cadmium
CDPHE- Colorado Department of Public Health and Environment
cfs- cubic feet per second
CGS- Colorado Geological Survey
COGCC- Colorado Oil & Gas Conservation Commission
CR- County Road
Cu- Copper
CUSP- Coalition for the Upper South Platte
CWQCC- Colorado Water Quality Control Commission
DRMS- Colorado Division of Reclamation, Mining and Safety
EPA- U.S. Environmental Protection Agency
Fe- Iron
HUC- Hydrologic Unit Code
JMJSWA- James Mark Jones State Wildlife Area
MAP- Mine Assessment Project
Mn- Manganese
ng/l- nanograms/liter
NOV/CDO- Notice of Violation/Cease and Desist Order
NWIS- National Water Information System
O&G- Oil and Gas
OPT- ounces per ton
OSM- Office of Surface Mining, U.S. Department of the Interior
Pb- Lead
ppb- parts per billion
TMDL- Total Maximum Daily Load
TU- Trout Unlimited
µg/l- micrograms per liter (equivalent to a ppb)
USFS- United States Forest Service
VISTA- Volunteers in Service to America, Corporation for National Service
Zn- Zinc

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INTRODUCTION AND BACKGROUND

Mining, traditionally an important economic engine within the Upper South Platte Watershed, has left its mark: runoff from tailings and acid from drainage carries heavy metals and results in acidification of streams. The mines, located in the headwaters of the watershed, are mostly abandoned and negatively impact not only area residents, but also the entire state, as this watershed provides drinking water to approximately three quarters of Colorado's residents.

In 1998, a group of Upper South Platte Watershed stakeholders, ranging from local governments and federal and state agencies, to businesses and interested individuals, banded together to protect the health of the watershed by forming a 501(c)(3) charitable nonprofit.

Three major events spurred the formation of the Coalition for the Upper South Platte (CUSP):

1. Potential designation of South Platte River segments under the Wild and Scenic Rivers Act, based on Outstandingly Remarkable Values. Front Range water providers (for whom the Upper South Platte Watershed is a major source of drinking water) were concerned about how a possible designation would affect their water rights and their ability to provide water to their communities.
2. Water providers were required to study the watershed as part of the U.S. Environmental Protection Agency's Source Water Assessment Programs.
3. The 1996 Buffalo Creek Fire burned 11,700 acres in the watershed, and the subsequent flooding resulted in serious impacts on lives, properties, and water supplies. The largest fire in Colorado history at the time, the Buffalo Creek Fire was a wake-up call for organizations dealing with forest health and fire issues that worse could come.

With these three events looming large, a series of stakeholder meetings were held, and a watershed nonprofit was born for the Upper South Platte Watershed. CUSP has been working tirelessly ever since to uphold our mission and protect this vital resource.

EPA NINE ELEMENTS

The United States Environmental Protection Agency (EPA) requires all implementation, demonstration, and outreach-education projects funded under Section 319 of the federal Clean Water Act to be supported by a Comprehensive Watershed Plan which includes nine listed elements. The nine EPA required elements:

A. Identify causes and sources of pollution

B. Estimate pollutant loading into the watershed and the expected load reductions

C. Describe management measures that will achieve load reductions and targeted critical areas.

D. Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the plan

E. Develop an information/education component

F. Develop a project schedule

G. Describe the interim, measurable milestones

H. Identify indicators to measure progress

I. Develop a monitoring component

CUSP's Mission

To protect the water quality and ecological health of the Upper South Platte Watershed, with emphasis on community values and economic sustainability…

Purpose of the Watershed Plan

This report is the result of almost 10 years of work to improve water quality for the Middle Fork of the Upper South Platte River near the towns of Alma and Fairplay, Colorado. This plan identifies critical areas of concern and implementation strategies to effectively remedy mining activities.

The purpose of this watershed plan is to:

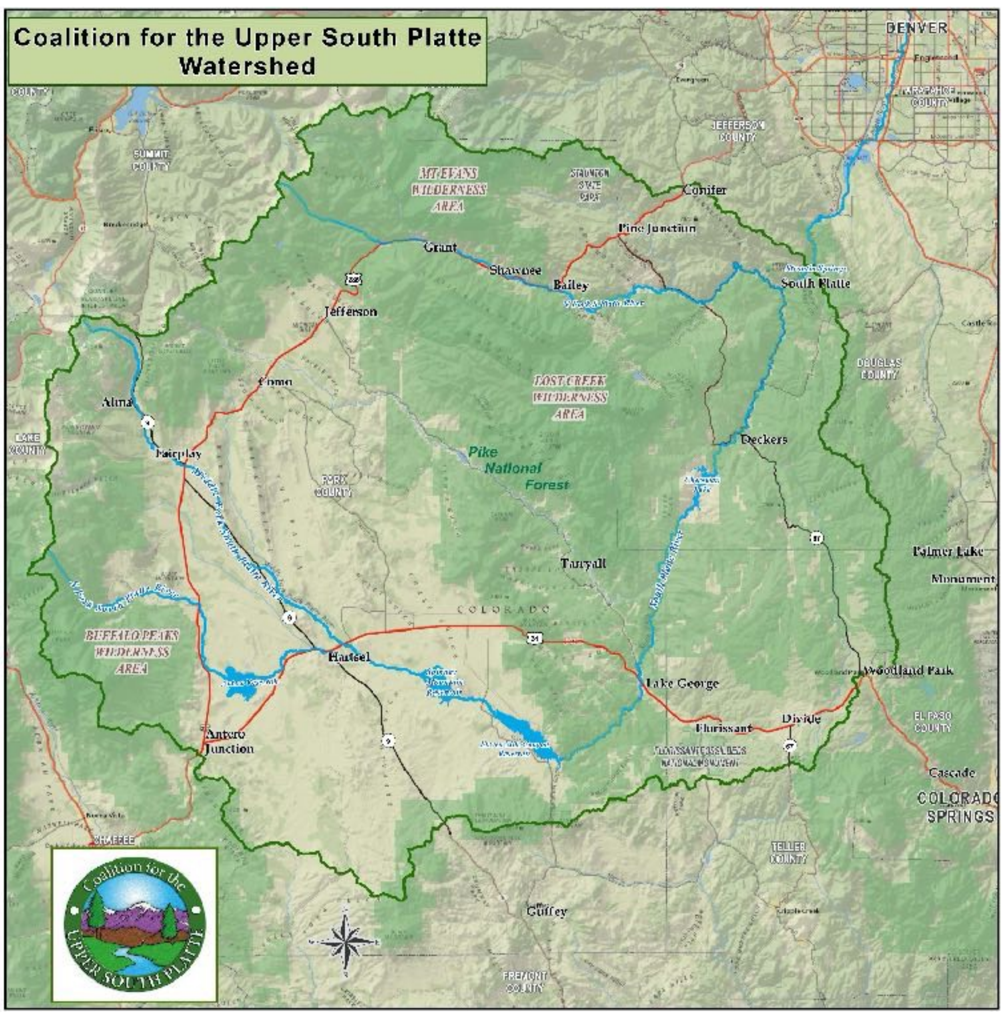
1. Review and summarize recent studies
2. Prepare a watershed plan detailing current watershed status
3. Propose projects that can be completed with current information
4. Determine areas where further analysis is needed
5. Establish a monitoring plan

Historic Orphan Boy Mine (structure burned in 2012.) Credit: Christie Wright, Park County Archives

WATERSHED DESCRIPTION

The Upper South Platte Watershed is a high-priority watershed for federal and state agencies and local partners. It covers 2,600 square miles southwest of Denver (encompassing two hydrologic units, numbers 10190001 and 10190002). The watershed is an important source-water area for Colorado's Front Range cities, providing about 80% of Denver's water and 95% of Aurora's municipal water. Portions of the Upper South Platte River convey both native flows and transmountain diversion water. The watershed is a major recreational area, with visitation from all over the state, including fisherman accessing its miles of "Gold-medal" fishing streams and half dozen reservoirs. Several stream segments are listed on the 303(d) list for metals/acid mine drainage.

The Upper South Platte Watershed begins along the Continental Divide in the Mosquito Range and ends at Strontia Springs Reservoir (map below). It varies in elevation from about 6,000 feet to over 14,000 feet above mean sea level. The Upper South Platte Watershed includes Park County and parts of Douglas, Teller, Jefferson, and Clear Creek counties. The watershed above Strontia Springs Reservoir can be defined by six main subwatersheds: main stem of the Upper South Platte River (upstream of the Strontia Springs to the confluence of the South and Middle Forks), North Fork, South Fork, Middle Fork, Horse Creek, and Tarryall Creek. There are five major municipal reservoirs within the watershed and several smaller reservoirs (CUSP, 2016).



Mine issues were ranked as an "issue of high priority" in the Coalition for the Upper South Platte's overall strategic plan (originally completed in 2000 and most recently updated in 2016). Although some mining still occurs within the watershed (currently, 162 permitted operations in Park County according the Colorado Division of Reclamation, Mining and Safety (DRMS) website; primarily permitted for sand/ gravel, or small-scale mining for gemstones, gold, and silver), these operators are subject to permitting through DRMS, and may be subject to enforcement actions for activities that cause water quality impacts, such as spills or failure to apply stormwater BMPs. Thus, water quality issues are largely associated with historic mines that are no longer operational. These water quality issues were the impetus for this project.

Water quality issues associated with mines in the Upper South Platte Watershed

Acid mine drainage, and high levels of metals that are harmful to fish and aquatic species, and may impact drinking water supplies. Primary metals of concern are Zn, Pb, and Cd.

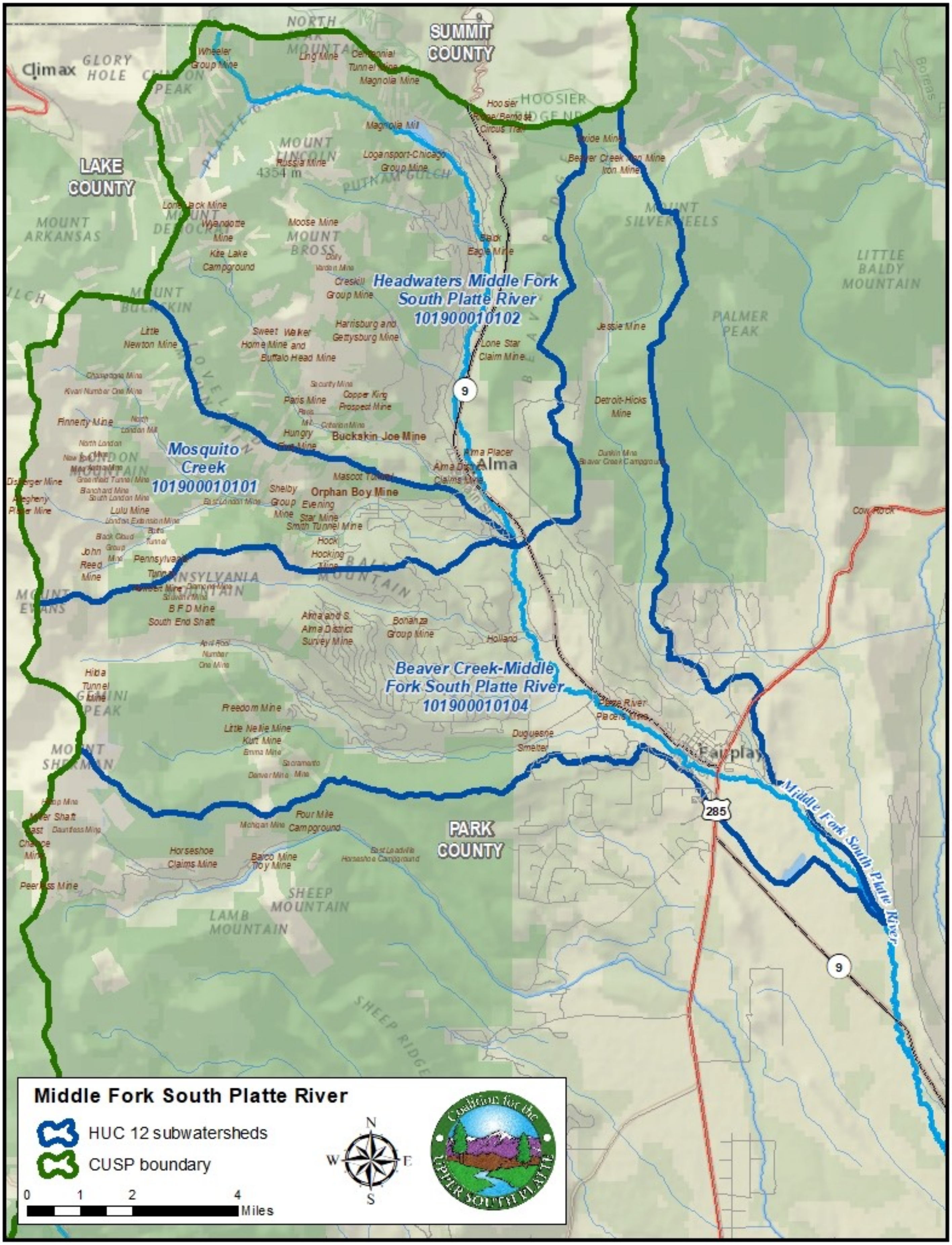
Study Area: Upper Middle Fork of the Upper South Platte

The Middle Fork of the Upper South Platte (see map, next page) originates in the snow-fed tarns of the Platte and Wheeler drainages. Mount Democrat (14,148 ft.), Traver Peak (13,852 ft.), Clinton Peak (13,857 ft.), Wheeler Mountain (13,690 ft.), and North Star Mountain (13,614 ft.) (from south to north) surround the headwaters of the Middle Fork. Montgomery Reservoir is located approximately 2.5 miles from the confluence of Platte and Wheeler gulch, the start of the main stem of the Middle Fork. The study focuses on three, 12-digit HUCs: Headwaters Middle Fork; Mosquito Creek; and Beaver Creek/ Middle Fork. The Middle Fork drains an area of 250 square miles comprising ~9.6% of the Upper South Platte watershed. Prominent tributaries in the upper Middle Fork drainage include Quartzville Creek, Dolly Varden Creek, Buckskin Creek, Mosquito Creek, and Sacramento Creek. The majority of mines near the headwaters are located high on the north slopes of Mount Lincoln (14,286 ft.) or high on the south slopes of North Star Mountain.

Hydrology and Climate

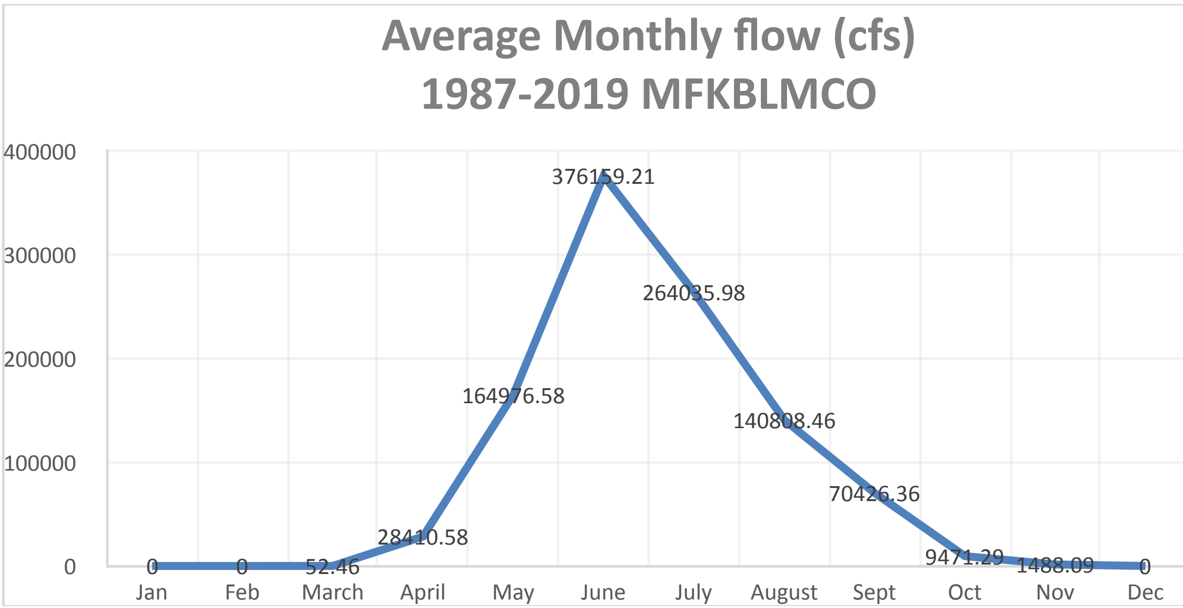
Climate within the watershed is highly dependent on elevation and location. The area covered by this plan has cool summers, with high-intensity, short-duration monsoonal rain patterns typically developing late afternoons during the hottest portion of summer. The area is characterized by very cold winters, with average temperatures ranging from substantially below 0°F (-30 is not uncommon) to afternoon highs occasionally exceeding freezing. Average annual precipitation ranges from about 15 to 40 inches and varies with altitude (Miller and Ortiz, 2007). Much of the precipitation is in the form of snow, which can accumulate to more than 300 inches per year in the mountains (Miller and Ortiz, 2007).

Hydrology is impacted by both precipitation and trans mountain diversions by Colorado Springs Utilities from the Blue River (in Summit County, west of the Continental Divide) to Montgomery Reservoir at the headwaters of the Middle Fork. Flows peak during runoff (May and June) and come down precipitously through the summer and fall, with little or no flow in the river during the winter due to freezing throughout the headwaters reaches. Water consumed in the study area includes municipal supplies for



Middle Fork South Platte River
HUC 12 subwatersheds
CUSP boundary
0 1 2 4 Miles
N
S
E
W
Coalition for the Upper South Platte
Headwaters Middle Fork South Platte River 101900010102
Mosquito Creek 101900010101
Beaver Creek-Middle Fork South Platte River 101900010104
Middle Fork South Platte River
SUMMIT COUNTY
LAKE COUNTY
PARK COUNTY
Climax
Alma
Fairplay
MOUNT LINCOLN
MOUNT BROSS
MOUNT DEMOCRAT
MOUNT BUCKSKIN
MOUNT SILVERHEELS
LITTLE BALDY MOUNTAIN
PALMER PEAK
LONDON MOUNTAIN
PENNSYLVANIA MOUNTAIN
MOUNT SHERMAN
SHEEP MOUNTAIN
LAMB MOUNTAIN
SHEEP RIDGE
MOUNT ARKANSAS
HOOSIER RIDGE
NORTH STAR MOUNTAIN
Buckskin Joe Mine
Orphan Boy Mine
Magnolia Mill
Russia Mine
Kite Lake Campground
Fourmile Campground

the town of Alma, which utilizes surface water from the Buckskin Gulch tributary, and the town of Fairplay, which has shallow wells northeast of town (the two towns use about 2 cfs). There are no major diversions for agriculture. There are several industrial diversions for mine operations. The latest is the Columbia placer, which can take up to 60 cs, but averages 10 cfs. Additional industrial diversions account for approximately 5 cfs.



Geology

Carbonate Geology of the Middle and South Fork Subdrainages and Its Influence on Buffering Capacity and Water Chemistry[1]

The geology of the Middle and South Forks of the Upper South Platte is dominated by highly faulted Proterozoic schist and gneiss, as well as Paleozoic marine carbonate, shale, and siltstone that were later intruded by Tertiary-age sills and dikes. Extensive Pleistocene glaciation is evident in the broad U-shaped valleys and small glacial tarn lakes situated at the bases of mountain cirques and arêtes. The valley bottoms are filled with both glacial debris and periglacial Quaternary gravels. These deposits host the gold placers exploited by early miners.

The headwalls of upper Buckskin Gulch, just south of Montgomery Gulch, are comprised of Archean schists and gneisses, and intrusive igneous rocks with Cambrian quartzite capping the tops of the peaks skylining the Buckskin amphitheater. Mines in this district exploited the silver-lead mantos and veins in

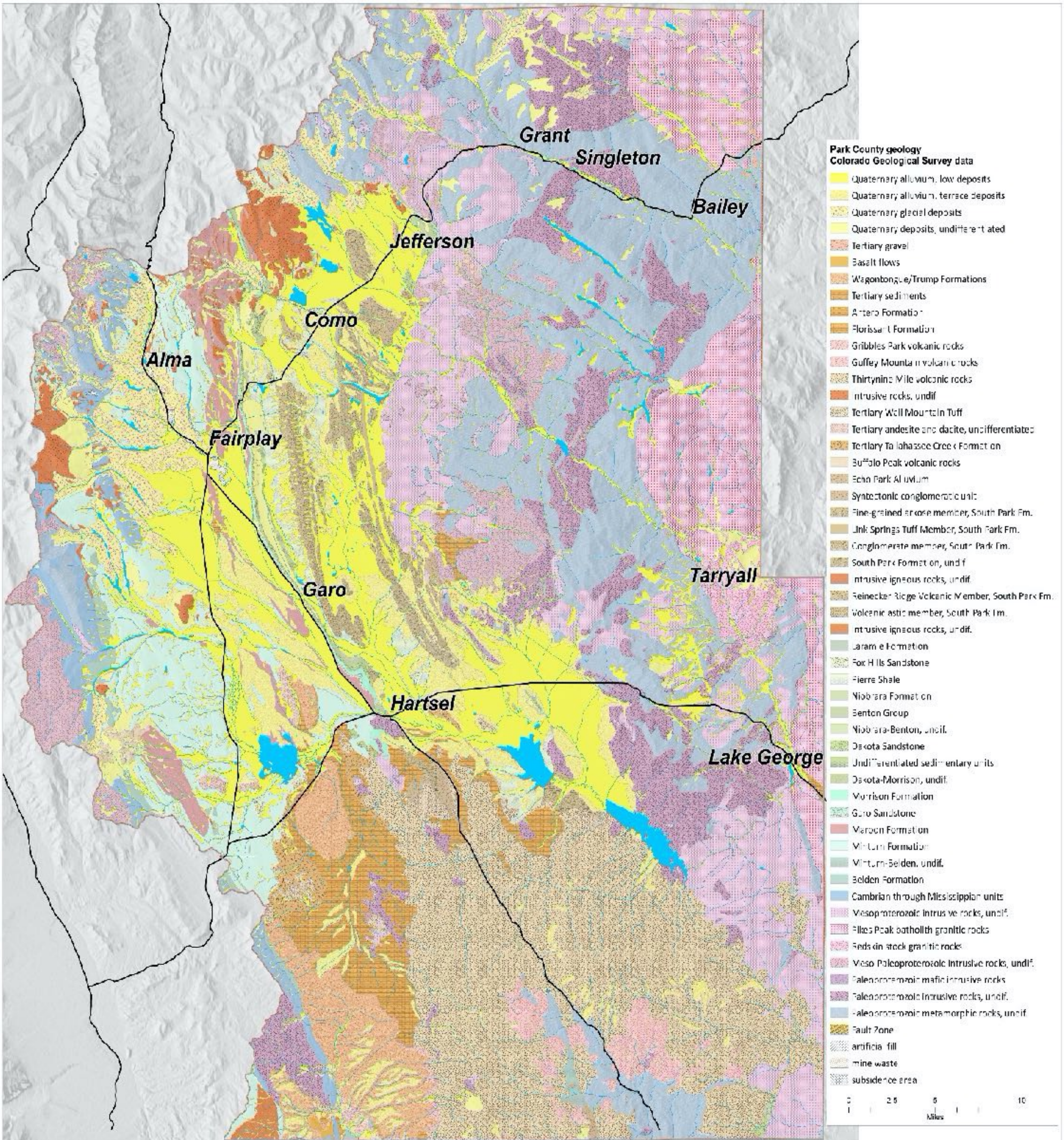
[1] Johnson, Jara: Report on Surface and Mine Water Sampling and Monitoring in the Upper South Platte Watershed, Park County, Colorado 2010 (https://cusp.ws/wp-content/uploads/2014/10/CUSPmineReport2010Comp.pdf)

carbonate host rocks, specifically the dolomite of the upper Mississippian Leadville Limestone. Other mines in the Buckskin subdistrict exploited polymetallic metal sulfide veins, hosted in both the Proterozoic igneous and metamorphic rocks and the Cambrian Sawatch Quartzite (Scarbrough, 2001). The Sawatch Quartzite is comprised of quartzite beds overlain by the Peerless Shale Member that includes layers of white and purple quartzites, limestone intervals, and grayish-green shale (McGookey, 2002).

The Orphan Boy Mine, in the Mosquito Drainage, is the southernmost vein and manto deposit of the Phillips Mine Group in the Buckskin drainage. The deposit is typical of the Sawatch Quartzite manto and vein deposit, in which the ore is confined to poorly developed quartzite-hosted mantos composed of massive pyrite containing variable amounts of galena, sphalerite, and chalcopyrite. Locally these sulfides constitute up to 30% of the vein along with calcite gangue (Patton et al., 1912). The Mosquito Gulch drainage is comprised of the same general geology as the Buckskin and Montgomery drainages. The London Group, the largest mine complex in the subdrainage, exploited a series of thick quartz monzonites and rhyolite sills (the London ore porphyry zone), hosted in a 175–575-foot-thick shattered zone near the base of the Pennsylvanian Weber Formation, comprised of siltstone, sandstone, and shale beds (Scarbrough, 2001). The London Group also exploited sills in the dolomitic portions of the Mississippian Leadville Limestone and Devonian-Mississippian Dyer Dolomite, the typical Mosquito Range host rock (Singewald and Butler, 1941). Mines located in the South Fork drainage also exploited similar deposits hosted in the typical Mosquito Range carbonate formations.

Mount Bross and the Red Amphitheater

Approximately three-quarters of the way up Buckskin Gulch from the town of Alma there is a semicircular break in the wall of the Ordovician sedimentary rocks, a thousand feet or more above the valley bottom along the southwest side of Mount Bross. Named the Red Amphitheater, the scree and talus slopes are various shades of red and yellow iron oxides. The Red Amphitheater represents a zone of pyritic hydrothermal alteration associated with the intrusion of the Buckskin stock into the Precambrian metamorphic rocks (McGookey, 2002). A small tributary drains the amphitheater and crosses County Road (CR) 8 just above its confluence with Buckskin Creek. This tributary is often cloudy with suspended and dissolved sediment and metals and represents a source of metal loading to Buckskin Creek that is considered natural rock drainage rather than mining-impacted.



Geologic map of Park County. The area of focus for this study covers the HUC 12s from Garo to the Continental Divide, including the area of Fairplay and Alma in the northwestern corner of the county.

MINING BACKGROUND OF THE STUDY AREA

Montgomery Gulch Area

As described above, the headwaters of the Middle Fork of the Upper South Platte originate high in Montgomery Gulch. Glacial geomorphology is dominant in this part of the watershed, including hanging valleys, broad U-shaped valleys, steep valley walls, glacial tarns (Upper and Lower Wheeler lakes), and prominent glacier cirques and arêtes. Outcrops of banded gneiss in Montgomery Gulch have deep grooves or glacial striations. The majority of the placer deposits in the Alma District originated from Montgomery Gulch. Montgomery was the first established mining camp in the Greater Alma Mining District in about 1861, the present location of Montgomery Reservoir. Early prospectors washed the glacial gravels for gold. Later, lode deposits of gold and silver were exploited by mines such as the Present Help, Orion, Kansas, Sovereign, Magnolia, and Tippecanoe. Some of these mines were located in the sedimentary formations of upper Mount Lincoln, while others were located along the gold-bearing fissure-type deposits in the schists on both sides of the Middle Fork of the Upper Platte River above Montgomery (Patton et al., 1912). The geology of Montgomery Gulch is typical of the Mosquito Range and consists of east-dipping Paleozoic sediments cut by east-dipping high-angle reverse faults and intruded by several sills and stocks.

Magnolia Mine and Mill

The Magnolia Mine is located on the south-facing slopes of North Star Mountain, among several other notable claims such as the Ling Mine and the Sovereign Mine. The Magnolia claim is located on both private and USFS lands. The area is accessed by FR 188 and FR 189 near 11,900 ft. The Magnolia Mine is currently owned by Earth Energy Resources, LLC, which also owns the Missouri Mine, the Russia Mine, much of the Moose Mine, and almost the entire top of Mount Lincoln. An aerial tramway connected the Magnolia Mine to the Magnolia Mill. The cable and towers are still present today. The Magnolia Mill is a massive structure at the inlet of Montgomery Reservoir. By 1862 as many as 1,000 people lived at the Montgomery town site. Six gold mills, including the Magnolia, processed ore from the area’s many mines.

Magnolia tram tower, looking west toward the headwaters of the Middle Fork.

Magnolia Mill, with Montgomery Reservoir in background.

Buckskin Gulch

Buckskin Gulch is the first major tributary to the Middle Fork just south of Placer Valley. The Buckskin subdistrict within the Greater Alma Mining District was settled and prospected in 1859 and derives its name from buckskin-clad prospector Joseph Higgenbottom. The booming camp of Buckskin Joe boasted many saloons, gambling halls, stores, offices, mills, and hotels, including the Tabor general store. The headwaters of Buckskin Creek originate from Kite Lake and Lake Emma. These two small glacial cirque lakes are located at the bases of Mount Democrat and Mount Bross. Buckskin Gulch was heavily mined and prospected until the last operating mine, the Sweet Home rhodochrosite mine, closed in 2004. Today there are a few small-scale active claims that are prospected seasonally.

Buckskin Gulch, looking toward Mount Democrat

Lake Emma, Kite Lake, and the Kentucky Bell Mine

Lake Emma is located above Kite Lake to the west, at an elevation of approximately 12,600 ft. Lake Emma is a typical glacial tarn that feeds the headwaters of the west fork of Buckskin Creek. The Buckskin Amphitheater is a very popular recreational area with a heavily used trailhead leading to the summits of the surrounding 14,000-ft. peaks, including Mounts Bross, Lincoln, Democrat, and Cameron. Prominent claims on the eastern slope of the ridge connecting Buckskin Mountain and Mount Democrat include the Black Barnet MS #3745, Queen of the Lakes MS #2162, and Little Mary MS #2161, all owned by the Earth Energy Resources, LLC., and the Ora King MS 3073, owned by the Climax Molybdenum Co. (Photograph 21). Directly behind Kite Lake to the north, on the slopes of Mount Democrat, prominent claims include the Humbolt MS #3044, owned by the Dukes Resources, LLC, the Quail MS #3508 (just to the north of the Humbolt) and the Kentucky Bell group, owned by Earth Energy Resources.

The most popular and productive mine site in the upper Buckskin drainage is the Kentucky Bell Mine. Buildings associated with the Kentucky Bell are located on the upslope of a ridge connecting Mount Democrat and Mount Cameron. The Kentucky Bell Mine exploited pyrite-associated gold veins, hosted in a northwest-striking porphyry dike intruding the granite country rock (Patton et al., 1912). The soft nature of the porphyry made stoping treacherous, requiring significant amounts of timber supports. Almost all of the work done at the Kentucky Bell was done by hand. In the summer of 1910, the mine was leased and bonded by the Colorado Gold Mining and Smelting Co. to provide ore to its smelter located in Alma (Patton et al., 1912). The production at this mine was limited by the high haulage costs from the high-elevation mine via wagons down to Alma. In 1910, the haulage capacity was one trip per day transporting about twenty tons of ore (Patton et al., 1912).

Lake Emma, Buckskin Gulch

The Kentucky Bell group was inventoried by Colorado Geological Survey (CGS) personnel in the 1994 United States Forest Service–Abandoned Mine Lands Initiative and given an Environmental Degradation Rating of 1 (extreme) because the test results exceeded state standards for aquatic life (chronic) in Al, Cd, Cu, Pb, and Zn and secondary drinking water standards for Mn (Neubert, 2006). In 1998, the U.S. Bureau of Reclamation (BOR) did a preliminary assessment of the mine and, based on visual observations, field testing, and the water samples collected in 1994, concluded that the mine effluent from the crosscut adit of the Kentucky Bell MS #19928 could be negatively impacting aquatic life as well as the Town of Alma's water supply (located approximately 4 miles downstream). The crosscut portal was closed by DRMS in 2001 (Neubert, 2006). The site was inventoried again in 2006 as part of a Land Transaction Screening Process instigated by a possible donation of the land to the USFS. This study concluded that although the mine effluent is degraded with respect to several trace metals, especially copper and to a lesser extent zinc, the effluent is naturally attenuated and meets all water-quality standards before it reaches Kite Lake, approximately 1,000 feet downstream from the mine (Neubert, 2006). Due to the proximity of the site to a popular access route to the Fourteeners (mountains higher than 14,000 feet) above, this site is highly visible and accessed by the public.

Prospects above Lake Emma

Sweet Home Mine

The Sweet Home Mine is located at the base of the Red Amphitheater, approximately 1.3 miles downstream from the Kite Lake parking area. The Sweet Home Mine was originally located as a silver mine in 1873 and in its first 20 years of operation this mine shipped approximately $185,000 in ore (Voynick, 1998, in Misantoni et al., 2006). The mine was dormant until the late 1910s, when it was reactivated through the 1920s, producing over $30,000 in silver prices of the time. Silver exploration was renewed in the 1960s through the 1980s without significant production (Voynick, 1998, in Misantoni et al., 2006). Although rhodochrosite was found early in the mine's history, it wasn't until the 1960s when it became valuable enough to mine as a byproduct. The Collector's Edge Minerals Company mined rhodochrosite from the early 1990s until 2004. Specimens from the Sweet Home Mine have been sold for over $1 million and the total gross production value of rhodochrosite specimens is estimate to be on the order of $15 million (Misantoni et al., 2006). In 2004, the Sweet Home Mine closed, the workings were plugged, the mine entrance adit collapsed, and the hillside was completely regraded and reclaimed. At the time of this inventory, there was a small amount of water draining in the vicinity of the reclaimed adit at <1 gpm.

Buckskin Joe Mine

The Buckskin Joe Mine site was originally located as the Phillips Lode, and was one of the earliest lode claims in the Alma Mining District circa 1859. "The rapid success of this mine was such, it has been reliably reported, that about $300,000 was recovered from it within the first two years of its discovery" (Patton et al., 1912). The ore from the Phillips was originally crushed using one of the 7 arastras in Buckskin Creek. Shortly thereafter, stamp mills could be heard echoing through Buckskin Gulch. The first stamp mill was erected in 1860 by Charles M. Farrend to crush ore from the Phillips (Fossett, 1878). By April 1862, there were 9 stamp mills in operation in Buckskin Gulch, totaling 78 stamps. In 1878, only 20 residents lived in Buckskin Joe and the Phillips Lode was owned by J. Q. Hart (Fossett, 1878). The Buckskin Joe Mine (listed as the Phillips in the Park County assessor database) is predominantly on private lands and therefore was not thoroughly investigated. The Buckskin Joe Mine consists of upper and lower sections, the upper being more extensive with a large waste-rock pile and several buildings still standing. It is believed that there are over 5 miles of underground workings between the upper and lower portions of the Buckskin Joe Mine (personal communication with Maury Reiber). The Phillips MS #234 and MS #2259A are owned by Mine Reclamation, LLC; these claims cover the upper and part of the lower Buckskin Joe Mine. The remainder of the lower mine, Phillips MS #143, is owned by the Peggi Tabor 1989 Trust.

Buckskin Joe adit

Mineral Park Mill Ponds

The Mineral Park area is located near timberline on Mount Bross, overlooking Alma and the greater South Park area. It is accessed off of CR 8 (Buckskin Gulch) via CR 787 (the Windy Ridge Road). The Mineral Park Mine and mill are more closely related to the high-elevation workings on the east side of Mount Bross, such as the Moose and Dolly Varden mines, than to those on the southwest side of Mount Bross, bounding the Buckskin drainage. The Mineral Park Mine itself is located on private land but is a popular parking area for access to the Bristlecone Pine Scenic Area. There are three mining buildings still standing at the mine site and a culvert with grate closing has been installed over a historical shaft. The mill lies upslope from the mine site at an elevation of approximately 11,600 ft. All that remains of the mill site is a concrete foundation. Just to the east of the mill foundation are five tailings ponds of variable sizes. At the time of the site visit, only one of the ponds still contained standing water. There are a significant amount of tailings fines in each bermed pond. The Mineral Park Mine site is owned by a number of individuals, but the mill lies within the boundaries of the Bristlecone Pine Scenic Area, USFS property.

Mosquito Gulch

Mosquito Gulch is the next drainage to the south from the Buckskin drainage and can be accessed by CR 12 approximately one mile from the town of Alma. The headwaters of Mosquito Creek begin as north and south forks in the high elevations of the Mosquito Range and extend approximately 3.6 and 3 miles, respectively, from the confluence to their sources. A series of cirque lakes, including Cooney Lake at the base of Treasure Vault Mountain (13,701 ft.) and Oliver Twist Lake at the base of Mosquito Peak (13,781 ft.), feed the headwaters of North Mosquito Creek. North Mosquito Creek is bound to the north by Loveland Mountain (13,361 ft.) and separated from South Mosquito Creek by London Mountain (13,194 ft.). Some of the largest gold nuggets found in Colorado are from London Mountain.

South Mosquito Creek originates just to the south of the Mosquito Pass summit (13,186 ft.). The South Mosquito drainage (approximately 4.4 square miles) is bounded by London Mountain to the north and Pennsylvania Mountain (13,006 ft.) to the south. Both drainages experienced intense mining activity from the 1860s until the South London Mine closed in 1989. Property ownership is dominated by private mining claims, primarily owned by the Write Trust. The remainder of the public lands are owned by the State of Colorado, the Bureau of Land Management (BLM), and the USFS.

London Mine Complex

The London gold vein was discovered in 1873 on the basis of mineralized float and sporadic outcrops. In 1875, the North London Mine was developed into a lode gold mine exploiting the London Fault ore body and specifically the contact zones between Tertiary intrusives and the Pennsylvanian-age Weber Formation and the Mississippian-age Leadville Limestone. The London vein is a structurally controlled polymetallic quartz vein that averages 1:1 gold to silver. The London Group of Mines is extensive, spanning both sides of London Mountain including the London, North London, South London, London

Extension, and Butte mines. Production was continuous until at least 1942, with production totals of 263,273 oz. gold, 237,178 oz. silver, 5,897,725 lbs. lead, and 165,520 lbs. of copper. From the 1970s through the early 1990s, sporadic mining occurred in the lowest tunnel of the complex, associated with the South London and the London Extension tunnel (Herron, 2004). The American Mine shaft is located about one-quarter mile north of the London Extension tunnel at an elevation of 12,200 feet and provides natural ventilation to all the workings of the London Extension and water tunnel levels. The American Mine shaft was also used to transport ore between the workings of the London mine complex and to the valley bottom.

In 1997, as part of a 319 funded project with the Colorado Nonpoint Source Pollution Control Program, a water treatment project was implemented to treat the mine drainage emerging from the London Extension Tunnel. Completed in 1998 and modified in 2002, the treatment system removed over 99.8% of the heavy metals with the effluent maintained at a pH between 9.5 and 10.0. The zinc removal averaged approximately 20 pounds per day. The system consisted of a collection system inside the mine, followed by the cement kiln dust (CKD) addition equipment and settling pond. The collected water was mixed with a measured amount of CKD, which acted as a neutralizing agent thereby precipitating the heavy metals. Total construction cost for the treatment system was approximately $150,000 and annual operation costs are estimated to be at least $10,000 (Herron, 2004).

London Mine, *credit /Eve Kuenn, Park County Archives*

The treatment system was working well until an internal collapse caused the water flow to reroute around the treatment plant causing violations from both the Extension Tunnel (held by Prairie Center Metropolitan District until November 2016) and the Water Tunnel (held by London Mine, LLC until November 2016). In 2009 a Notice of Violation/Cease and Desist Order (NOV/CDO) was issued to Prairie Center Metropolitan District for ongoing violations of the pH, zinc and cadmium permit effluent limitations at the Extension Tunnel. In 2012 the NOV/CDO was resolved with a Compliance Order on Consent that included requirements to make improvements to the Extension Tunnel wastewater treatment plant, which were completed in September 2013. In 2009 and 2013 NOV/CDOs were also issued to London Mine, LLC for violations of the zinc and cadmium permit effluent limitations at the water tunnel. In 2014 the Colorado Water Quality Control Division and London Mine, LLC entered into an agreement to undertake a pilot project aimed at treating the discharge to meet the permit effluent limitations, however the pilot project stalled because London Mine, LLC did not provide financing.

In 2016 MineWater Finance, LLC, acquired the London Mine, agreeing to pay the penalties accrued prior to their ownership and to bring the discharge back to meeting permit requirements. In 2018 MineWater acquired the land previously held by Prairie Center Metropolitan District and consolidated water rights to enable development of the water. MineWater has repaired the collapsing water tunnel, implemented an in-situ mine pool treatment that precipitates heavy metal using bacterial sulfate reductions, completed several critical water diversions and developed additional water rights. As a result of these actions the long-term (trailing 24 month) average of the dissolved zinc concentrations discharging from London Mine has decreased from over 4,500 ppb to less the 1,000 ppb, with the 2019 concentrations below 500 ppb zinc.

MineWater has partnered with Aurora Water, who acquired water for municipal use, and the partners are implementing additional work at the site. The partners expect to improve the water quality through additional remediation and reclamation such that the zinc concentration will, by October 2022, meet the target of 165 ppb.

Orphan Boy Mine

One of the original mines in the Leadville land district with an initial survey number of 37, the Orphan Boy gold mine is another substantial mine in the Mosquito drainage, downstream of the London Complex. The mine is located near Park City, once a stage stop on the route to Leadville over Mosquito Pass (McGookey, 2002). The Orphan Boy group is made up of 23 patented claims that cover approximately 133 acres on the eastern slope of Loveland Mountain. The gold ore of the Orphan Boy is closely associated with pyrite and chalcopyrite. At one point, the Orphan Boy workings included the tunnel house or shop; an ore house with bins of 75 tons capacity; a power house containing two boilers, a 6-drill Rand Imperial compressor, a 3-drill Norwalk compressor, a large air receiver, and feed-water heaters; a boarding house; and an assay office.

The adits in the Orphan Boy are generally driven in the northwest direction until contact with the ore-bearing horizon, where the main bore was diverted to the northeast to follow the strike of the beds. The principal production of the mine was from the workings below the Honeycomb chute. In 1912, James

Moynahan of Alma (a future Colorado state senator) was president of the Kennebec Mining Company and had plans to resume operations at the dormant mine (Patton et al., 1912). By 1912, over 11,000 tons of ore were recovered from the Orphan Boy Mine, generally averaging 0.25–0.5 opt gold, 10–25 opt silver, 3–4% copper, and 20% zinc (Patton et al., 1912).

Orphan Boy, drainage through tailings.

Beaver Creek HUC

The Beaver Creek HUC includes Beaver Creek, Sacramento Creek, and Pennsylvania Creek. These drainages are ringed by Mount Evans, Mount Sherman, and Gemini Peak on the West side, and Hoosier Ridge on the north.

There are approximately a dozen historic mines in this area. Iron and Iron oxide were mined in the upper reach of Beaver Creek at the Oxide Mine and the Beaver Creek Iron Mine. The Majestic, Hilda, and Bonanza mines operated for lead and zinc; South End, Venus, Sitting Bull and Little Nell were operated for uranium; the Alma and South Alma Survey were lead mines; the Shewood was a silver mine. (westernmininghistory.com, 2020).

WATER QUALITY

Studies

CUSP

2010- Coalition for the Upper South Platte (CUSP) Mine Assessment Project: Report on Surface and Mine Water Sampling and Monitoring in the Upper South Platte Watershed, Park County, Colorado

In 2010, with aid of the Colorado Healthy Rivers Fund and the Hillsdale Fund, CUSP collected water quality data and mapped mine features throughout the watershed on a reconnaissance level. While some mine data was gathered on National Forest Service and other public lands, there was a significant lack of information for mines on private lands. Some public land also required a more detailed analysis of mine areas previously identified along with impaired river segments. The 2010 reconnaissance level monitoring identified specific mines within the watershed that require additional monitoring and eliminated many mines that were found to not be significant pollutant sources within the watershed.

During the 2010 field season, approximately 50 mine sites were visited; 50 water-quality samples were sent to Denver Water Laboratory for analysis, as part of an in-kind donation; 73 sites were tested for field parameters throughout eight prominent tributaries; basic property ownership and boundaries were determined for the 50 sites; and mine sites and tributaries were prioritized for continued monitoring. Most importantly, partnerships with local, state, and federal agencies and groups were developed and positive connections were made with mine owners.

The 2010 Mine Assessment Project (MAP) confirmed three sources of natural water-quality degradation associated with hydrothermally altered geologic terrain: Handcart Gulch and Geneva Creek (tributaries to the North Fork of the Upper South Platte) and drainage from the Red Amphitheater in Buckskin Gulch (a tributary to the Middle Fork of the Upper South Platte), represent notable sources of metal loading to the watershed. Water chemistry throughout the watershed is dominantly a result of the surrounding geology. This was demonstrated by the neutral to basic pH readings in the Middle Fork and South Fork drainages. These pH values are the result of surface and groundwater interaction with the carbonate sedimentary formations that also hosted the ore deposits exploited by the miners of gold, silver, lead, zinc, and copper. The data collected in the 2010 season confirmed that not all mines discharge acid mine drainage, and neutral to basic pH dominated the mine drainage in the Upper South Platte inventory. Although the majority of mine drainage was neutral, heavy metals were detected at levels that exceeded state aquatic life standards and, in some cases, drinking water standards.

A 2015 MAP was conducted as a joint effort between CUSP, USFS, Colorado DRMS, CDPHE, Region 8 EPA and the town of Alma. The mines and subdrainages identified during the 2010 season and monitored in the 2011 field seasons were the focus of this project. This information was used to establish a baseline of water quality conditions representative of high and low stream flow conditions and characterization of mine source (adit loading and heavy metal concentration in mine waste). Information collected was used to determine if cleanup was warranted at any of the mine site areas.

2011-2012 Surface and Mine Water Sampling and Monitoring in the Upper South Platte Watershed, Park County, Colorado

Priorities for the 2011 season were slightly different than the goals of the 2010 season. The primary objectives of the 2011 CUSP Mine Assessment Project were to: (1) Collect samples from the selected mines identified in the 2010 reconnaissance study. Specifically: collect 50 water quality samples from selected sites during the spring snow melt event and the fall low-flow event for laboratory analysis to better identify seasonal trends; delineate the source and extent of metals exceeding state water quality standards from selected 2010 sample locations; collect waste rock samples from selected mine sites; and better map (using a Magellan GPS) private mine sites not visited during the 2010 season; (2) Visit mines and mining areas in order to collect more accurate GPS readings at the mines, including documenting significant features such as extent and placement of tailings piles, draining tunnels, etc.; (3) Continue to establish and map ownership information for problem mines on private lands and develop working relationships with private owners; (4) Following analysis of the 2011 data, develop conceptual remediation plans for the highest priority projects that include a preferred alternative approach; (5) Provide outreach to interested parties on findings and opportunities; (6) Create a potential funding matrix to allow pursuit of funding for on-the-ground project implementation in the coming years; (7) Update the comprehensive mine assessment document created in 2010 with 2011 data, analysis, and potential remediation alternatives; and (8) Create a database of mine data collected in the 2010 and 2011 CUSP mine assessment studies as well as historical data and information for inactive mines throughout the Upper South Platte Watershed.

Mines and drainages prioritized for further monitoring and characterization following the 2010 field season consist of: (1) the Buckskin Creek drainage, including the Kentucky Bell Mine area, the Sweet Home Mine area, the Mineral Park Mill ponds, and the Buckskin Joe Mine; (2) both the North and South Forks of Mosquito Creek, including the American Mill site and the Orphan Boy Mine; (3) the North Fork of the Upper South Platte, including the Missouri and Whale Mine complex; (4) the Fourmile Creek drainage; (5) the Wilkerson Pass Mine (Great Eastern); and (6) the Lake George Industries site. Fieldwork during the 2011 summer season, included mine adit discharge, surface water sampling, and waste rock or tailings sediment sampling. Additionally, mine features such as location and extent of waste rock piles, historic structures, adits, shafts, and other mine related infrastructure were mapped using a Magellan GSP unit.

Geology and Groundwater Resources of Park County, Colorado By Peter E. Barkmann, Lesley A. Sebol, Erinn P. Johnson, F. Scot Fitzgerald, and William Curtiss Colorado Geological Survey, Colorado School of Mines Golden, Colorado 2015 (Revised 2017)

This report compiles the most recent geologic mapping and interpretations focusing on groundwater occurrences in the various geologic formations found in the area. It has been prepared as a web-based product with the general public in mind, although it contains detailed background information to be beneficial to more technical users. The intent is to create a framework that illustrates the variety of geologic formations and how groundwater resources fit in the many geologic settings across the county. Because of the regional nature of this effort, detailed specifics are not presented. Aquifer specifics would require site-specific data and interpretation. For many aquifers and areas, site specific data simply are not available in the public domain. This effort should help guide future data gathering efforts that would be very useful for detailed assessments on an aquifer-by-aquifer basis and area-by-area basis.

The quality of water is an important aspect of this vital resource. Ambient water chemistry is directly tied to the geologic framework of the hydrogeologic units through which is passes. Recognition of the need to characterize ambient water quality conditions, particularly in South Park, came from CUSP in 2011 in response to increased natural gas exploration in the greater South Park area. At that time, El Paso E&P Company, LP held three oil and gas (O&G) permits issued by the Colorado Oil and Gas Conservation Commission (COGCC). These permitted O&G wells were located within the James Mark Jones State Wildlife Area (JMJSWA). One well was drilled in September 2010, but was later abandoned.

Initial groundwater and surface water sampling was conducted between 2011 and 2014 to identify baseline water quality conditions in the vicinity of potential natural gas exploration in the South Park area. Additional groundwater sampling in 2016 expanded the coverage to include other hydrogeologic units across the entire county to provide more comprehensive baseline conditions for all recognized settings. Baseline data is the initial collection of data that serves as a basis for comparison with any data collected in the future. Therefore, the intent of this data is to aid in the understanding of the water quality conditions prior to the development of major natural gas or other mineral extraction activities. This report also summarizes historic work done by other agencies and organizations in relation to water quality.

EPA

2014- Buckskin Gulch and Mosquito Gulch Alma Mining District Park County, Colorado SAMPLING TRIP REPORT

This trip report describes activities specific to the September 23, 2014 sampling event at Buckskin Gulch and Mosquito Gulch which are part of the Alma Mining District located in the Pike National Forest located in Park County near the town of Alma, Colorado. Field activities followed the applicable United States Environmental Protection Agency (EPA) approved Environmental Services Assistance Team (ESAT) Standard Operating Procedures (SOPs), and provisions outlined in *Quality Assurance Project Plan/ Sampling and Analysis Plan* (SAP/QAPP)*, Buckskin Gulch and Mosquito Gulch: Alma Mining District* (Coalition for the Upper South Platte [CUSP]/United States Forest Service [USFS], 2014). On September 23, 2014, the EPA, working in cooperation with the USFS, CUSP, and ESAT, conducted sampling throughout the Alma Mining District. This sampling event supported the primary objective of the 2014 SAP, which was to identify seasonal trends and delineate the source and extent of metals loading, resulting in surface water conditions that exceed state water quality standards. Additional goals of the 2014 sampling events were: to assess the impact of specific mine sites and compare them to sources of natural contributions to the watershed, to identify spatial and temporal water quality conditions through seasonal sampling, and develop potential remediation alternatives for the respective sites.

2015 Buckskin Gulch and Mosquito Gulch Alma Mining District Park County, Colorado SAMPLING TRIP REPORTS

These trip reports describe activities specific to the September 2015 sampling event at Buckskin Gulch and Mosquito Gulch which are part of the Alma Mining District located in the Pike National Forest located in Park County near the town of Alma, Colorado. Field activities followed Environmental Protection Agency (EPA) approved Standard Operating Procedures (SOPs), and provisions outlined in *Quality Assurance Project Plan/Sampling and Analysis Plan* (SAP/QAPP)*, Buckskin Gulch and Mosquito Gulch: Alma Mining District* (Coalition for the Upper South Platte [CUSP]/United States Forest Service [USFS], 2015).

In September 2015, the EPA, working in cooperation with the USFS, CUSP, United States Fish and Wildlife Service (USFWS), and Division of Reclamation Mining and Safety (DRMS), with support provided by ESAT, conducted sampling throughout the Alma Mining District. This sampling event supported the primary objective outlined in the 2015 SAP, which was to identify seasonal trends and delineate the source and extent of metals loading resulting in surface water conditions that exceed state water quality standards. Additional goals of the 2015 sampling events were to assess the impact of specific mine sites and compare to sources of natural contributions to the watershed, to identify spatial and temporal water quality conditions through seasonal sampling, and develop potential remediation alternatives for the respective sites.

Both the Buckskin Joe and the Orphan Boy were identified as potential sources of contamination during previous water quality and abandoned mine inventories. Both mine sites are in close proximity to private and public drinking water sources and important tributaries to the Middle Fork of the South Platte. Historically, limited surface water samples have been collected on these two mine areas since they are on private property.

Surface Water Quality Data Sources

- CUSP studies (2010, 2011, 2012, 2018, 2019)
- EPA ESAT studies (2013, 2014, 2015*)
- NWIS database (1971, 1974, 1977-1980, 1998-2003)
- STORET database (1988-1990, 1992-2018)

*EPA 2015 dataset was the most complete of the reports that were reviewed, including both flow and concentration data, and served for loading calculations. Other water quality sampling generally occurred during high or low flow in the late spring or early fall, respectively. Corresponding surface water flow rate data is much more limited, especially during high flow (snow melt) events on the creeks. This is most likely due to safety issues.

2018-2019 Middle Fork Active Mines Assessment

In 2018 residents in the area raised concerns about currently operating gold mines in the Fairplay and Alma areas and their impact on water quality. Citizens were particularly concerned that operators might be polluting the Middle Fork of the South Platte with mercury from historic operations. Park county asked CUSP to collect samples to determine if there was any truth to this.

After identifying current operating mines, CUSP set up sampling points to collect samples above all operating mines and then working down the river and a few tributary locations. Samples were collected at 6 locations during high, medium and low flow times, and river-bed soil samples were also collected at a select set of locations. No points had the high levels of mercury that the community was worried about. In 2019, because there were low levels of mercury and methyl mercury, CUSP tested several points further upstream to determine if there was a source for the mercury. After two more rounds of sampling in 2019 CUSP determined there were no specific sources, and that the mercury and methyl mercury are probably a result of historic mining operations in the area.

During sampling, CUSP also monitored for a wide range of additional constituents, including gas and diesel organics, volatile organics, other metals, and nutrients. Results are included in the Appendix 1.

Data Gaps

Our analysis revealed a number of data gaps in our study area. We have made recommendations for future data collect on page 37. Gaps include:

- Lack of flow measurements during high-flow conditions (due to data collection safety issues and challenges of measuring turbulent flow) at many sites
- Inadequate measurements on Buckskin Creek above and below the Buckskin Joe Mine to the confluence with Middle Fork to differentiate other sources of metals.
- Sparse/inadequate, or no data, on the Platte or other tributary creeks in HUC 12 [Headwaters Middle Fork South Plate River 101900010102] above Buckskin Creek: i.e., Quartzville & Sawmill Creeks.
- Sparse/inadequate, or no data, in HUC 12 [Beaver Creek-Middle Fork South Plate River 101900010104]: i.e., Sacramento, Pennsylvania & Beaver Creeks

Current and Historic Stream Flow Gages

Site Name	Site Location	Begin Date	End Date	Recorded Years	Five Year Peak (cfs)
MFKABMCO	Middle Fork South Platte Above Montgomery Res	Jan-93	Current	26	151
MFKBLMCO	Middle Fork South Platte Below Montgomery Res	Jul-95	Current	24	125
MFKPRICO	Middle Fork South Platte at Prince	Aug-87	Current	32	641
LOMNINCO	London Mine * 2019 only—new gage	Feb-19	Current	1	3.7*
SPRBRBCO	Spring Branch Above Confluence with Middle Fork	Jul-91	Current	28	28.2
HSPTUNCO	Hoosier Pass Tunnel at Montgomery Res near Alma	May-53	Current	66	3.2
SFKANTCO	South Fork of South Platte Above Antero	Jul-87	Current	32	375

Discussion of Findings

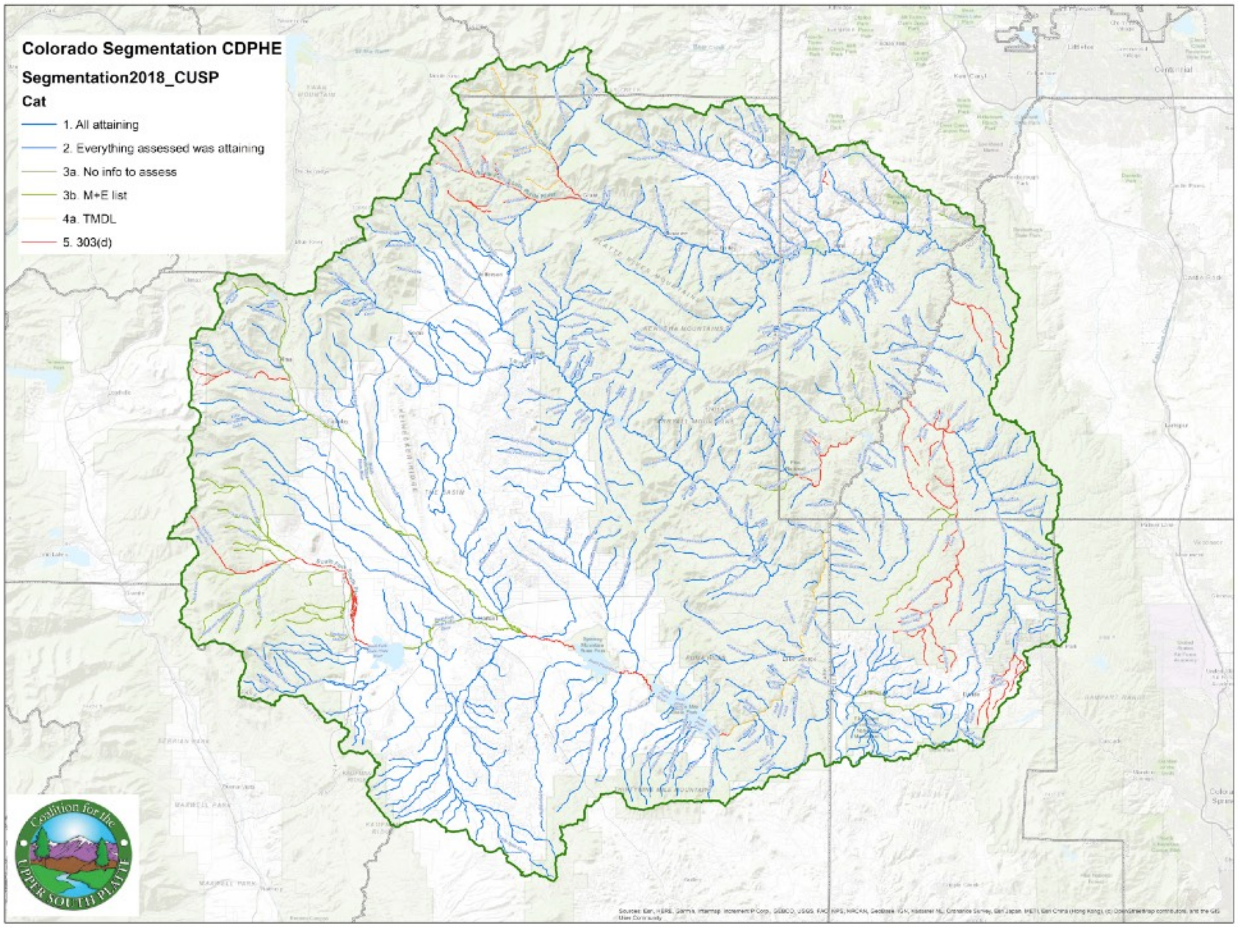
Water Quality Tool

Colorado Geologic Survey (CGS) staff served as the consulting team for CUSP's current analysis. As part of their outcomes, they produced a GIS-based map system that brings all existing data for this area into ArcGIS for viewing and analysis.

CGS also analyzed loading where flow data and concentration was available, and is the source of tables in this section.

Water-quality sampling within the Middle and South Fork tributaries, including the Montgomery, Buckskin, and Mosquito drainages revealed generally neutral to slightly basic pH values and relatively high hardness contents. Water hardness in these drainages is directly related to interactions with the extensive carbonate bedrock in the western part of the watershed. As described above, mines in these drainages exploited porphyry deposits hosted in the carbonate sedimentary rocks or in quartzite formations surrounded by carbonate-rich country rock. Therefore, groundwater flowing through the underground mine workings and surface waters flowing through the waste rock piles are interacting with these same sedimentary formations. Any acid generation resulting from water interaction with sulfides present in the mineralized zone of the ore deposit is minimized by the presence of carbonate host or country rock.

Both the main and south forks of Mosquito Creek were listed on the 1998 303(d) list and targeted for TMDL assignment by the Colorado Water Quality Control Commission (CWQCC.) South Mosquito Creek below the London Mine is designated as an Aquatic Life Use (Cold 1) stream that was not supporting its designated use due to high levels of Cd, Fe, Zn, and Mn. The main stem of Mosquito Creek below its confluence with the South Mosquito to the confluence with the Middle Fork of the Upper South Platte is also designated as an Aquatic Life Use (Cold 1) stream that was only partially supporting its designated use due to high levels of Zn, Cd, and Pb. TMDLs were signed in 2000 on both Mosquito Creek and South Mosquito Creek for these metals.



Studies done by NUS Corporation and CDPHE indicated that aquatic life in South Mosquito Creek was essentially nonexistent and that aquatic life in Mosquito Creek below the confluence of the north and south forks was severely depleted. The CDPHE identified five sources of contamination in the South Mosquito and Mosquito Creek drainage basins during a study in August 1988, including the Montgomery (Alma-Betts) Mill tailings, the historical London Mine tailings, the Butte tailings, the North London Mill tailings, and the drainage from the London Extension Tunnel, this last identified as the largest single source of metal contamination to the Mosquito Creek watershed (Herron, 2004); however, water quality is improving from the London system, as discussed above, and below in more detail.

All previous monitoring and sampling events were compiled into one Excel file to determine if there is enough data on any of the previously mentioned sites to move forward with projects. Exceedances and loadings were mapped using ArcGIS.

Surface Water Quality

Using CO Reg. 31 (Table III: metals) surface water aquatic life standards (acute and chronic) were calculated. Analytes having measured flows with one or more exceedances include:

Standards			
Analyte	**Reach 2a**	**Reach 2b**	**Reach 2c**
Cadmium*	0.51	1.33	1.31
Iron	300	300	300
Lead	0.91	5.22	5.04
Manganes	50	50	50
Zinc*	45	110	250

** Indicates many exceedances;*

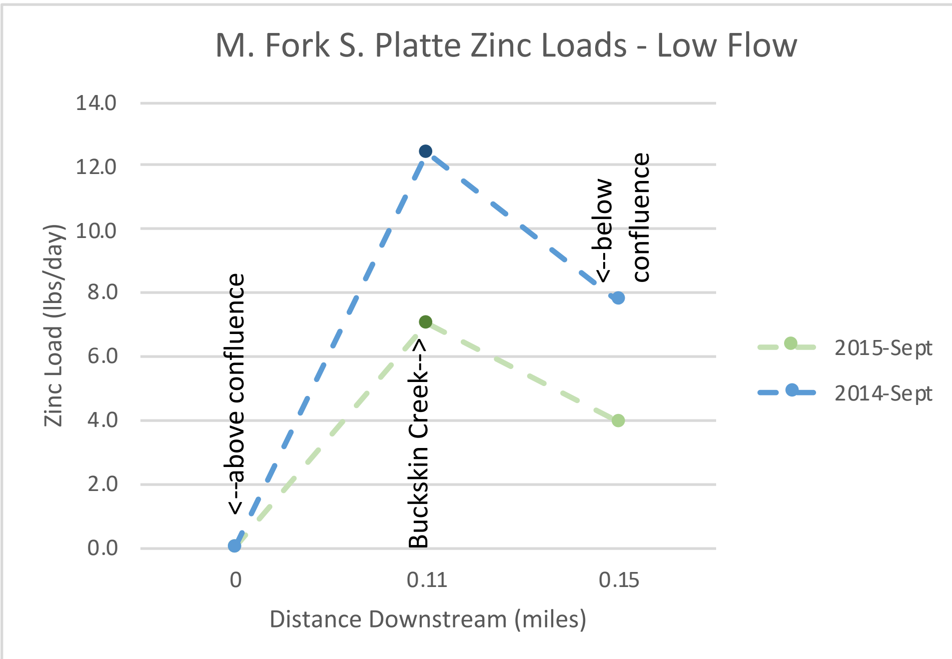
- *Standards in PPB or µg/l;*
- *Standards based on table values, with calculated factor, based on hardness (Source Reg 38 & TMDL, CDPHE)*
- *Metal standards set to meet the Aquatic 1, cold-water, with trout classification*

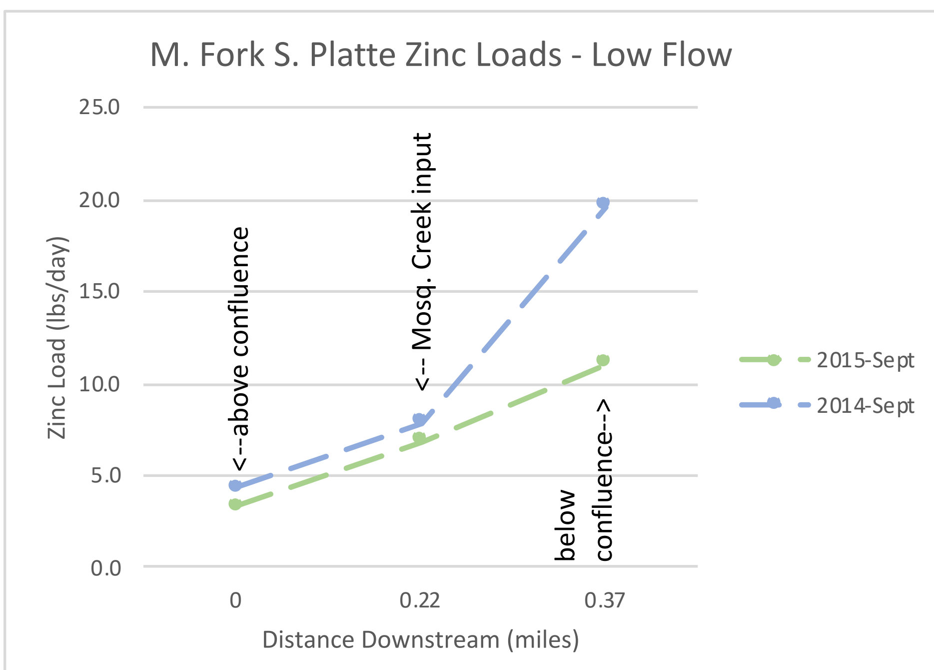
Although a number of analytes had some exceedances, we focus on zinc as the proxy for overall water quality in the rest of the report. Both zinc and cadmium had many exceedances each; however zinc concentrations are higher, and thus create the highest loading. Zinc is also more toxic for trout species (Melbane, 2012). Finally, Zinc has been used by CDPHE as the proxy in work on the London mine.

The map (right) documents where exceedances occurred in the study area, with zinc exceedances highlighted.

Middle Fork of the South Platte Loadings

Two tributaries, Buckskin Creek (chart on the top) and Mosquito Creek (chart on the bottom), are the primary contributors of loading to the Middle Fork of the South Platte. As it enters Alma, the Middle Fork has no zinc load. By the time it moves below the confluence of Mosquito Creek, there is clear loading in the 10-20 pound/day range for the period in which we have comparable-date loading data.

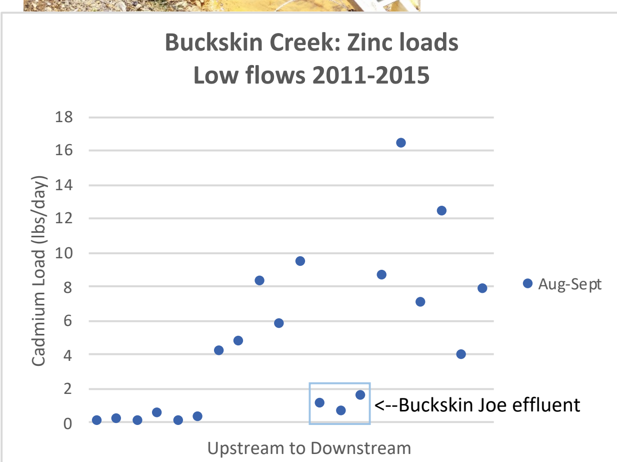


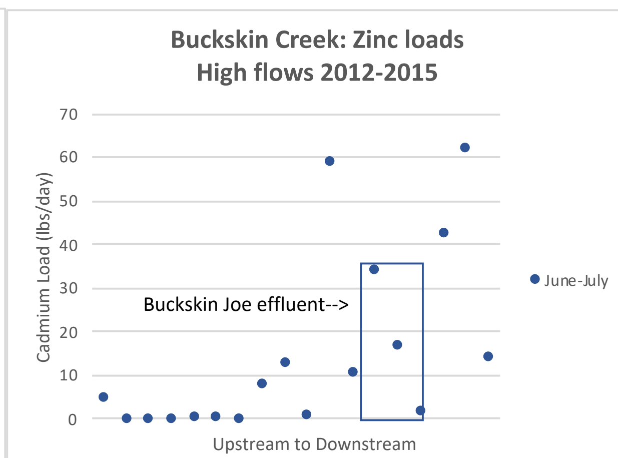


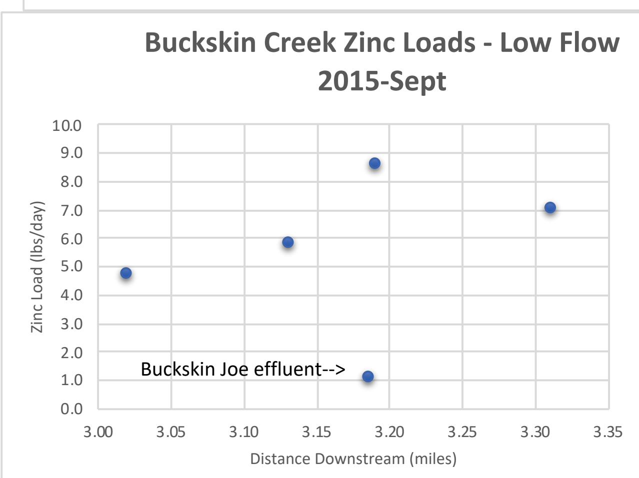
Buckskin Creek Loadings

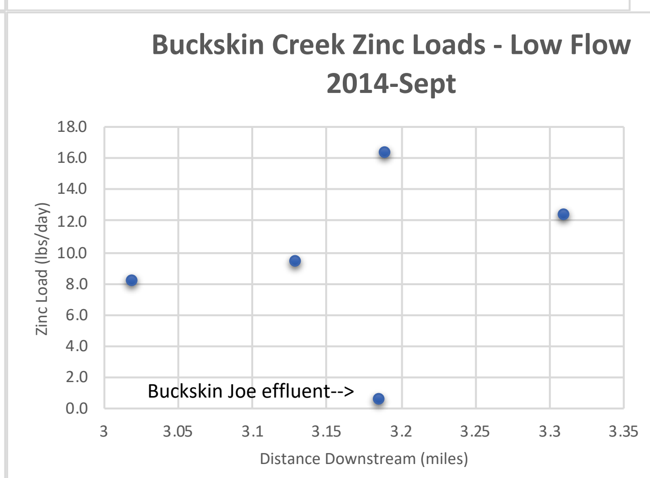
As discussed, the Buckskin Joe mine has a draining adit (left), and numerous tailings piles near the river, both upstream and downstream of the adit, which contribute to its impacts on Buckskin Creek. Additional historic mine areas in upper Buckskin Creek also contribute to the loading Buckskin itself, and to the Middle Fork below the confluence with Buckskin Creek, as seen in the following charts below.

Based on the loading data, we observe that the adit, which runs steadily, is a contributor to loading, but the tailings sites around it and in the drainage are contributing significantly to the loading in the river as well. For example, looking at data from the 7/1/14 monitoring visit, loading above the point where the adits enters was 5.8 lbs/day; the adit added 1.1 lbs/day; but the downstream site measured 8.5 lbs/day.



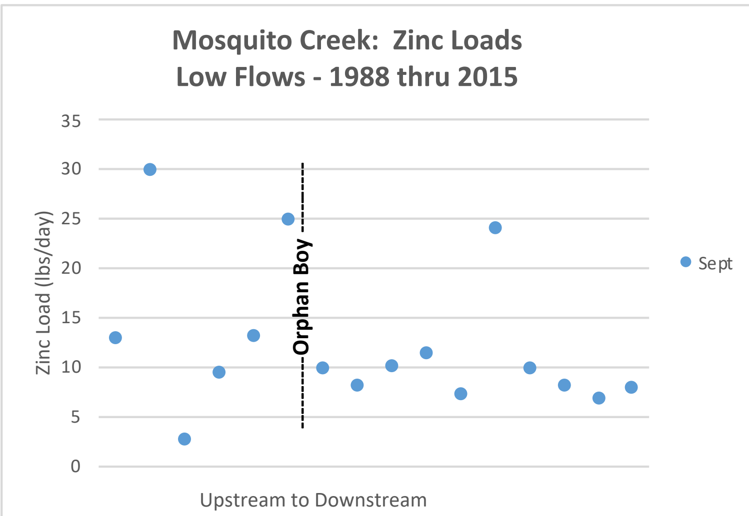


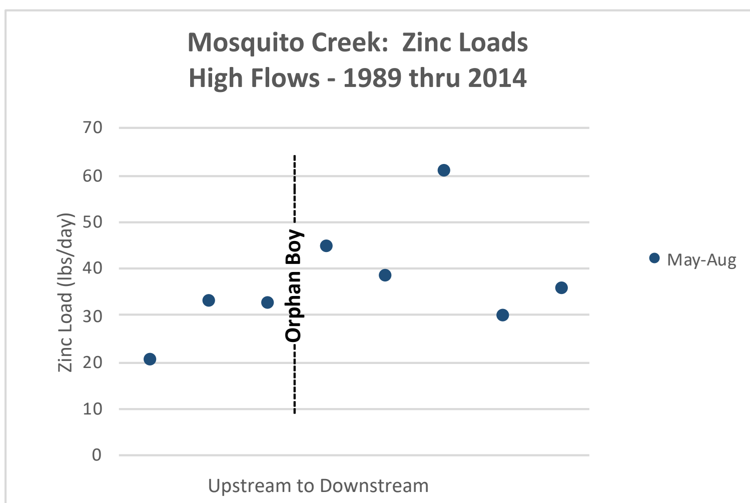




Mosquito Creek Loadings

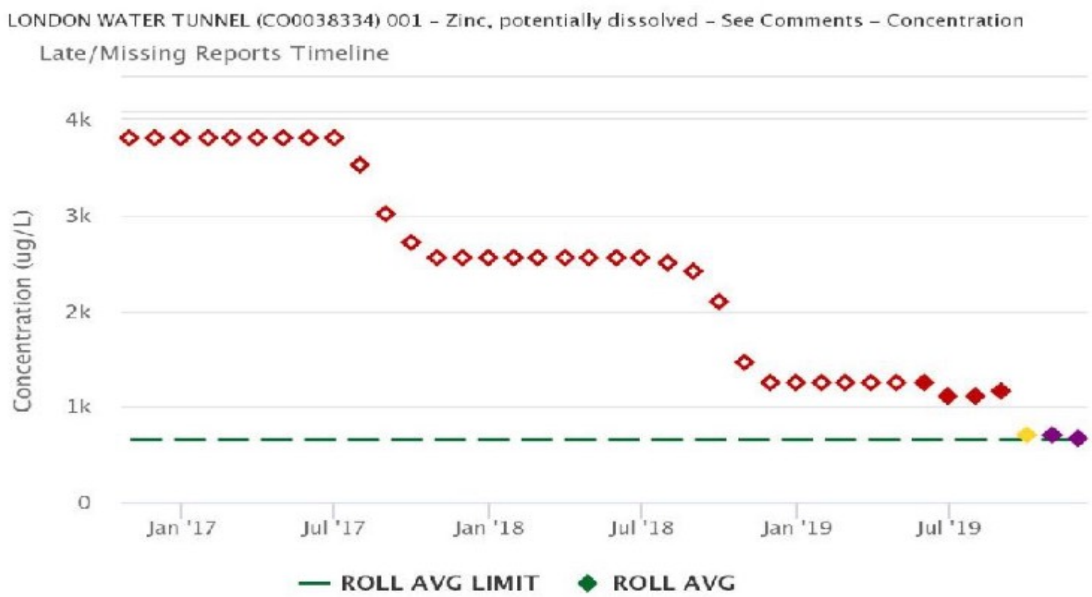
Mosquito Creek had historically been highly impacted by the London Mine, but additional tailings sites also have impact. The Orphan Boy has drainage, but at this time, the load from it (discussed more below) does not make it to the river, because it is being ameliorated by wetlands between it and the river.





London Mine

London mine, which is in the upper reaches of Mosquito Creek, was historically the largest contributor to water quality issues on Mosquito Creek and downstream on the Middle Fork; however, we will not be directly addressing issues at the London Mine in this report, as MineWater and the CDPHE are already addressing the issues through permits and consent agreements.

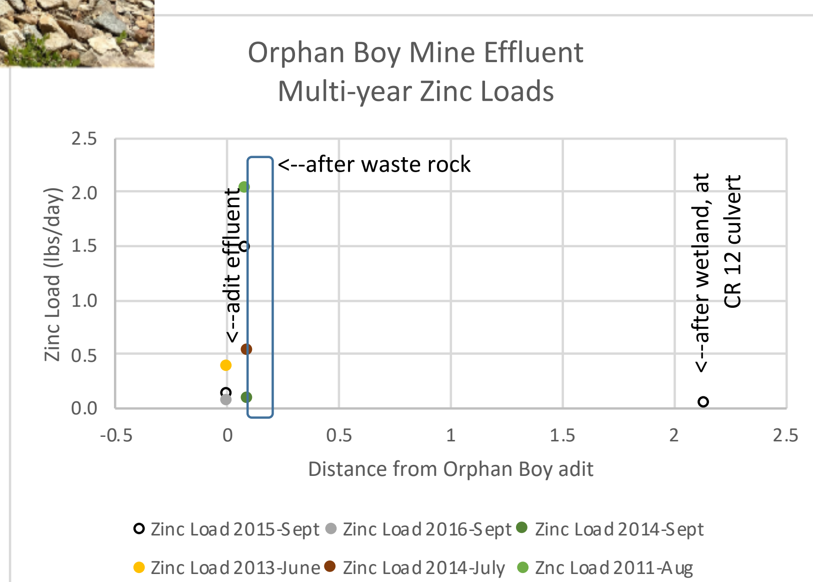


Although we will not be recommending work in the following area, we do want to point out the efforts being made are showing significant improvement in water quality emanating from the London Mine. The above graph is copied from the EPA ECHO website for the 24-month trailing average zinc concentration discharged from WT001 compared to the current limit of 654 ppb.

- In October 2022 the zinc limit will be decreased to a daily maximum of 235 ppb and a monthly average of 165 ppb.
- The cadmium concentration limit has been decreased from a monthly average of 3.2 to 0.46 ppb with a 2-year average of 1.5 ppb and a daily maximum of 1.9 ppb.
- Added compliance issues include temperature monitoring given the naturally warm, non-tributary groundwater, and new requirements for WET Testing. (Harrington, 2019)

Orphan Boy

As mentioned, Orphan Boy has definable drainage passing through tailings piles, and picking up significant loading, but at this time, the loading does not appear to make it all the way to the river, because the wetlands (downstream of the tailings in the photo below) are uptaking much of the loading. Although this has been good news for the river, there is a concern that a flood could release a significant portion of the load that is captured in the wetland, or that at some juncture the wetland could lose its assimilative capacity. Loadings have varied greatly in our data set, based on flow during different sampling cycles, but they have consistently increased by an order of a magnitude as they traverse the piles. For example, on the September, 2015 sampling cycle, loading leaving the adit was 0.125 lbs/day, but exiting the waste piles, it jumped to 1.484 lbs/day. As flow daylights from the wetland area, the load dropped back down to 0.038 lbs/day.



NEXT STEPS

Partners have been working collaboratively during this process. For example, EPA staff are studying options for Buckskin Joe and the Forest Service is conducting survey work to know which tailings piles are located on their lands. The major goal of this plan is to provide a roadmap for moving stream segments impacted by historic mining in the headwaters of the Middle Fork and its tributaries toward compliance with water quality standards, in order to meet the fishable/swimmable target of the Clean Water Act. In this section, we will discuss what we believe needs to be done to meet that goal.

Outreach & Education

1. Over the next year, provide presentations to key stakeholder groups, such as County Commissioners, Town Councils, Land & Water Trust Fund Board, community groups, etc., on the findings and 9-Element Watershed-based Plan

Data Gaps

There are several data gaps that we propose to fill in the coming years, as funding becomes available (see more about budgeting for Next Steps on page 39).

2. For all monitoring proposed, include flow measurement, so loading can be studied, unless safety issues make this impossible during peak flow season.
3. Perform at least two comprehensive monitoring seasons in the Beaver Creek HUC; above the confluence of Buckskin Creek on the mainstem of the Middle Fork; through the reach between the Buckskin confluence and the site below the confluence of Mosquito Creek; and in the upper reach of Buckskin Creek. This monitoring will provide a more comprehensive picture of additional sources, and to assist in prioritizing future project implementation.
4. Develop a Sampling and Analysis Plan and Quality Assurance Plan for this monitoring program.
5. Addend the report from such monitoring activities to this 9-Element Plan.

Buckskin Creek

The draining adit at the Buckskin Joe mine is a significant concern. For the data points we have available for calculating loads, the adit has reached a high load of 17 pounds per day, and has averaged 4 pounds per day. Also, our understanding, based on field visits by DRMS, CDPHE, EPA, USFS, and CUSP staff is the adit tunnel roof is vulnerable to collapse, and that a dam of sediment behind the adit entry is holding back a larger, yet unknown-in-size pond of polluted mine drainage water. If the adit roof collapses, it is possible that this dam will breach and send a large slug of polluted water downstream. A project to address the adit discharge is far outside the capabilities of our local stakeholders and CUSP, and is going to require EPA and other agency partners to lead such an endeavor.

In relation to Buckskin Creek we propose the following actions:

1. Work with the local stakeholder group and agency staff to continue pushing for an agency-driven project related to the adit.
2. Following the monitoring in upper Buckskin that is proposed above, develop and addendum to this plan identifying and prioritizing mitigation projects of the tailings piles and other features that are contributing loading. Work with partners such at the USFS and Trout Unlimited to implement such projects.
3. We believe such projects could reduce at least 50% of loading to the creek, which has reached as high as 62 pounds per day in June of 2013, below the Buckskin Joe mine and tailings piles, and has averaged 23 pounds per day over the series of data points we have available.

Orphan Boy

1. We are proposing a project at Orphan Boy to reduce the load out of Orphan Boy, in order to reduce loading entering the wetland. This project would be a partnership project with Trout Unlimited's Abandoned Mines Team. The Work Plan will:
    a. As the adit discharge is cleaner than the water moving through the piles, create an adit discharge diversion channel to move water currently exiting the adit and traveling through the waste piles to then discharge to the wetlands. This should protect the wetlands capacity to continue cleaning drainage before it reaches the stream.
    b. In-situ treatment of mine waste.

Indicators of Success

1. As zinc is our proxy pollutant, we will consider at least a 50% reduction in zinc loading to represent success in implementable projects.
2. We anticipate a quantifiable reduction in all other metals to result from projects.
3. We anticipate an increase in benthic organisms in the stream reaches over 10-years post-project monitoring, and increase in age-class biomass of trout.

Estimated Budget & Timeline

Estimated start periods depends upon securing landowner cooperation and successful fundraising for projects.

Task	Start Period	Time Estimate	Cost Estimate	Funding Status	Potential Load Reduction
Outreach/Education on 9-element plan to stakeholders	2020	9 months	$3,500	Secured	NA
Grant and fund raising	2020	6 months	$2,500	Secured	NA
Monitoring program & monitoring addendum	2021	2.5 years	$37,000	Not secured	NA
Buckskin plan addendum	2022	6 months	$3,500	Not secured	NA
Buckskin projects	2023	3 years	$500,000	Not secured	5lbs/day
Orphan Boy Phase 1	2021	1 year	$175,000	Not secured	>.5 lbs/day
Post-project monitoring	2022	10 years	$28,500	Not secured	NA
Total			**$750,000**		

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APPENDIX 1—2018-2019 MONITORING DATA

Location MFSP1- Above Alma	Analyte	Medium	Primary^	Secondary^	June 2018	August 2018	September 2018	June~ 2019	September~ 2019
			Drinking Water Standards 1 ug/l = 0.001 mg/l						
MPSP1	Aluminum	Water	5 mg/l	0.05 to 0.2 mgl	41 ug/l*	29 ug/l*	25 ug/l*		
MPSP1	Antimony	Water	0.006 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MPSP1	Arsenic	Water	0.01 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MPSP1	Barium	Water	2.0 mg/l		27 ug/l	45 ug/l	58 ug/l		
MPSP1	Beryllium	Water	0.004 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MPSP1	Bromide	Water			-999 mg/l	-999 mg/l	-999 mg/L		
MPSP1	Cadmium	Water	0.005 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MPSP1	Calcium	Water			17000 ug/l	29000 ug/l	32000 ug/l		
MPSP1	Chloride	Water	250 mg/l	250 mg/l	2.8 mg/l*	4.8 mg/l	6 mg/L		
MPSP1	Chromium	Water	0.1 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MPSP1	Cobalt	Water			0.06 ug/l*	-999 ug/l	-999 ug/l		
MPSP1	Copper	Water	1.3 mg/l	1.0 mg/l	1.7 ug/l*	0.72 ug/l*	0.61 ug/l*		
MPSP1	Diesel range organics	Water			-999 mg/l	0.07 mg/l*	0.035 mg/l*		
MPSP1	Fluoride	Water	4.0 mg/l	2.0 mg/l	0.082 mg/l*	-999 mg/l	0.071 mg/l*		
MPSP1	Gasoline range organics	Water			-999 ug/l	-999 ug/l	-999 ug/l		
MPSP1	Iron	Water	0.3 mg/l	0.3 mg/l	220 ug/l	380 ug/l	230 ug/l		
MPSP1	Lead	Water	0.015 mg.l		0.55 ug/l*	0.41 ug/l*	0.39 ug/l*		
MPSP1	Magnesium	Water			6600 ug/l	11000 ug/l	14000 ug/l		
MPSP1	Manganese	Water	0.05 mg/l		41 ug/l	71 ug/l	76 ug/l		
MPSP1	Mercury	Water	0.002 mg/l		-999 ug/l	-999 ug/l	-999 ug/l	0.0058 ug/l	0.0023 ug/l
MPSP1	Methylmercury(1+)	Water			0.07 ng/l	0.11 ng/l	0.058 ng/l	0.069 ng/L	0.11 ng/L
MPSP1	Nickel	Water	0.1 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MPSP1	Potassium	Water			710 ug/l*	1100 ug/l*	1100 ug/l*		
MPSP1	Selenium	Water	0.05 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MPSP1	Silver	Water	0.05 mg/l	0.1 mg/l	-999 ug/l	-999 ug/l	-999 ug/l		
MPSP1	Sodium	Water			1600 ug/l	1700 ug/l	2300 ug/l		
MPSP1	Sulfate	Water	250 mg/l	250 mg/l	15 mg/l	16 mg/l	19 mg/L		
MPSP1	Thallium	Water	0.002 mg/l		0.061 ug/l*	-999 ug/l	-999 ug/l		
MPSP1	Total dissolved solids	Water		500 mg/l	88 mg/l	60 mg/l	160 mg/L		
MPSP1	Vanadium	Water			-999 ug/l	-999 ug/l	-999 ug/l		
MPSP1	Zinc	Water	5 mg/l	5 mg/l	9.7 ug/l*	3 ug/l*	3.3 ug/l*		
MPSP1	Gross alpha radioactivity, (Thorium-230 ref std)	Water	15 pCi/l		-999 pCi/L	-999 pCi/L	2.51 pCi/L		
MPSP1	Gross beta radioactivity, (Strontium-Yttrium-90 ref std)	Water			1.37 pCi/L	1.71 pCi/L	1.65 pCi/L		
MPSP1	Methylmercury(1+)	Soil				-999 ug/kg		-999 ug/kg	-999 ug/kg
MPSP1	Mercury	Soil				15 ug/kg*		29 ug/kg	22 ug/kg

^ Blank space means the EPA has not designated a primary and/or secondary standard

~ Blank space means not tested for this round

*=Amount is an estimate, it is between the RL and MDL

Analyte not detected= -999

Location	Analyte	Medium	Primary^ Drinking Water Standards	Secondary^	June 2018	August 2018	September 2018	June~ 2019	September~ 2019
MFSP2- CR 14 Above Bridge			1 ug/l = 0.001 mg/l						
MFSP2	Aluminum	Water	5 mg/l	0.05 to 0.2 mgl	35 ug/l*	-999 ug/l	-999 ug/l		
MFSP2	Antimony	Water	0.006 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MFSP2	Arsenic	Water	0.01 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MFSP2	Barium	Water	2.0 mg/l		33 ug/l	52 ug/l	56 ug/l		
MFSP2	Beryllium	Water	0.004 mg/l		0.11 ug/l*	-999 ug/l	-999 ug/l		
MFSP2	Bromide	Water			-999 mg/l	-999 mg/l	0.47 mg/L		
MFSP2	Cadmium	Water	0.005 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MFSP2	Calcium	Water			18000 ug/l	35000 ug/l	37000 ug/l		
MFSP2	Chloride	Water	250 mg/l	250 mg/l	1.9 mg/l*	4.5 mg/l	6 mg/L		
MFSP2	Chromium	Water	0.1 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MFSP2	Cobalt	Water			-999 ug/l	-999 ug/l	-999 ug/l		
MFSP2	Copper	Water	1.3 mg/l	1.0 mg/l	1.8 ug/l*	0.82 ug/l*	0.8 ug/l*		
MFSP2	Diesel range organics	Water			-999 mg/l	0.077 mg/l*	-999 mg/L		
MFSP2	Fluoride	Water	4.0 mg/l	2.0 mg/l	0.2 mg/l*	0.19 mg/l*	0.23 mg/l*		
MFSP2	Gasoline range organics	Water			-999 ug/l	-999 ug/l	-999 ug/l		
MFSP2	Iron	Water	0.3 mg/l	0.3 mg/l	110 ug/l	140 ug/l	100 ug/l		
MFSP2	Lead	Water	0.015 mg.l		0.89 ug/l*	0.66 ug/l*	0.63 ug/l*		
MFSP2	Magnesium	Water			7600 ug/l	14000 ug/l	16000 ug/l		
MFSP2	Manganese	Water	0.05 mg/l		23 ug/l	31 ug/l	30 ug/l		
MFSP2	Mercury	Water	0.002 mg/l		-999 ug/l	-999 ug/l	-999 ug/l	0.0047 ug/l	0.0013 ug/l
MFSP2	Methylmercury(1+)	Water			0.053 ng/l	0.058 ng/l	-999 ng/l	0.045 ng/L*	0.049 ng/L*
MFSP2	Nickel	Water	0.1 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MFSP2	Potassium	Water			660 ug/l*	1100 ug/l*	830 ug/l*		
MFSP2	Selenium	Water	0.05 mg/l		-999 ug/l	-999 ug/l	0.8 ug/l*		
MFSP2	Silver	Water	0.05 mg/l	0.1 mg/l	-999 ug/l	-999 ug/l	-999 ug/l		
MFSP2	Sodium	Water			1400 ug/l	2600 ug/l	3400 ug/l		
MFSP2	Sulfate	Water	250 mg/l	250 mg/l	21 mg/l	39 mg/l	48 mg/L		
MFSP2	Thallium	Water	0.002 mg/l		-999 ug/l	-999 ug/l	-999 ug/l		
MFSP2	Total dissolved solids	Water		500 mg/l	95 mg/l	180 mg/l	190 mg/L		
MFSP2	Vanadium	Water			-999 ug/l	-999 ug/l	-999 ug/l		
MFSP2	Zinc	Water	5 mg/l	5 mg/l	51 ug/l	33 ug/l	29 ug/l		
MFSP2	Gross alpha radioactivity, (Thorium-230 ref std)	Water	15 pCi/l		-999 pCi/L	2.45 pCi/L	2.18 pCi/L		
MFSP2	Gross beta radioactivity, (Strontium-Yttrium-90 ref std)	Water			-999 pCi/L	-999 pCi/L	-999 pCi/L		

^ Blank space means the EPA has not designated a primary and/or secondary standard ~ Blank space means not tested for this round

*=Amount is an estimate, it is between the RL and MDL Analyte not detected= -999

Location	Analyte	Medium	Primary^ Drinking Water Standards 1 ug/l = 0.001 mg/l	Secondary^	June 2018	August 2018	September 2018	June~ 2019	September~ 2019
MFSP3- Above Fairplay Beach									
MFSP3	Aluminum	Water	5 mg/l	0.05 to 0.2 mgl	60 ug/l*	23 ug/l*	-999 ug/l	100 ug/l	-999 ug/l
MFSP3	Antimony	Water	0.006 mg/l		-999 ug/l	-999 ug/l	-999 ug/l	-999 ug/l	-999 ug/l
MFSP3	Arsenic	Water	0.01 mg/l		-999 ug/l	-999 ug/l	0.39 ug/l*	-999 ug/l	-999 ug/l
MFSP3	Barium	Water	2.0 mg/l		33 ug/l	52 ug/l	20 ug/l	37 ug/l	49 ug/l
MFSP3	Beryllium	Water	0.004 mg/l		0.13 ug/l*	-999 ug/l	-999 ug/l	0.13 ug/l*	-999 ug/l
MFSP3	Bromide	Water			-999 mg/l	0.25 mg/l	0.36 mg/L		
MFSP3	Cadmium	Water	0.005 mg/l		-999 ug/l	-999 ug/l	-999 ug/l	-999 ug/l	-999 ug/l
MFSP3	Calcium	Water			18000 ug/l	36000 ug/l	37000 ug/l	20000 ug/l	33000 ug/l
MFSP3	Chloride	Water	250 mg/l	250 mg/l	2 mg/l*	5.9 mg/l	6.8 mg/L		
MFSP3	Chromium	Water	0.1 mg/l		-999 ug/l	-999 ug/l	0.73 ug/l*	-999 ug/l	0.61 ug/l*
MFSP3	Cobalt	Water			-999 ug/l	-999 ug/l	0.33 ug/l*	-999 ug/l	-999 ug/l
MFSP3	Copper	Water	1.3 mg/l	1.0 mg/l	1.7 ug/l*	1 ug/l*	9.5 ug/l	1.8 ug/l*	-999 ug/l
MFSP3	Diesel range organics	Water			-999 mg/l	0.048 mg/l*	-999 mg/L		
MFSP3	Fluoride	Water	4.0 mg/l	2.0 mg/l	0.17 mg/l*	0.18 mg/l*	0.21 mg/l*		
MFSP3	Gasoline range organics	Water			-999 ug/l	-999 ug/l	-999 ug/l		
MFSP3	Iron	Water	0.3 mg/l	0.3 mg/l	170 ug/l	260 ug/l	64 ug/l*	190 ug/l	93 ug/l*
MFSP3	Lead	Water	0.015 mg/l		1.3 ug/l	0.72 ug/l*	0.31 ug/l*	2.3 ug/l	0.55 ug/l*
MFSP3	Magnesium	Water			7800 ug/l	15000 ug/l	16000 ug/l	8100 ug/l	14000 ug/l
MFSP3	Manganese	Water	0.05 mg/l		26 ug/l	14 ug/l	15 ug/l	34 ug/l	21 ug/l
MFSP3	Mercury	Water	0.002 mg/l		-999 ug/l	0.045 ug/l*	-999 ug/l	0.0036 ug/l	0.0012 ug/l
MFSP3	Methylmercury(1+)	Water			0.058 ng/l	0.054 ng/l	-999 ng/l	0.07 ng/L	0.031 ng/L*
MFSP3	Nickel	Water	0.1 mg/l		0.33 ug/l*	-999 ug/l	1.7 ug/l*	-999 ug/l	-999 ug/l
MFSP3	Potassium	Water			670 ug/l*	1100 ug/l*	870 ug/l*	690 ug/l*	900 ug/l*
MFSP3	Selenium	Water	0.05 mg/l		-999 ug/l	-999 ug/l	33 ug/l	-999 ug/l	-999 ug/l
MFSP3	Silver	Water	0.05 mg/l	0.1 mg/l	-999 ug/l	-999 ug/l	-999 ug/l	-999 ug/l	-999 ug/l
MFSP3	Sodium	Water			1700 ug/l	3500 ug/l	4100 ug/l	1300 ug/l	2900 ug/l
MFSP3	Sulfate	Water	250 mg/l	250 mg/l	20 mg/l	39 mg/l	47 mg/L		
MFSP3	Thallium	Water	0.002 mg/l		-999 ug/l	-999 ug/l	-999 ug/l	-999 ug/l	-999 ug/l
MFSP3	Total dissolved solids	Water		500 mg/l	90 mg/l	180 mg/l	190 mg/L	100 mg/l	160 mg/l
MFSP3	Vanadium	Water			-999 ug/l	-999 ug/l	-999 ug/l	-999 ug/l	-999 ug/l
MFSP3	Zinc	Water	5 mg/l	5 mg/l	50 ug/l	22 ug/l	25 ug/l	68 ug/l	42 ug/l
MFSP3	Gross alpha radioactivity, (Thorium-230 ref std)	Water	15 pCi/l		-999 pCi/L	2.92 pCi/L	3.89 pCi/L	1.42 pCi/L	4.3 pCi/L
MFSP3	Gross beta radioactivity, (Strontium-Yttrium-90 ref std)	Water			1.02 pCi/L	-999 pCi/L	1.17 pCi/L	1.46 pCi/L	1.94 pCi/L
MFSP3	Methylmercury(1+)	Soil				-999 ug/kg		0.11 ug/kg	-999 ug/kg
MFSP3	Mercury	Soil				8.6 ug/kg*		42 ug/kg	26 ug/kg

^ Blank space means the EPA has not designated a primary and/or secondary standard ~ Blank space means not tested for this round

*=Amount is an estimate, it is between the RL and MDL Analyte not detected= -999

Location	Analyte	Medium	Primary^	Secondary^	June 2018	August 2018	September 2018
MFSP4- Bridge on Hwy 9			Drinking Water Standards 1 ug/l = 0.001 mg/l				
MFSP4	Aluminum	Water	5 mg/l	0.05 to 0.2 mgl	75 ug/l*	39 ug/l*	29 ug/l*
MFSP4	Antimony	Water	0.006 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
MFSP4	Arsenic	Water	0.01 mg/l		-999 ug/l	-999 ug/l	0.38 ug/l*
MFSP4	Barium	Water	2.0 mg/l		38 ug/l	52 ug/l	23 ug/l
MFSP4	Beryllium	Water	0.004 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
MFSP4	Bromide	Water			-999 mg/l	-999 mg/l	0.17 mg/l*
MFSP4	Cadmium	Water	0.005 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
MFSP4	Calcium	Water			21000 ug/l	38000 ug/l	39000 ug/l
MFSP4	Chloride	Water	250 mg/l	250 mg/l	2.3 mg/l*	6.7 mg/l	7.6 mg/L
MFSP4	Chromium	Water	0.1 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
MFSP4	Cobalt	Water			-999 ug/l	-999 ug/l	0.14 ug/l*
MFSP4	Copper	Water	1.3 mg/l	1.0 mg/l	2 ug/l	0.71 ug/l*	1.8 ug/l*
MFSP4	Diesel range organics	Water			-999 mg/l	0.059 mg/l*	0.049 mg/l*
MFSP4	Fluoride	Water	4.0 mg/l	2.0 mg/l	0.17 mg/l*	0.15 mg/l*	0.17 mg/l*
MFSP4	Gasoline range organics	Water			-999 ug/l	-999 ug/l	-999 ug/l
MFSP4	Iron	Water	0.3 mg/l	0.3 mg/l	210 ug/l	270 ug/l	82 ug/l*
MFSP4	Lead	Water	0.015 mg.l		1.8 ug/l	0.84 ug/l*	0.18 ug/l*
MFSP4	Magnesium	Water			8600 ug/l	15000 ug/l	16000 ug/l
MFSP4	Manganese	Water	0.05 mg/l		25 ug/l	27 ug/l	27 ug/l
MFSP4	Mercury	Water	0.002 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
MFSP4	Methylmercury(1+)	Water			0.054 ng/l	0.06 ng/l	0.027 ng/L*
MFSP4	Nickel	Water	0.1 mg/l		0.41 ug/l*	-999 ug/l	0.69 ug/l*
MFSP4	Potassium	Water			760 ug/l*	1300 ug/l*	850 ug/l*
MFSP4	Selenium	Water	0.05 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
MFSP4	Silver	Water	0.05 mg/l	0.1 mg/l	-999 ug/l	-999 ug/l	-999 ug/l
MFSP4	Sodium	Water			1900 ug/l	3700 ug/l	4200 ug/l
MFSP4	Sulfate	Water	250 mg/l	250 mg/l	21 mg/l	39 mg/l	44 mg/L
MFSP4	Thallium	Water	0.002 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
MFSP4	Total dissolved solids	Water		500 mg/l	110 mg/l	190 mg/l	190 mg/L
MFSP4	Vanadium	Water			-999 ug/l	-999 ug/l	-999 ug/l
MFSP4	Zinc	Water	5 mg/l	5 mg/l	34 ug/l	12 ug/l	2.8 ug/l*
MFSP4	Gross alpha radioactivity, (Thorium-230 ref std)	Water	15 pCi/l		-999 pCi/L	2.68 pCi/L	4.49 pCi/L
MFSP4	Gross beta radioactivity, (Strontium-Yttrium-90 ref std)	Water			-999 pCi/L	1.58 pCi/L	1.02 pCi/L

^ Blank space means the EPA has not designated a primary and/or secondary standard

*=Amount is an estimate, it is between the RL and MDL Analyte not detected= -999

Location	Analyte	Medium	Primary^	Secondary^	June~ 2019	September~ 2019
MFSP6-Outlet Columbia Reservoir			Drinking Water Standards 1 ug/l = 0.001 mg/l			
MFSP6	Aluminum	Water	5 mg/l	0.05 to 0.2 mgl	140 ug/l	-999 ug/l
MFSP6	Antimony	Water	0.006 mg/l		-999 ug/l	-999 ug/l
MFSP6	Arsenic	Water	0.01 mg/l		0.38 ug/l*	-999 ug/l
MFSP6	Barium	Water	2.0 mg/l		27 ug/l	31 ug/l
MFSP6	Beryllium	Water	0.004 mg/l		-999 ug/l	-999 ug/l
MFSP6	Bromide	Water				
MFSP6	Cadmium	Water	0.005 mg/l		-999 ug/l	-999 ug/l
MFSP6	Calcium	Water			17000 ug/l	26000 ug/l
MFSP6	Chloride	Water	250 mg/l	250 mg/l		
MFSP6	Chromium	Water	0.1 mg/l		-999 ug/l	-999 ug/l
MFSP6	Cobalt	Water			-999 ug/l	-999 ug/l
MFSP6	Copper	Water	1.3 mg/l	1.0 mg/l	2.3 ug/l	-999 ug/l
MFSP6	Diesel range organics	Water				
MFSP6	Fluoride	Water	4.0 mg/l	2.0 mg/l		
MFSP6	Gasoline range organics	Water				
MFSP6	Iron	Water	0.3 mg/l	0.3 mg/l	330 ug/l	240 ug/l
MFSP6	Lead	Water	0.015 mg.l		1.2 ug/l	0.4 ug/l*
MFSP6	Magnesium	Water			6100 ug/l	10000 ug/l
MFSP6	Manganese	Water	0.05 mg/l		38 ug/l	91 ug/l
MFSP6	Mercury	Water	0.002 mg/l		0.0057 ug/l	0.0019 ug/l
MFSP6	Methylmercury(1+)	Water			0.069 ng/L	0.12 ng/L
MFSP6	Nickel	Water	0.1 mg/l		-999 ug/l	-999 ug/l
MFSP6	Potassium	Water			650 ug/l*	820 ug/l*
MFSP6	Selenium	Water	0.05 mg/l		-999 ug/l	-999 ug/l
MFSP6	Silver	Water	0.05 mg/l	0.1 mg/l	-999 ug/l	-999 ug/l
MFSP6	Sodium	Water			1500 ug/l	1500 ug/l
MFSP6	Sulfate	Water	250 mg/l	250 mg/l		
MFSP6	Thallium	Water	0.002 mg/l		-999 ug/l	-999 ug/l
MFSP6	Total dissolved solids	Water		500 mg/l	95 mg/l	110 mg/l
MFSP6	Vanadium	Water			-999 ug/l	-999 ug/l
MFSP6	Zinc	Water	5 mg/l	5 mg/l	9.2 ug/l*	5.1 ug/l*
MFSP6	Gross alpha radioactivity, (Thorium-230 ref std)	Water	15 pCi/l		-999 pCi/L	-999 pCi/L
MFSP6	Gross beta radioactivity, (Strontium-Yttrium-90 ref std)	Water			1.93 pCi/L	-999 pCi/L

^ Blank space means the EPA has not designated a primary and/or secondary stand ~ Blank space means not tested

*=Amount is an estimate, it is between the RL and MDL Analyte not detected=-999

Location	Analyte	Medium	Primary^	Secondary^	June~	September~
			Drinking Water Standards		2019	2019
MFSP7- Below Montgomery Reservoir			1 ug/l = 0.001 mg/l			
MFSP7	Aluminum	Water	5 mg/l	0.05 to 0.2 mgl	71 ug/l*	-999 ug/l
MFSP7	Antimony	Water	0.006 mg/l		-999 ug/l	-999 ug/l
MFSP7	Arsenic	Water	0.01 mg/l		-999 ug/l	-999 ug/l
MFSP7	Barium	Water	2.0 mg/l		16 ug/l	13 ug/l
MFSP7	Beryllium	Water	0.004 mg/l		-999 ug/l	-999 ug/l
MFSP7	Bromide	Water				
MFSP7	Cadmium	Water	0.005 mg/l		-999 ug/l	-999 ug/l
MFSP7	Calcium	Water			11000 ug/l	12000 ug/l
MFSP7	Chloride	Water	250 mg/l	250 mg/l		
MFSP7	Chromium	Water	0.1 mg/l		-999 ug/l	-999 ug/l
MFSP7	Cobalt	Water			0.086 ug/l*	-999 ug/l
MFSP7	Copper	Water	1.3 mg/l	1.0 mg/l	1.8 ug/l*	0.77 ug/l*
MFSP7	Diesel range organics	Water				
MFSP7	Fluoride	Water	4.0 mg/l	2.0 mg/l		
MFSP7	Gasoline range organics	Water				
MFSP7	Iron	Water	0.3 mg/l	0.3 mg/l	90 ug/l*	25 ug/l*
MFSP7	Lead	Water	0.015 mg.l		0.32 ug/l*	0.21 ug/l*
MFSP7	Magnesium	Water			2900 ug/l	3300 ug/l
MFSP7	Manganese	Water	0.05 mg/l		14 ug/l	8.6 ug/l
MFSP7	Mercury	Water	0.002 mg/l		0.0025 ug/l	0.0007 ug/l
MFSP7	Methylmercury(1+)	Water			0.023 ng/L*	0.023 ng/L*
MFSP7	Nickel	Water	0.1 mg/l		0.94 ug/l*	-999 ug/l
MFSP7	Potassium	Water			600 ug/l*	490 ug/l*
MFSP7	Selenium	Water	0.05 mg/l		-999 ug/l	-999 ug/l
MFSP7	Silver	Water	0.05 mg/l	0.1 mg/l	-999 ug/l	-999 ug/l
MFSP7	Sodium	Water			1500 ug/l	1200 ug/l
MFSP7	Sulfate	Water	250 mg/l	250 mg/l		
MFSP7	Thallium	Water	0.002 mg/l		-999 ug/l	-999 ug/l
MFSP7	Total dissolved solids	Water		500 mg/l	71 mg/l	52 mg/l
MFSP7	Vanadium	Water			-999 ug/l	-999 ug/l
MFSP7	Zinc	Water	5 mg/l	5 mg/l	18 ug/l	15 ug/l
MFSP7	Gross alpha radioactivity, (Thorium-230 ref std)	Water	15 pCi/l		1.33 pCi/L	1.7 pCi/L
MFSP7	Gross beta radioactivity, (Strontium-Yttrium-90 ref std)	Water			1.41 pCi/L	-999 pCi/L
MFSP7	Methylmercury(1+)	Soil			-999 ug/kg	0.087 ug/kg*
MFSP7	Mercury	Soil			3.4 ug/kg	14 ug/kg

^ Blank space means the EPA has not designated a primary and/or secondary stan ~ Blank space means not tested

*=Amount is an estimate, it is between the RL and MDL Analyte not detected=-999

Location	Analyte	Medium	Primary^	Secondary^	June~ 2019	September~ 2019
MFSP8- Above Montgomery Reservoir			Drinking Water Standards 1 ug/l = 0.001 mg/l			
MFSP8	Aluminum	Water	5 mg/l	0.05 to 0.2 mgl	52 ug/l*	-999 ug/l
MFSP8	Antimony	Water	0.006 mg/l		-999 ug/l	-999 ug/l
MFSP8	Arsenic	Water	0.01 mg/l		-999 ug/l	-999 ug/l
MFSP8	Barium	Water	2.0 mg/l		12 ug/l	14 ug/l
MFSP8	Beryllium	Water	0.004 mg/l		-999 ug/l	-999 ug/l
MFSP8	Bromide	Water				
MFSP8	Cadmium	Water	0.005 mg/l		-999 ug/l	-999 ug/l
MFSP8	Calcium	Water			8000 ug/l	14000 ug/l
MFSP8	Chloride	Water	250 mg/l	250 mg/l		
MFSP8	Chromium	Water	0.1 mg/l		-999 ug/l	-999 ug/l
MFSP8	Cobalt	Water			0.066 ug/l*	-999 ug/l
MFSP8	Copper	Water	1.3 mg/l	1.0 mg/l	1.6 ug/l*	0.56 ug/l*
MFSP8	Diesel range organics	Water				
MFSP8	Fluoride	Water	4.0 mg/l	2.0 mg/l		
MFSP8	Gasoline range organics	Water				
MFSP8	Iron	Water	0.3 mg/l	0.3 mg/l	47 ug/l*	59 ug/l*
MFSP8	Lead	Water	0.015 mg.l		0.23 ug/l*	0.26 ug/l*
MFSP8	Magnesium	Water			1600 ug/l	2900 ug/l
MFSP8	Manganese	Water	0.05 mg/l		5.8 ug/l	16 ug/l
MFSP8	Mercury	Water	0.002 mg/l		0.0017 ug/l	0.00098 ug/l
MFSP8	Methylmercury(1+)	Water			-999 ng/L	0.083 ng/L
MFSP8	Nickel	Water	0.1 mg/l		-999 ug/l	-999 ug/l
MFSP8	Potassium	Water			320 ug/l*	370 ug/l*
MFSP8	Selenium	Water	0.05 mg/l		-999 ug/l	-999 ug/l
MFSP8	Silver	Water	0.05 mg/l	0.1 mg/l	-999 ug/l	-999 ug/l
MFSP8	Sodium	Water			540 ug/l*	830 ug/l*
MFSP8	Sulfate	Water	250 mg/l	250 mg/l		
MFSP8	Thallium	Water	0.002 mg/l		-999 ug/l	-999 ug/l
MFSP8	Total dissolved solids	Water		500 mg/l	50 mg/l	58 mg/l
MFSP8	Vanadium	Water			-999 ug/l	-999 ug/l
MFSP8	Zinc	Water	5 mg/l	5 mg/l	24 ug/l	17 ug/l
MFSP8	Gross alpha radioactivity, (Thorium-230 ref std)	Water	15 pCi/l		1.17 pCi/L	3.22 pCi/L
MFSP8	Gross beta radioactivity, (Strontium-Yttrium-90 ref std)	Water			1.79 pCi/L	-999 pCi/L

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*=Amount is an estimate, it is between the RL and MDL Analyte not detected= -999

Location	Analyte	Medium	Primary^	Secondary^	June~ 2019	September~ 2019
			Drinking Water Standards			
MFSP9- Above Magnolia Mill			1 ug/l = 0.001 mg/l			
MFSP9	Aluminum	Water	5 mg/l	0.05 to 0.2 mgl	57 ug/l*	-999 ug/l
MFSP9	Antimony	Water	0.006 mg/l		-999 ug/l	-999 ug/l
MFSP9	Arsenic	Water	0.01 mg/l		-999 ug/l	-999 ug/l
MFSP9	Barium	Water	2.0 mg/l		12 ug/l	16 ug/l
MFSP9	Beryllium	Water	0.004 mg/l		-999 ug/l	-999 ug/l
MFSP9	Bromide	Water				
MFSP9	Cadmium	Water	0.005 mg/l		-999 ug/l	0.29 ug/l*
MFSP9	Calcium	Water			7800 ug/l	14000 ug/l
MFSP9	Chloride	Water	250 mg/l	250 mg/l		
MFSP9	Chromium	Water	0.1 mg/l		-999 ug/l	-999 ug/l
MFSP9	Cobalt	Water			-999 ug/l	-999 ug/l
MFSP9	Copper	Water	1.3 mg/l	1.0 mg/l	1.7 ug/l*	0.65 ug/l*
MFSP9	Diesel range organics	Water				
MFSP9	Fluoride	Water	4.0 mg/l	2.0 mg/l		
MFSP9	Gasoline range organics	Water				
MFSP9	Iron	Water	0.3 mg/l	0.3 mg/l	92 ug/l*	79 ug/l*
MFSP9	Lead	Water	0.015 mg.l		0.29 ug/l*	0.29 ug/l*
MFSP9	Magnesium	Water			1600 ug/l	2900 ug/l
MFSP9	Manganese	Water	0.05 mg/l		5.7 ug/l	23 ug/l
MFSP9	Mercury	Water	0.002 mg/l		0.0017 ug/l	0.00087 ug/l
MFSP9	Methylmercury(1+)	Water			0.023 ng/L*	0.08 ng/L
MFSP9	Nickel	Water	0.1 mg/l		-999 ug/l	-999 ug/l
MFSP9	Potassium	Water			370 ug/l*	380 ug/l*
MFSP9	Selenium	Water	0.05 mg/l		-999 ug/l	-999 ug/l
MFSP9	Silver	Water	0.05 mg/l	0.1 mg/l	-999 ug/l	-999 ug/l
MFSP9	Sodium	Water			520 ug/l*	800 ug/l*
MFSP9	Sulfate	Water	250 mg/l	250 mg/l		
MFSP9	Thallium	Water	0.002 mg/l		-999 ug/l	-999 ug/l
MFSP9	Total dissolved solids	Water		500 mg/l	51 mg/l	56 mg/l
MFSP9	Vanadium	Water			-999 ug/l	-999 ug/l
MFSP9	Zinc	Water	5 mg/l	5 mg/l	23 ug/l	19 ug/l
MFSP9	Gross alpha radioactivity, (Thorium-230 ref std)	Water	15 pCi/l		2.03 pCi/L	2.35 pCi/L
MFSP9	Gross beta radioactivity, (Strontium-Yttrium-90 ref std)	Water			2.36 pCi/L	-999 pCi/L
MFSP9	Methylmercury(1+)	Soil			0.29 ug/kg	0.19 ug/kg
MFSP9	Mercury	Soil			180 ug/kg	13 ug/kg

^ Blank space means the EPA has not designated a primary and/or secondary standar ~ Blank space means not tested
*=Amount is an estimate, it is between the RL and MDL Analyte not detected= -999

Location	Analyte	Medium	Primary^	Secondary^	June 2018	August 2018	September 2018
PNC1-Penn Creek			Drinking Water Standards 1 ug/l = 0.001 mg/l				
PNC1	Aluminum	Water	5 mg/l	0.05 to 0.2 mgl	320 ug/l	98 ug/l*	120 ug/l
PNC1	Antimony	Water	0.006 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Arsenic	Water	0.01 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Barium	Water	2.0 mg/l		64 ug/l	100 ug/l	110 ug/l
PNC1	Beryllium	Water	0.004 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Bromide	Water			-999 mg/l	-999 mg/l	-999 mg/L
PNC1	Cadmium	Water	0.005 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Calcium	Water			19000 ug/l	32000 ug/l	31000 ug/l
PNC1	Chloride	Water	250 mg/l	250 mg/l	0.57 mg/l*	0.59 mg/l*	0.67 mg/l*
PNC1	Chromium	Water	0.1 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Cobalt	Water			0.15 ug/l*	-999 ug/l	-999 ug/l
PNC1	Copper	Water	1.3 mg/l	1.0 mg/l	0.67 ug/l*	-999 ug/l	-999 ug/l
PNC1	Diesel range organics	Water			-999 mg/l	0.045 mg/l*	0.044 mg/l*
PNC1	Fluoride	Water	4.0 mg/l	2.0 mg/l	-999 mg/l	-999 mg/l	-999 mg/L
PNC1	Gasoline range organics	Water			-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Iron	Water	0.3 mg/l	0.3 mg/l	560 ug/l	290 ug/l	310 ug/l
PNC1	Lead	Water	0.015 mg.l		1.2 ug/l	0.32 ug/l*	0.5 ug/l*
PNC1	Magnesium	Water			8700 ug/l	15000 ug/l	16000 ug/l
PNC1	Manganese	Water	0.05 mg/l		31 ug/l	15 ug/l	18 ug/l
PNC1	Mercury	Water	0.002 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Methylmercury(1+)	Water			0.036 ng/l*	0.025 ng/l*	-999 ng/l
PNC1	Nickel	Water	0.1 mg/l		0.44 ug/l*	-999 ug/l	-999 ug/l
PNC1	Potassium	Water			630 ug/l*	810 ug/l*	790 ug/l*
PNC1	Selenium	Water	0.05 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Silver	Water	0.05 mg/l	0.1 mg/l	-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Sodium	Water			1300 ug/l	1900 ug/l	2500 ug/l
PNC1	Sulfate	Water	250 mg/l	250 mg/l	11 mg/l	10 mg/l	13 mg/L
PNC1	Thallium	Water	0.002 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Total dissolved solids	Water		500 mg/l	100 mg/l	74 mg/l	170 mg/L
PNC1	Vanadium	Water			-999 ug/l	-999 ug/l	-999 ug/l
PNC1	Zinc	Water	5 mg/l	5 mg/l	5.4 ug/l*	2.2 ug/l*	3.2 ug/l*
PNC1	Gross alpha radioactivity, (Thorium-230 ref std)	Water	15 pCi/l		-999 pCi/L	-999 pCi/L	-999 pCi/L
PNC1	Gross beta radioactivity, (Strontium-Yttrium-90 ref std)	Water			-999 pCi/L	-999 pCi/L	2.18 pCi/L

^ Blank space means the EPA has not designated a primary and/or secondary standard

*=Amount is an estimate, it is between the RL and MDL   Analyte not detected= -999

Location	Analyte	Medium	Primary^ Drinking Water Standards	Secondary^	June 2018	August 2018	September 2018
SAC1-Sacramento Creek			1 ug/l = 0.001 mg/l				
SAC1	Aluminum	Water	5 mg/l	0.05 to 0.2 mgl	56 ug/l*	-999 ug/l	-999 ug/l
SAC1	Antimony	Water	0.006 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Arsenic	Water	0.01 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Barium	Water	2.0 mg/l		38 ug/l	53 ug/l	52 ug/l
SAC1	Beryllium	Water	0.004 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Bromide	Water			-999 mg/l	-999 mg/l	-999 mg/L
SAC1	Cadmium	Water	0.005 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Calcium	Water			14000 ug/l	22000 ug/l	22000 ug/l
SAC1	Chloride	Water	250 mg/l	250 mg/l	0.55 mg/l*	0.77 mg/l*	0.97 mg/l*
SAC1	Chromium	Water	0.1 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Cobalt	Water			-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Copper	Water	1.3 mg/l	1.0 mg/l	-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Diesel range organics	Water			-999 mg/l	0.053 mg/l*	-999 mg/L
SAC1	Fluoride	Water	4.0 mg/l	2.0 mg/l	-999 mg/l	-999 mg/l	-999 mg/L
SAC1	Gasoline range organics	Water			-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Iron	Water	0.3 mg/l	0.3 mg/l	110 ug/l	130 ug/l	28 ug/l*
SAC1	Lead	Water	0.015 mg.l		0.19 ug/l*	-999 ug/l	-999 ug/l
SAC1	Magnesium	Water			6200 ug/l	9000 ug/l	9500 ug/l
SAC1	Manganese	Water	0.05 mg/l		5.4 ug/l	7.6 ug/l	12 ug/l
SAC1	Mercury	Water	0.002 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Methylmercury(1+)	Water			0.039 ng/l*	-999 ng/l	0.019 ng/L*
SAC1	Nickel	Water	0.1 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Potassium	Water			490 ug/l*	740 ug/l*	540 ug/l*
SAC1	Selenium	Water	0.05 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Silver	Water	0.05 mg/l	0.1 mg/l	-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Sodium	Water			790 ug/l*	950 ug/l*	1400 ug/l
SAC1	Sulfate	Water	250 mg/l	250 mg/l	9.6 mg/l	13 mg/l	15 mg/L
SAC1	Thallium	Water	0.002 mg/l		-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Total dissolved solids	Water		500 mg/l	70 mg/l	100 mg/l	110 mg/L
SAC1	Vanadium	Water			-999 ug/l	-999 ug/l	-999 ug/l
SAC1	Zinc	Water	5 mg/l	5 mg/l	7.7 ug/l*	2.1 ug/l*	-999 ug/l
SAC1	Gross alpha radioactivity, (Thorium-230 ref std)	Water	15 pCi/l		-999 pCi/L	-999 pCi/L	-999 pCi/L
SAC1	Gross beta radioactivity, (Strontium-Yttrium-90 ref std)	Water			-999 pCi/L	1.23 pCi/L	-999 pCi/L

^ Blank space means the EPA has not designated a primary and/or secondary standard

*=Amount is an estimate, it is between the RL and MDL   Analyte not detected= -999

MonLocID	Date	Ag	Cd	Cu	Fe	Hg	Mn	Pb	Se	Zn
057	8/23/10		8							1600
21COL001_WQX-5988A3	9/12/16		0.72							
21COL001_WQX-5988B1	7/20/15		2.3							420
21COL001_WQX-5988B1	6/28/16		0.79							160
21COL001_WQX-5988B1	9/12/16		1.9							260
21COL001_WQX-5988B1	6/13/17		0.67							98
21COL001_WQX-5988D1	6/28/16		0.47							
21COL001-5954	6/16/99							2		
21COL001-5988	12/3/97		0.74							240
21COL001-5988	12/30/97									210
21COL001-5988	7/1/98							1.7		90
21COL001-5988	8/12/98		0.7							180
21COL001-5988	9/9/98		0.9							300
21COL001-5988	10/27/98		0.8							300
21COL001-5988	12/3/98									230
21COL001-5988	12/9/98		0.8							350
21COL001-5988	5/12/99							10		
21COL001-5988	6/16/99							4		
21COL001-5988	7/19/99		0.6					2		160
21COL001-5988	9/14/99		0.5							
21COL001-5988	10/21/99		0.6							220
21COL001-5988	12/1/99									190
21COL001-5988	5/24/00							3		78
21COL001-5988	7/23/00		0.4							160
21COL001-5988	9/18/00									150
21COL001-5988	12/19/00									210
21COL001-5988	5/21/01		0.4					2		120
21COL001-5988	6/18/01									92
21COL001-5988	7/17/01		0.5							180
21COL001-5988	8/15/01		0.5							160
21COL001-5988	9/24/01		0.6							230
21COL001-5988	10/18/01									240
21COL001-5988	11/8/01									250
21COL001-5988	6/3/03							2		
21COL001-5988	12/16/03		1.2					13		
21COL001-5988	6/22/06							3		85
21COL001-5988A1	9/9/98		1.1							360
21COL001-5988A1	12/9/98		1							430

MonLocID	Date	Ag	Cd	Cu	Fe	Hg	Mn	Pb	Se	Zn
21COL001-5988A1	12/9/98		1							430
21COL001-5988A1	1/12/99									240
21COL001-5988A1	2/25/99									230
21COL001-5988A1	3/23/99							4		190
21COL001-5988A1	4/21/99									
21COL001-5988A1	5/12/99							6		170
21COL001-5988A1	6/16/99		0.4					4	960	
21COL001-5988A1	7/20/99		0.7					2		180
21COL001-5988A1	9/14/99		1.2							320
21COL001-5988A1	10/21/99		0.9							250
21COL001-5988A1	12/1/99		0.7							280
21COL001-5988A1	5/24/00							4		72
21COL001-5988A2	9/9/98		1.5							390
21COL001-5988A2	6/16/99		0.5		1100			7		170
21COL001-5988A2	9/14/99		1.1							
21COL001-5988A3	9/9/98		1.4							380
21COL001-5988A3	12/9/98		1.1							760
21COL001-5988A3	1/12/99									290
21COL001-5988A3	2/25/99									260
21COL001-5988A3	3/23/99									220
21COL001-5988A3	4/21/99									180
21COL001-5988A3	6/16/99		0.3					5		100
21COL001-5988A3	7/20/99		0.7							200
21COL001-5988A3	9/14/99		0.9							
21COL001-5988A3	10/21/99		1.1							360
21COL001-5988A3	12/1/99		0.9							320
21COL001-5988A3	4/4/00									190
21COL001-5988A3	5/24/00		0.5					7		130
21COL001-5988A3	7/23/00		0.7							210
21COL001-5988A3	9/18/00		1.5							340
21COL001-5988A3	1/9/01		0.8							340
21COL001-5988A3	4/17/01									170
21COL001-5988A3	5/21/01		0.3							130
21COL001-5988A3	6/18/01		0.4					2		100
21COL001-5988A3	7/17/01		1.6							440
21COL001-5988A3	8/15/01		0.8							260
21COL001-5988A3	9/24/01		1.3							360

MonLocID	Date	Ag	Cd	Cu	Fe	Hg	Mn	Pb	Se	Zn
21COL001-5988A3	10/18/01		1.6							490
21COL001-5988A3	11/8/01		1.1							370
21COL001-5988A3	2/14/02		0.7							320
21COL001-5988A4	6/16/99							2		
21COL001-5988B1	9/9/98		3.3							770
21COL001-5988B1	12/9/98		1.9							700
21COL001-5988B1	1/12/99									430
21COL001-5988B1	2/25/99									310
21COL001-5988B1	3/23/99									300
21COL001-5988B1	4/21/99		0.7							290
21COL001-5988B1	5/12/99							8		280
21COL001-5988B1	6/16/99		1		5000			8		180
21COL001-5988B1	7/20/99		1.9							530
21COL001-5988B1	9/14/99		3.1							570
21COL001-5988B1	12/1/99		1.3							500
21COL001-5988B1	7/23/00		1.6							440
21COL001-5988B1	9/18/00		2.6							610
21COL001-5988B1	5/21/01		0.8					3		230
21COL001-5988B1	6/18/01		0.9					3		230
21COL001-5988B1	7/17/01		0.7							220
21COL001-5988B1	8/15/01		1.9							520
21COL001-5988B1	9/24/01		2.4							630
21COL001-5988B1	10/18/01		2.4							720
21COL001-5988B1	11/8/01		2							670
21COL001-5988B2	9/9/98		5.1							1100
21COL001-5988B2	6/16/99		0.9		16000			5		130
21COL001-5988B2	9/14/99		5.7							1200
21COL001-5988B3	6/16/99				1900					
21COL001-5988C1	9/9/98		0.8							450
21COL001-5988C1	6/16/99		1.4							400
21COL001-5988C1	9/14/99									200
21COL001-5988C2	9/9/98		160	1100	11000		3600			43000
21COL001-5988C2	6/16/99		150	1100	22000		3900	10		38000
21COL001-5988C2	9/14/99		160	1100	43000		3900	11		42000
21COL001-5988D1	9/9/98		15	18	2200					3300
21COL001-5988D1	6/16/99		1.2	9						280
21COL001-5988D1	9/14/99		18		2600					3900

MonLocID	Date	Ag	Cd	Cu	Fe	Hg	Mn	Pb	Se	Zn
21COL001-LM001	8/30/88				4500					
21COL001-LM001	5/10/89		0.76							280
21COL001-M1	5/11/89		0.3					5		
21COL001-M2	5/11/89			7				6		70
21COL001-M2	12/6/90							5		
21COL001-M3	12/6/90							5		
21COL001-M5	9/15/90				5500					
21COL001-M5	12/6/90		2.7	11	15000			13		500
21COL001-M9	9/5/90							18		
21COL001-MC1	5/11/89			7				6		70
21COL001-MC2	5/11/89		0.3					5		
21COL001-MC3	8/30/88		0.46							
21COL001-MC3	5/10/89		0.55	8	1100			5		220
21COL001-MC4	8/30/88		0.78							150
21COL001-MC4	5/11/89		1					6		380
21COL001-MC5	8/30/88		0.75							180
21COL001-MC5	5/11/89		0.76					6		320
21COL001-MF2	5/11/89									120
21COL001-NN2	8/30/88		17	11	8300					5300
21COL001-NN2	5/10/89		2.5	15	5300					700
21COL001-SMC3	8/30/88		2		1800					580
21COL001-SMC3	5/10/89		1.5		1300					610
21COL001-SMC4	8/30/88		1.9		1560					530
21COL001-SMC4	5/10/89		1.5		1300					600
21COL001-SMC5	8/30/88		1.9		1410					530
21COL001-SMC5	5/10/89		1.4		2500			6		520
CC01	8/11/11		2.7							730
CORIVWCH_WQX-241	1/31/14		1.28							425.4
CORIVWCH_WQX-241	4/21/14		0.67							209.1
CORIVWCH_WQX-241	5/21/14		0.72					5.8		196.5
CORIVWCH_WQX-241	6/26/14		0.43							92.8
CORIVWCH_WQX-241	8/6/14		0.79							227.5
CORIVWCH_WQX-241	9/24/14		1.17							308.4
CORIVWCH_WQX-241	12/4/14		0.83							292
CORIVWCH_WQX-241	4/18/15		0.57							147.5
CORIVWCH_WQX-241	5/30/15		0.83							181.4
CORIVWCH_WQX-241	8/8/15		0.96							182.6

MonLocID	Date	Ag	Cd	Cu	Fe	Hg	Mn	Pb	Se	Zn
CORIVWCH_WQX-3314	7/13/93			3.3						
CORIVWCH_WQX-3314	9/27/94							2.7		
CORIVWCH_WQX-3318	6/26/92		0.59	14.9						117
CORIVWCH_WQX-3318	9/9/92		0.9							258
CORIVWCH_WQX-3318	5/21/93		0.51							199
CORIVWCH_WQX-3318	7/5/94		0.43							135
CORIVWCH_WQX-3318	9/28/94		0.74							227
CORIVWCH_WQX-3319	5/21/93		1.86	8.9						521
CORIVWCH_WQX-3319	10/20/93		2.26							705
CORIVWCH_WQX-3320	10/20/93		1.43							541
CORIVWCH_WQX-3320	7/5/94		1.15							342
CORIVWCH_WQX-3320	9/28/94		1.68							710
CORIVWCH_WQX-3321	6/26/92		1.05	7.4						266
CORIVWCH_WQX-3321	9/9/92		3.07							643
CORIVWCH_WQX-3321	5/21/93		1.23							424
CORIVWCH_WQX-3321	10/20/93		1.87							550
CORIVWCH_WQX-3321	7/5/94		0.87							328
CORIVWCH_WQX-3321	9/28/94		1.97							712
CORIVWCH_WQX-3322	6/26/92		1.01							255
CORIVWCH_WQX-3322	9/9/92		2.55							523
CORIVWCH_WQX-3322	5/21/93		1.14							416
CORIVWCH_WQX-3322	10/20/93		1.65							505
CORIVWCH_WQX-3322	7/5/94		0.94							297
CORIVWCH_WQX-3322	9/28/94		1.64							639
DRMS-71	9/5/16		1.5							300
MC04	8/11/11		0.9	10				2		250
MC05	8/11/11		0.7							190
MF02	8/11/11			10						
MG-04	6/6/13	29	0.85					2.87		217
MG-05	6/6/13							1.03		23
MG-05	6/17/15		0.252							92.9
MG-05	9/15/15		1.02							264
MG-06	7/1/14		0.315							96.4
MG-06	9/23/14		0.911							260
MG-07	9/23/14		2.58							675
MG-07	6/17/15		2.49							630
MG-07	9/15/15		2.94							834

MonLocID	Date	Ag	Cd	Cu	Fe	Hg	Mn	Pb	Se	Zn
MG-08	6/6/13		0.342					2.24		103
MG-08	9/23/14		0.995							252
MG-08	6/17/15		0.25							86.1
MG-08A	6/6/13	22	0.287					2.28		102
MG-09	6/6/13		11							2320
MG-09	7/1/14		1.56							302
MG-09	9/23/14		4.44							704
MG-09	6/17/15		2.52			0.062				440
MG-09	9/15/15		14.4							3000
MG-10	6/6/13		1.8							332
MG-10	7/1/14		1.51							301
MG-10	9/23/14		1.75							301
MG-10	6/17/15		1.59							290
MG-10	9/15/15		1.75							352
MG-11	6/6/13		0.296					1.92		103
MG-11	7/1/14		0.322							105
MG-11	9/23/14		0.978							261
MG-11	6/17/15		0.35							98.5
MG-11	9/15/15		0.848							250
MG-12	7/1/14									106
MG-12	6/17/15							1.27		81.8
MG-15	6/6/13		12.5							2540
MG-15	6/17/15		4.82							846
MG-15	9/15/15		3.29							592
MG-16	6/6/13		9.78							2040
MG-16	6/17/15		4.32							837
MG-16	9/15/15		4.89							847
MG-17	6/6/13		4.4							1460
MG-17	6/17/15		3.79							796
MG-17	9/15/15		4.78							989
NM01	8/11/11			5				1		
OB01	8/11/11		5.5							1000
SM01	8/11/11		2.5	13						580

MonLocID	Date	Ag	Cd	Cu	Hg	Mn	Pb	Zn
001	7/14/10	1						
002	7/14/10							
002b	7/14/10							
002c	7/14/10							
003	7/14/10	1.6		14				
004	7/14/10	2.3						
005	6/9/11							
006	7/15/10	0.6		8				
007	7/15/10						4	38
008	7/15/10			6				
009	7/15/10	0.6						
010	7/15/10	1.2	0.7					230
011	7/15/10							140
012	7/15/10		0.6					180
BG01	8/17/11		2.1	830			7	430
BG-01	9/9/11			10			4	
BG02	8/17/11		1.6	180				200
BG-02	6/6/12		2.6	540			3	440
BG-02A	6/6/12		0.9	58				130
BG03	8/17/11		1.6	120				200
BG-03A	6/6/12			7				45
BG05	8/17/11			9				
BG-05	9/9/11		0.9				2	280
BG-07	6/6/12							130
BG-11	6/6/12							190
BG-13	6/6/13		0.622					229
BG-14	6/9/12							140
BG-14	6/6/13		0.457					159
BG-14	7/1/14		0.32					124
BG-14	9/23/14		0.979					222
BG-14	6/17/15		0.351					119
BG-14	9/15/15		0.552					173
BG-15	7/1/14		0.373					127
BG-15	9/23/14		0.671					224
BG-15	6/17/15		0.346					114
BG-15	9/15/15		0.708					208
BG-16	7/1/14		41.7					9550

MonLocID	Date	Ag	Cd	Cu	Hg	Mn	Pb	Zn
BG-16	9/23/14		27.1			2710		6970
BG-16	6/17/15		81.4	59.7		3510		16900
BG-16	9/15/15		24.6					6450
BG-17	6/6/13		0.755					236
BG-17	7/1/14		2.81					701
BG-17	9/23/14		1.54					439
BG-17	6/17/15		0.863					217
BG-17	9/15/15		1.03					277
BG-17B	6/6/13		0.651				16.8	
BG-17B	7/1/14		0.429					142
BG-17B	6/17/15		0.385					141
BG-17B	9/15/15		0.744					211
BG-18	6/9/12							160
BG-18	6/6/13		0.589					198
BG-18	7/1/14		0.499					170
BG-18	9/23/14		0.855					277
BG-18	6/17/15		0.542					165
BG-18	9/15/15		0.939					258
BG-19	6/9/12							
BG-19	6/6/13		0.411					
BG-19	7/1/14		0.494					
BG-19	9/23/14		0.546					
BG-19	6/17/15							211
BG-19	9/15/15		0.537					
BG-20	7/1/14							
BG-20	9/23/14							
BG-20	6/17/15							
BG-20	9/15/15							
BG-21	7/1/14							
BG-21	9/23/14							
BG-21	6/17/15							
BG-21	9/15/15							
BJ-01	7/1/14		355	1290	0.141	25400	50	60900
BJ-01	6/17/15		159	666	0.053	9660	45.4	33300
BJ-01A	6/17/15		74.4	216		3460	34.3	12400
BJ-01A	9/15/15		0.505					171
CORIVWCH_WQX-3553	6/28/00							

MonLocID	Date	Ag	Cd	Cu	Hg	Mn	Pb	Zn
CORIVWCH_WQX-4050	9/15/15							
CORIVWCH_WQX-4200	9/15/15							
CORIVWCH_WQX-895	11/11/10		0.71					184.8
CORIVWCH_WQX-895	12/15/10		0.72					167.6
CORIVWCH_WQX-895	2/2/11		0.67					175.8
CORIVWCH_WQX-895	3/23/11		0.65					
CORIVWCH_WQX-895	7/28/11		0.66					151
CORIVWCH_WQX-895	10/28/11							
CORIVWCH_WQX-895	1/10/12		0.99					202.4
CORIVWCH_WQX-895	5/8/12		0.77					210.4
CORIVWCH_WQX-895	10/6/12		0.71					163.7
CORIVWCH_WQX-895	2/19/13							
CORIVWCH_WQX-895	3/12/13		0.69					
CORIVWCH_WQX-895	4/16/13							
CORIVWCH_WQX-895	5/20/13		0.63					139.6
CORIVWCH_WQX-978	9/17/09							
CORIVWCH_WQX-978	11/9/09							
CORIVWCH_WQX-978	12/29/09							
CORIVWCH_WQX-978	2/25/10							
CORIVWCH_WQX-978	3/10/10							
CORIVWCH_WQX-978	4/14/10							
CORIVWCH_WQX-978	5/12/10							
CORIVWCH_WQX-978	11/4/10							
CORIVWCH_WQX-978	11/11/10							
CORIVWCH_WQX-978	12/15/10							
CORIVWCH_WQX-978	2/21/11							
CORIVWCH_WQX-978	3/23/11							
CORIVWCH_WQX-978	7/28/11							
CORIVWCH_WQX-978	10/28/11							
CORIVWCH_WQX-978	1/10/12							
CORIVWCH_WQX-978	5/8/12							
CORIVWCH_WQX-978	10/6/12							
CORIVWCH_WQX-978	2/19/13							
CORIVWCH_WQX-978	3/12/13							
CORIVWCH_WQX-978	4/16/13							
CORIVWCH_WQX-978	5/20/13							
DRMS-69	9/7/16		27			2700		6500

MonLocID	Date	Ag	Cd	Cu	Hg	Mn	Pb	Zn
OFM	6/6/13		6.79					2850
Opp-2	6/17/15		16.2					2910
Opp-3	6/17/15		105	410			57	20700
Opp-4	6/17/15		40.7					9900
USGS-39174010603540(	9/29/71							
USGS-39174010603540(	4/10/74							
USGS-39174010603540(	7/18/74							
USGS-39174010603540(	9/14/99							