2013 Eleven-Mile Canyon Nutrient Sampling

Final Report


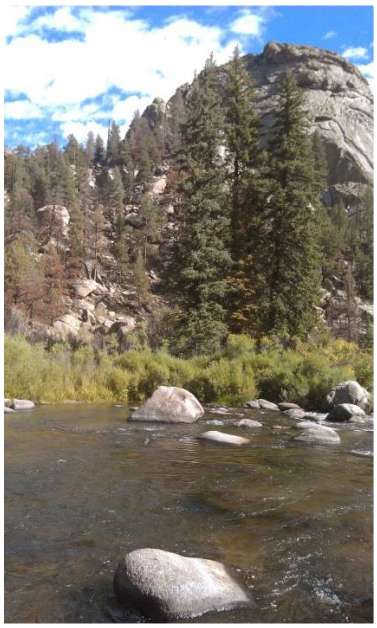


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Table of Contents

1.0 Executive Summary

This report summarizes the results of nutrient sampling in the South Platte River in the Eleven-mile Canyon Recreation Area (Eleven-mile Canyon) that was conducted by the Coalition for the Upper South Platte (CUSP) in the summer of 2013. Algal blooms in the South Platte River along Eleven-mile Canyon have increased over the years, and it is suspected sediment from erosion and/or the existence of old vault and pit toilets along the river is adding nutrients to the river. An excess of algal growth in a river system can negatively impact plant and aquatic life. In 2012, CUSP applied for and was granted funding through the 2008-2011 Secure Rural Schools program managed by the USDA Forest Service's Resource Advisory Committee (RAC). This grant outlined multiple project objectives such as replacing two old vault toilets in the canyon, hosting volunteer projects to reduce sediment loading in the river and conducting further water monitoring in the South Platte River in Eleven-mile Canyon. In the summer of 2013, CUSP sampled 19 locations along the South Platte River in Eleven-mile Canyon at three separate times during the summer for nitrates/nitrogen and total phosphorous (sediment loading). These results will be used to design projects to improve water quality in this area.

2.0 About CUSP

CUSP is a 501(c)3 non-profit organization initiated in 1998 to protect the water quality and ecological health of the Upper South Platte Watershed through the cooperative efforts of watershed stakeholders, with emphasis on community values and economic sustainability. CUSP has completed multi-year, multi-partner projects in Eleven-mile Canyon and throughout the 2,600-square-mile watershed that reaches from the Continental Divide to Strontia Springs Reservoir, southwest of Denver. The watershed is a recreational destination with over 1.6 million acres of public lands, and provides municipal water for about three quarters of Colorado's residents. CUSP recognizes that you cannot approach watershed health by standing in the river and looking down, but rather we must stand in the river and look around. This is the approach we took with potential issues in the South Platte River in Eleven-mile Canyon to try to identify causes of the algal blooms in this area.

3.0 – 2013 Nutrient Program

3.1 Background

An increase in algal blooms in the South Platte River in Eleven-mile Canyon motivated CUSP to take grab samples in 2011 to assess possible causes. Algal blooms have the potential to reduce available oxygen leading to the death of aquatic animals such as fish, and can increase the release of nutrients and toxic chemicals from sediment. Primary causes of algal blooms are linked to an increase in phosphorous and nitrogen. As suspected, these 2011 grab samples indicated an excess of nutrients in the river, but it was still unclear what was causing the increase. Based on these findings, CUSP requested funding in 2012 through the 2008-2011 Secure Rural Schools program managed by

the USDA Forest Service's Resource Advisory Committee (RAC). This grant covered multiple projects along the river in Eleven-mile Canyon, such as volunteer projects to reduce erosion, maintain and repair trails along the river and to conduct further water sampling. The largest amount of funding outlined in the grant was used to replace old vault toilets at the Spillway and Riverside Campgrounds. These toilets were replaced in addition to two other vault toilets replaced by the park in 2012. The remainder of the grant funding went towards further nutrient sampling in 2013.

3.2 Description of Study Area and Project Overview

In recent years, the increase in algal blooms along this section of the South Platte River has caused some concern. Phosphorous, which is a good indicator of sediment loading in the river, is a nutrient that is in short supply in most fresh waters. Even a modest increase in phosphorous can set off a whole chain of undesirable events in a stream, including accelerated plant growth, algal blooms, low dissolved oxygen, and the death of certain fish, invertebrates, and other aquatic animals. Runoff and erosion from river banks, river beds, land clearing, dirt roads, trails and burn scars from forest fires are the major sources of phosphorous entering waterways.

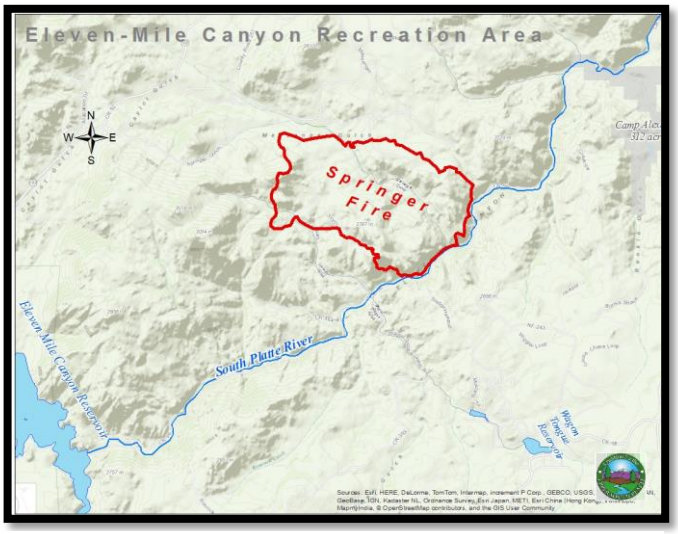
CUSP understands that there are many considerations when assessing the potential causes of algal blooms in the South Platte River. In this section, we try to paint a picture of what is happening around this area of the river instead of speculating what might be the problem.

Eleven-mile Canyon is located below the dam of the Eleven-mile reservoir near Lake George, CO in the southeast corner of South Park. Lake George is a small town (pop. ~1,500) located 45 miles west of Colorado Springs in the Rocky Mountains with an elevation of about 8,000 feet. The bedrock of this semiarid area in the Rocky Mountains is biotite granite that produces highly erodible soils resulting in sparse ground cover, contributing to the area's erosive nature.

The South Platte River is dammed at the top of the canyon to store water in the six-mile long reservoir owned and operated by Denver Water. Eleven-mile reservoir is the second largest in the Denver system and one of the largest bodies of water east of the Continental Divide storing up to 97,779 acre feet of water (one acre foot = 325,851 gallons). The South Platte River pours from the dam and continues 11 miles through the canyon. The flow from the dam is regulated by Denver Water and flow is variable throughout the year. Flow amounts can be found at www.dwr.state.co.us. Stratification and sediment storage in Eleven-mile reservoir, which is inherent with most dammed rivers, is a consideration when assessing possible causes of increased algal blooms in the South Platte River through Eleven-mile Canyon.

Map 1: Campground & Picnic Areas

Eleven-mile Canyon attracts well over 200,000 visitors each year, contributing to heavy use in areas around the South Platte River. It is enjoyed by anglers, rock climbers, hikers, campers and many other recreationists that flock to this unique area. There are eight campground and picnic areas that host open dirt parking lots, pull offs, camp & picnic sites and 11 pit toilets. We made sure to take samples above and below each campground, picnic area and vault toilet during this program. There is one main dirt road used by recreationists in and out of this narrow canyon that runs very close to the river. Established and social trails are abundant throughout the canyon leading to rock climbing, angling spots and scenic views. This use generates more exposed dirt in close proximity to the river, which in effect adds sediment to the water.



Map 2: Springer Fire Perimeter

In addition to the already highly erodible and exposed soil in the canyon, the 2012 Springer Fire burned very close to the river from June 17th to June 23rd consuming 1,145 acres of forest to the west of the canyon. The burn scar from this fire is most likely adding sediment loads to the South Platte River in the canyon. According to the Burned Area Report produced after the fire by the USDA Forest Service on June 29th 2012, there are 9.8 miles of ephemeral and 1.6 miles of perennial streams within the fire perimeter. Adjacent to the fire perimeter to the southeast lies 1.3 miles of the South Platte River. "Should runoff from the fire reach the South Platte River, nearly 100% of it would be transported through Messenger and Springer Gulches" (USDA 2012). When organizing our sampling program in 2013, CUSP took into consideration the gulches leading into the canyon transporting sediment into the South Platte River, including Messenger and Springer Gulches. In addition to running a sampling program in the Eleven-Mile Canyon in 2013, CUSP hosted a multitude of fire recovery projects on the Springer burn scar to reduce the amount of sediment loading to the river. With the help of 116 volunteers whom worked over 800 hours, CUSP was able to install many different sediment reduction structures and rake &

seed burnt ground on the Springer burn scar to help reduce the amount of sediment being carried to the River.

The South Platte River through this area pours directly from the Eleven-mile Reservoir, which is maintained by Denver Water. There are two caretaker homes for Denver Water employees near the dam for Eleven-mile Reservoir which use leach fields for managing waste like most remote homes in this area. Other close occupants to the river include the Camp Alexander Boy Scout Camp, which hosts 3,400 campers each year according to their publications, and the Wagon Tongue sub-division with 133 residential dwellings. Both Camp Alexander and the Wagon Tongue sub-division have drainages leading to the South Platte River in Eleven-mile Canyon and were considered when choosing sample locations.

All of these unique circumstances are possible causes for nutrient loading in the South Platte River in Eleven-mile Canyon.

3.3 Sampling Program

Funding from the USDA Forest Service RAC grant covered a more extensive sampling program conducted in the South Platte River in Eleven-mile Canyon in 2013. CUSP identified 19 locations along the river to sample based on possible nutrient loading. As discussed in the previous section, we generally picked locations on the river that were downstream of the dam, upstream and downstream of Denver Water caretaker homes, all 11 vault toilets, picnic areas, campgrounds, gulches, tributaries, and the Camp Alexander and Wagon Tongue subdivision outlets. Below is a list of all sample locations, associated sample IDs and sample site descriptions.

Sample ID	Location Description
EM06	300ft below dam, above bridge & caretaker house
EM07	Upstream of Spillway campground, downstream of caretaker houses
EM08	Above Idlewild picnic area, below Spillway campground
EM09	Downstream Idlewild picnic area
EM10	Upstream Cove campground, below bridge
EM11	Downstream Cove campground
EM12	Upstream Springer Gulch campground, just below bridge
EM13	Upstream of Wagon Tongue tributary, downstream of Springer Gulch campground
EM14	Downstream Wagon Tongue tributary
EM15	Upstream of Messenger Gulch picnic area
EM16	Upstream Messenger Gulch, downstream Messenger picnic area
EM17	Downstream Messenger Gulch
EM18a	Upstream of Eleven-Mile picnic area
EM18	Downstream of Eleven-Mile picnic area
EM19	Upstream of O'Brien campground
EM20	Downstream of O'Brien campground
EM21	Upstream of Camp Alexander property
EM22	Upstream of Riverside campground
EM23	Downstream of Riverside campground

Table 1: Sample Site Descriptions

4.0 Methods

Specific sampling protocols, quality control, and additional data management protocols are outlines in the Quality Assurance Project Plan (QAPP) prepared for this study (Appendix 1). Field parameters including pH, conductivity, water temperatures, and dissolved oxygen were measured using a Hanna multi-parameter GPS capable probe following manufacture specifications and protocols outlined in the associated program QAPP; this meter was maintained on a regular basis as outlined in the QAPP and calibrated at the beginning of each sampling event for both the May 28th 2013 and July 26th 2013 sampling events. Due to a malfunction with the cord attached to the Hanna multi-parameter probe after the July 26th 2013 sample event, sampling equipment was borrowed from the Woodland Park waste water treatment plant for the September 19th 2013 sampling event.

All samples were analyzed by Colorado Analytical Laboratories, INC in Brighton, CO. Laboratory methods used to analyze our samples were EPA 300.0 for Nitrate Nitrogen and EPA 365.1 for Phosphorous-T.

4.1 Sampling Process Design

Specific sample sites are listed in Table 1 in section 3.3 above. Generally, the 19 locations we identified on the South Platte River in the Eleven-mile Canyon were sampled three times during the year, once in the spring (May 28th 2013), once in the summer (July 26th 2013) and once in the fall (September 19th 2013). We had planned to record one rain event during the sampling season but due to logistical planning, we did not sample a rain event in 2013 although the July 26th and September 19th sample events had rain on or just before the sample day. Monitoring sites were identified by GPS coordinates with predetermined sample IDs that were used consistently throughout the summer.

Sampling was conducted by the CUSP designated field lead and at least one other individual, either volunteer or other CUSP staff. Access to all sampling sites was obtained prior to commencement of field work. Notice was given to property owners at least 48 hours prior to sampling events in the case of Denver Water Property. Property owners were encouraged to be on site during the sampling event. Samples taken elsewhere in the Canyon were on public property and did not require license to enter documents but written or verbal agreements and notifications was made to appropriate agency personnel.

Samples were delivered in iced coolers to the Colorado Analytical laboratory, located at 4955 Yarrow Street, 240 South Main Street Brighton, CO 80601, at the end of each sampling event to ensure that all sample holding times and temperatures were met.

4.2 Sampling Method Requirements

Decontamination was required for all sampling equipment. The goal of equipment decontamination was to help ensure that the equipment was not a source of foreign substances that could affect the

ambient concentrations of target analytes in samples or otherwise affect sample chemistry. Prior to each sampling event all equipment was inspected for stains, cuts, or abrasions. The Hanna multiprobe was serviced each month to ensure that all o-rings were lubricated and that there were no cracks or crimps in rings, the dissolved oxygen membrane probe tip was replacement every 2 months or earlier if damaged and was inspected prior to each sampling event to ensure that no air bubbles were present. All sampling equipment was rinsed with DI water directly after use while equipment was still wet. Sample bottles were certified clean and prepped by Colorado Analytical; therefore there was no need for decontamination of this sampling equipment. Decontamination focused on the Hanna multiprobe and other equipment used for sample acquisition. Following each sampling event, equipment was cleaned and stored appropriately; no equipment was stored dirty.

4.3 Sample Handling and Custody Requirements

Sample labels were affixed to the sample containers at the time of sampling. They contained the following information:

- Sample identification
- Initials of sampler
- Sample location
- Analysis to be conducted
- Date and time of collection
- Preservatives, if any
- Name or organization

The sample labels remained on the containers throughout the time they were retained.

A sample identification system was used to identify each sample for chemical analysis and the management of data. The sample IDs allocated for this sampling effort was used on all sample labels, field sheets, chain-of-custody records, and all applicable documentation used during the field sampling activities. A list of all sample IDs was maintained in the iCrop water sampling form.

4.3.1 *Chain-of-Custody*

A COC record was completed for each shipment of samples to track the movement of samples to provide a written record of persons handling the samples and specify sample analyses. A COC record accompanied the field samples during shipment to and at the laboratory. The information provided on the COC record included the following:

- Project name
- Signature of the sampler(s)
- Sampling station number or sample ID
- Date and time of collection
- Grab or composite designation
- Signature of individuals involved in the sample transfer
- Time and date of sample receipt
- Type of matrix

- Preservatives used
- Sample analysis methods required

COC records initiated in the field were placed in a plastic bag and taped to the inside of the lid of the shipping containers used for sample transport from the field to the laboratory.

4.4 Instrument/Equipment Testing, Inspection, Calibration Frequency, and Maintenance Requirements

Prior to each site visit or sampling event, all equipment including pH and multi parameter probes, flow meters, sample coolers, GPS units, cameras, decontamination equipment, and other sampling tools were inspected. The Hanna multi-probe was calibrated the morning of each sampling event. The DO probe was inspected to ensure there is no damage to the membrane, tips are replaced bi-monthly and manufacture solution is replaced monthly; DI tip and solution change was recorded in the maintenance log book. The Hanna multi-probe was maintained with the manufacture maintenance kit supplied with the unit. The Hanna probe is calibrated using the HI-9282 quick calibration solution each sampling event, additionally pH 7.01, 10.01, and 4.01 buffers were used periodically to ensure adequate pH calibration.

4.5 Data Management

Following each sampling event all field data was entered into the appropriate spreadsheet and stored on the field coordinators computer files as well as the CUSP office database. At the end of each sampling day, electronic water sampling forms were uploaded from the field monitoring iPad to the CUSP server via the *Cloud*. Field data spreadsheets are kept in the same computer file as the COC forms, lab acknowledgments of sample receipts, and subsequent laboratory analysis results. Computer files stored in the CUSP documents and database are protected through routine system backups. Field data entered into spreadsheets was checked against data collected through iCrop on the field monitoring iPad prior to report writing.

5.0 Sample Results Discussion

There are no aquatic regulations for nutrient loading in river systems in Colorado but according to the Environmental Protection Agency (EPA), the natural background concentration of phosphorus in river systems is generally less than 0.03 mg/L, ranging from 0.005 mg/L to 0.05 mg/L. Over the three sample events phosphorus was recorded as high as 0.09 mg/L. When thinking about nutrient loading and increased algal blooms in the South Platte River in Eleven-mile Canyon we must consider a few basic facts about nitrogen and phosphorus. Generally, phosphorus is the limiting nutrient in fresh water aquatic systems. If all phosphorus is used, plant growth will cease no matter how much nitrogen is available. The increased concentration of available phosphorus allows plants to assimilate more nitrogen before the phosphorus is depleted. Thus, if sufficient phosphorus is available, elevated concentrations of nitrates will lead to algal blooms. In reservoirs, a large amount

of sediment is trapped behind the dam outlet. Phosphorus is most likely released from the Eleven-mile reservoir bottom sediment during seasonal overturns.

Nitrates were not present at all or barely detected in samples taken on May 28th and July 26th and were present at all 19 sample locations on September 19th, but concentrations only ranged from 0.1 mg/L to 0.13 mg/L which in normal range for a river system. According to the EPA:

> Nitrates are a form of nitrogen, which is found in several different forms in terrestrial and aquatic ecosystems. These forms of nitrogen include ammonia (NH3), nitrates (NO3), and nitrites (NO2). Nitrates are essential plant nutrients, but in excess amounts they can cause significant water quality problems. Together with phosphorus, nitrates in excess amounts can accelerate eutrophication, causing dramatic increases in aquatic plant growth and changes in the types of plants and animals that live in the stream. This, in turn, affects dissolved oxygen, temperature, and other indicators. Excess nitrates can cause hypoxia (low levels of dissolved oxygen) and can become toxic to warm-blooded animals at higher concentrations (10 mg/L) or higher) under certain conditions. The natural level of ammonia or nitrate in surface water is typically low (less than 1 mg/L); in the effluent of wastewater treatment plants, it can range up to 30 mg/L.

It is worth considering then that the excess of phosphorus loading in the South Platte River from runoff and Eleven-mile Reservoir is causing the increased algal blooms in Eleven-mile Canyon. Below is a brief discussion on sample results. In-depth tables with all sample parameters and results are included at the end of this document.

May 28th 2013 Sample Event

On May 28th during the sampling period, river flow was recorded by Denver Water at 0.95 cubic feet per second. Results for nitrate at all locations were below the lower quantification limit (LQL) of 0.02 mg/L except for the sample taken downstream of Camp Alexander with a reading of 0.03 mg/L which is very low. Phosphorous was detected above the LQL of 0.01 mg/L at 4 locations on the May 28th sampling event and are as follows:

- 0.01 mg/L upstream of the Spillway Campground and downstream of the Denver Water caretaker homes;
- 0.04 mg/L downstream of Cove Campground;
- 0.02 mg/L upstream of Messenger Gulch;
- 0.01 mg/L downstream of O'Brien Campground.

July 26th 2013 Sample Event

On July 26th during the sampling period, river flow was recorded by Denver Water at 2.1 cubic feet per second. Results for nitrate at all locations were below the lower quantification limit (LQL) of 0.02 mg/L except for the sample taken downstream of Springer Gulch with a reading of 1.05 mg/L. There were no other nitrate readings this high throughout the summer so we assume that this was an outlier result. All results for phosphorus on the July 26th sampling event were above the lower quantification limit (LQL) of 0.01 mg/L ranging from 0.04 mg/L to 0.09 mg/L. Rainfall was

recorded on July 25th at 0.14 inches and on July 26th at 0.19 inches. This could explain the increase in phosphorus due to sediment runoff draining into the river at this time.

September 19th 2013 Sample Event

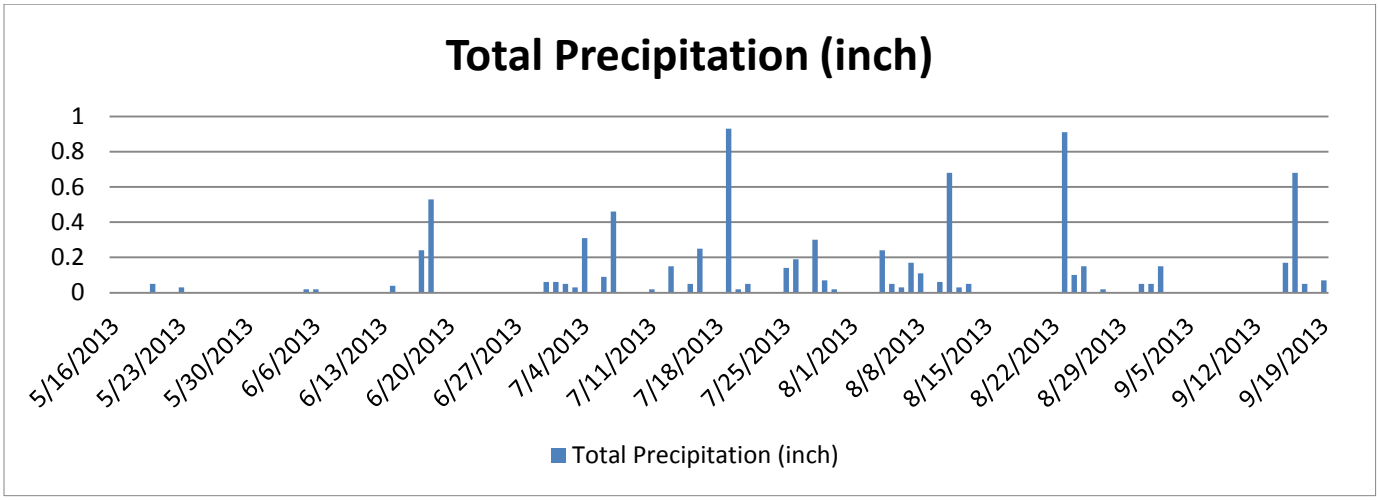
On September 19th during the sampling period, river flow was recorded by Denver Water at 1.5 cubic feet per second. Results for nitrate at all locations were above the lower quantification limit of 0.02 mg/L ranging from 0.1 mg/L to 0.13 mg/L. All results for phosphorus on the September 19th sampling event were above the lower quantification limit of 0.01 mg/L ranging from 0.03 mg/L to 0.08 mg/L. There was a significant rain event on September 16th just 3 days prior that could explain the increase in phosphorus in the samples as a result to increases sediment flow into the river.

Rainfall from May 16th to September 19th 2013

Date	Precipitation (inches)
5/20/2013	0.05
5/23/2013	0.03
6/5/2013	0.02
6/6/2013	0.02
6/14/2013	0.04
6/17/2013	0.24
6/18/2013	0.53
6/30/2013	0.06
7/1/2013	0.06
7/2/2013	0.05
7/3/2013	0.03
7/4/2013	0.31
7/6/2013	0.09
7/7/2013	0.46
7/11/2013	0.02
7/13/2013	0.15
7/15/2013	0.05
7/16/2013	0.25
7/19/2013	0.93
7/20/2013	0.02
7/21/2013	0.05
7/25/2013	0.14
7/26/2013	0.19
7/28/2013	0.3
7/29/2013	0.07
7/30/2013	0.02

8/4/2013	0.24
8/5/2013	0.05
8/6/2013	0.03
8/7/2013	0.17
8/8/2013	0.11
8/10/2013	0.06
8/11/2013	0.68
8/12/2013	0.03
8/13/2013	0.05
8/23/2013	0.91
8/24/2013	0.1
8/25/2013	0.15
8/27/2013	0.02
8/31/2013	0.05
9/1/2013	0.05
9/2/2013	0.15
9/15/2013	0.17
9/16/2013	0.68
9/17/2013	0.05
9/19/2013	0.07

Table 2: Precipitation from May 16th to September 19th 2013. **When dates are missing, there was no rainfall.



Eleven Mile Canyon

2013 Surface Water Monitoring

Eleven Mile Canyon is located on the South Platte River in Park County near Lake George, Colorado. The South Platte River and its tributaries are a critical part of the Denver municipal water supply.
In 2013 a U.S. Forest Service Resource Advisory Committee (RAC) Grant was used to establish a water sampling program to increase understanding of water quality impacts associated with human factors, fire impacts and sediment run-off in the South Platte River in Eleven Mile Canyon.
CUSP sampled for phosphorous and nitrogen at 19 locations along the river at three separate times during the summer of 2013. This data will be used to assess possible contributions to algae blooms in the South Platte River and determine next steps.

Inset

EM15	MAY	JULY	SEPT
pH	8.81	9.31	8.36
Algae	Moderate	Moderate	Moderate
Total Phosphorous	0.02	0.05	0.07
Nitrate	<0.02	<0.02	0.12

EM16	MAY	JULY	SEPT
pH	8.81	9.33	8.35
Algae	Moderate	Moderate	Moderate
Total Phosphorous	<0.01	0.04	0.07
Nitrate	<0.02	<0.02	0.13

EM17	MAY	JULY	SEPT
pH	8.66	9.35	8.54
Algae	Moderate	Moderate	Moderate
Total Phosphorous	<0.01	0.07	0.04
Nitrate	<0.02	<0.02	0.11

EM18	MAY	JULY	SEPT
pH	8.6	9.38	8.59
Algae	Moderate	Low	Moderate
Total Phosphorous	<0.01	0.05	0.07
Nitrate	<0.02	<0.02	0.11

EM18a	MAY	JULY	SEPT
pH	8.67	9.37	8.6
Algae	Moderate	Low	Moderate
Total Phosphorous	<0.01	0.05	0.06
Nitrate	<0.02	<0.02	0.11

Inset

EM06	MAY	JULY	SEPT
pH	8.88	8.17	7.83
Algae	High	Moderate	High
Total Phosphorous	<0.01	0.09	0.06
Nitrate	<0.02	<0.02	0.12

EM11	MAY	JULY	SEPT
pH	9.04	9.05	8.38
Algae	High	High	High
Total Phosphorous	0.04	0.05	0.04
Nitrate	<0.02	<0.02	0.13

EM10	MAY	JULY	SEPT
pH	9.07	9.03	8.27
Algae	Moderate	High	High
Total Phosphorous	<0.01	0.06	0.03
Nitrate	<0.02	<0.02	0.1

EM07	MAY	JULY	SEPT
pH	9.07	8.76	8.27
Algae	Moderate	Moderate	High
Total Phosphorous	0.01	0.05	0.03
Nitrate	<0.02	<0.02	0.11

EM08	MAY	JULY	SEPT
pH	9.05	8.95	8.24
Algae	High	Moderate	High
Total Phosphorous	<0.01	0.06	0.05
Nitrate	<0.02	<0.02	0.11

EM09	MAY	JULY	SEPT
pH	9.05	9.17	8.33
Algae	High	Low	Moderate
Total Phosphorous	<0.01	0.05	0.05
Nitrate	<0.02	<0.02	0.13

Inset

EM19	MAY	JULY	SEPT
pH	8.56	9.35	8.61
Algae	Low	Low	Moderate
Total Phosphorous	<0.01	0.06	0.07
Nitrate	<0.02	<0.02	0.1

EM23	MAY	JULY	SEPT
pH	7.76	n/a	8.8
Algae	None	Low	High
Total Phosphorous	<0.01	0.06	0.08
Nitrate	<0.02	<0.02	0.11

EM20	MAY	JULY	SEPT
pH	8.51	9.35	8.63
Algae	Low	Low	Moderate
Total Phosphorous	0.01	0.06	0.08
Nitrate	<0.02	<0.02	0.1

EM21	MAY	JULY	SEPT
pH	8.36	9.36	8.72
Algae	None	Moderate	High
Total Phosphorous	<0.01	0.06	0.08
Nitrate	<0.02	<0.02	0.12

EM22	MAY	JULY	SEPT
pH	8.24	n/a	8.73
Algae	Low	Moderate	Moderate
Total Phosphorous	<0.01	0.06	0.05
Nitrate	0.03	<0.02	0.11

Inset

EM12	MAY	JULY	SEPT
pH	8.94	9.22	8.41
Algae	High	High	Moderate
Total Phosphorous	<0.01	0.05	0.04
Nitrate	<0.02	<0.02	0.13

EM13	MAY	JULY	SEPT
pH	8.93	9.27	8.5
Algae	Moderate	Moderate	Moderate
Total Phosphorous	<0.01	0.06	0.06
Nitrate	<0.02	1.05	0.1

EM14	MAY	JULY	SEPT
pH	8.79	9.28	8.38
Algae	Moderate	High	High
Total Phosphorous	<0.01	0.07	0.03
Nitrate	<0.02	<0.02	0.11

- 2013 Water Quality Monitoring sites
  - 5/28/2013 - average flow 0.95 cfs
  - 7/26/2013 - average flow 2.09 cfs
  - 9/19/2013 - average flow 1.49 cfs
- Pit toilet location
- Springer Fire boundary June 24 2012
  - Park County parcel data
- USFS feature
- Camp Alexander

Stream flow data reported by Dever Water
Total Phosphorous and Nitrate measured in mg/L
Map by CUSP - April 2014

N

0 1,250 2,500 5,000 Feet

Eleven-Mile Canyon Nutrient Sampling Results - May 28th 2013

Sample ID	Site Description	Date	Time	pH	Temp (°C)	DO (%)	Cond. (mS/cm)	TDS	Algae Growth	T_Phosporous (mg/L) LQL=0.01	Nitrate Nitrogen (mg/L) LQL=0.02
EM06-052813	300 ft below dam, above bridge and caretaker house	5/28/2013	11:40:07 AM	8.88	6.99	6.3	228	173	HIGH	<0.01	<0.02
EM07-052813	US Spillway CG, DS caretaker houses	5/28/2013	11:26:11 AM	9.07	7.44	6.81	232	174	MODERATE	0.01	<0.02
EM08-052813	Above Lidlewild PA, below Spillway CG	5/28/2013	11:17:04 AM	9.05	8.21	6.95	238	174	HIGH	<0.01	<0.02
EM09-052813	DS Idlewild PA	5/28/2013	11:05:31 AM	9.05	8.83	6.96	240	174	HIGH	<0.01	<0.02
EM10-052813	US Cove CG, below bridge	5/28/2013	10:56:09 AM	9.07	8.55	6.62	237	173	MODERATE	<0.01	<0.02
EM11-052813	DS Cove CG	5/28/2013	10:46:26 AM	9.04	8.73	6.83	237	172	HIGH	0.04	<0.02
EM12-052813	US Springer Gulch CG, just below bridge	5/28/2013	10:27:38 AM	8.94	7.5	6.5	232	174	HIGH	<0.01	<0.02
EM13-052813	US Wagon Tongue Gulch trib. DS Springer Gulch CG	5/28/2013	10:20:03 AM	8.93	7.48	6.04	232	174	MODERATE	<0.01	<0.02
EM14-052813	DS Wagon Tongue Gulch trib.	5/28/2013	10:03:58 AM	8.79	7.34	6.29	230	174	MODERATE	<0.01	<0.02
EM15-052813	US Messenger Gulch PA	5/28/2013	9:52:31 AM	8.81	7.06	6.18	226	171	MODERATE	0.02	<0.02
EM16-052813	US Messenger Gulch, DS Messenger PA	5/28/2013	9:38:52 AM	8.81	6.79	6.25	226	173	MODERATE	<0.01	<0.02
EM17-052813	DS Messenger Gulch	5/28/2013	9:30:30 AM	8.66	6.6	6.1	225	173	MODERATE	<0.01	<0.02
EM18a-052813	US 11-mile PA	5/28/2013	9:18:01 AM	8.67	6.48	6.14	224	173	MODERATE	<0.01	<0.02
EM18-052813	DS 11-mile PA	5/28/2013	9:11:46 AM	8.6	6.43	6	221	170	MODERATE	<0.01	<0.02
EM19-052813	US O'Brien CG	5/28/2013	8:54:39 AM	8.56	6.47	5.67	226	174	LOW	<0.01	<0.02
EM20-052813	DS O'Brien CG	5/28/2013	8:43:09 AM	8.51	6.5	5.41	228	176	LOW	0.01	<0.02
EM21-052813	US Camp Alexander	5/28/2013	8:29:04 AM	8.36	7.21	4.92	227	172	NONE	<0.01	<0.02
EM22-052813	US Riverside CG	5/28/2013	8:17:24 AM	8.24	7.26	4.32			LOW	<0.01	0.03
EM23-052813	DS Riverside CG	5/28/2013	8:07:59 AM	7.76	7.16	3.88	217	164	NONE	<0.01	<0.02

Table 3

Eleven-Mile Canyon Nutrient Sampling Results - May 28th 2013

Sample ID	Site Description	Date	Time	Latitude	Longitude	Odor	Color	Notes	Flow (cfs)
EM06-052813	300 ft below dam, above bridge and caretaker house	5/28/2013	11:40:07 AM	38.90521	105.47378	NONE	CLEAR		0.95
EM07-052813	US Spillway CG, DS caretaker houses	5/28/2013	11:26:11 AM	38.90643	105.47091	NONE	CLEAR	geese in river above sample loc.	0.95
EM08-052813	Above Lidlewild PA, below Spillway CG	5/28/2013	11:17:04 AM	38.90447	105.46541	NONE	CLEAR		0.95
EM09-052813	DS Idlewild PA	5/28/2013	11:05:31 AM	38.90607	105.46268	NONE	CLEAR		0.95
EM10-052813	US Cove CG, below bridge	5/28/2013	10:56:09 AM	38.90846	105.46052	NONE	CLEAR		0.95
EM11-052813	DS Cove CG	5/28/2013	10:46:26AM	38.91006	105.45964	NONE	CLEAR		0.96
EM12-052813	US Springer Gulch CG, just below bridge	5/28/2013	10:27:38 AM	38.92649	105.42538	NONE	CLEAR		0.95
EM13-052813	US Wagon Tongue Gulch trib. DS Springer Gulch CG	5/28/2013	10:20:03 AM	38.92716	105.42456	NONE	CLEAR		0.95
EM14-052813	DS Wagon Tongue Gulch trib.	5/28/2013	10:03:58 AM	38.92719	105.42404	NONE	CLEAR		0.95
EM15-052813	US Messenger Gulch PA	5/28/2013	9:52:31 AM	38.93295	105.41155	NONE	CLEAR		0.95
EM16-052813	US Messenger Gulch, DS Messenger PA	5/28/2013	9:38:52 AM	38.93332	105.41067	NONE	CLEAR		0.95
EM17-052813	DS Messenger Gulch	5/28/2013	9:30:30 AM	38.93360	105.41020	NONE	CLEAR		0.95
EM18a-052813	US 11-mile PA	5/28/2013	9:18:01 AM	38.93591	105.40641	NONE	CLEAR		0.96
EM18-052813	DS 11-mile PA	5/28/2013	9:11:46 AM	38.93659	105.40582	NONE	CLEAR		0.96
EM19-052813	US O'Brien CG	5/28/2013	8:54:39 AM	38.95788	105.38978	NONE	CLEAR		0.95
EM20-052813	DS O'Brien CG	5/28/2013	8:43:09 AM	38.95871	105.38863	Slight Manure Odor	CLEAR		0.95
EM21-052813	US Camp Alexander	5/28/2013	8:29:04 AM	38.95796	105.37990	NONE	CLEAR		0.96
EM22-052813	US Riverside CG	5/28/2013	8:17:24 AM	38.96003	105.37696	NONE	CLEAR		0.96
EM23-052813	DS Riverside CG	5/28/2013	8:07:59 AM	38.96293	105.37486	NONE	CLEAR	water level up since recon day	0.96

Table 3

Eleven-Mile Canyon Nutrient Sampling Results - June 26th 2013

Sample ID	Site Description	Date	Time	pH	Temp (°C)	DO (%)	Cond. (mS/cm)	TDS	Algae Growth	T_Phosporous (mg/L) LQL=0.01	Nitrate Nitrogen (mg/L) LQL=0.02
EM06-072613	300 ft below dam, above bridge and caretaker house	7/26/2013	9:47:47 AM	8.17	15.36	probe una	285	175	MODERATE	0.09	<0.02
EM07-072613	US Spillway CG, DS caretaker houses	7/26/2013	10:02:03 AM	8.76	15.8	6.25	286	173	MODERATE	0.05	<0.02
EM08-072613	Above Lidlewild PA, below Spillway CG	7/26/2013	10:39:40 AM	8.95	16.36	7.27	290	173	MODERATE	0.06	<0.02
EM09-072613	DS Idlewild PA	7/26/2013	10:51:33 AM	9.17	16.58	6.89	292	174	LOW	0.05	<0.02
EM10-072613	US Cove CG, below bridge	7/26/2013	11:16:01 AM	9.03	16.91	7.92	293	173	HIGH	0.06	<0.02
EM11-072613	DS Cove CG	7/26/2013	11:05:52 AM	9.05	16.97	8.06	293	173	HIGH	0.05	<0.02
EM12-072613	US Springer Gulch CG, just below bridge	7/26/2013	11:35:39 AM	9.22	17.24	4.77	295	173	HIGH	0.05	<0.02
EM13-072613	US Wagon Tongue Gulch trib. DS Springer Gulch CG	7/26/2013	11:44:28 AM	9.27	17.42	4.96	292	170	Moderate	0.06	1.05
EM14-072613	DS Wagon Tongue Gulch trib.	7/26/2013	11:54:40 AM	9.28	17.62	5.4	297	173	HIGH	0.07	<0.02
EM15-072613	US Messenger Gulch PA	7/26/2013	12:08:37 PM	9.31	17.68	6.32	298	173	MODERATE	0.05	<0.02
EM16-072613	US Messenger Gulch, DS Messenger PA	7/26/2013	12:15:03 PM	9.33	17.81	6.46	299	173	MODERATE	0.04	<0.02
EM17-072613	DS Messenger Gulch	7/26/2013	12:26:38 PM	9.35	17.94	5.83	303	175	MODERATE	0.07	<0.02
EM18a-072613	US 11-mile PA	7/26/2013	12:37:32 PM	9.37	18.12	6.17	304	175	LOW	0.05	<0.02
EM18-072613	DS 11-mile PA	7/26/2013	12:45:50 PM	9.38	18.29	6.51	305	175	LOW	0.05	<0.02
EM19-072613	US O'Brien CG	7/26/2013	1:03:41 PM	9.35	18.59	4.36	307	174	LOW	0.06	<0.02
EM20-072613	DS O'Brien CG	7/26/2013	1:10:39 PM	9.35	18.7	4.54	308	175	LOW	0.06	<0.02
EM21-072613	US Camp Alexander	7/26/2013	1:27:44 PM	9.36	18.82	4.61	309	175	MODERATE	0.06	<0.02
EM22-072613	US Riverside CG, DS Camp Alexander	7/26/2013	1:50:48 PM	Probe malfunction					MODERATE	0.06	<0.02
EM23-072613	DS Riverside CG	7/26/2013	1:55:18 PM	Probe malfunction					LOW	0.06	<0.02

Table 4

Eleven-Mile Canyon Nutrient Sampling Results - June 26th 2013

Sample ID	Site Description	Date	Time	Latitude	Longitude	Odor	Color	Notes	Flow (cfs)
EM06-072613	300 ft below dam, above bridge and caretaker house	7/26/2013	9:47:47 AM	38.90523	105.47377	slight fish smell	CLEAR	Spillway flowing, bottom valve open	2.09
EM07-072613	US Spillway CG, DS caretaker houses	7/26/2013	10:02:03 AM	38.90656	105.47099	NONE	CLEAR	fishermen US	2.09
EM08-072613	Above Lidlewild PA, below Spillway CG	7/26/2013	10:39:40 AM	39.90538	105.46339	NONE	CLEAR	Fishermen US	2.1
EM09-072613	DS Idlewild PA	7/26/2013	10:51:33 AM	38.90613	105.46265	NONE	CLEAR		2.1
EM10-072613	US Cove CG, below bridge	7/26/2013	11:16:01 AM	38.90848	105.46073	NONE	CLEAR	Fishermen US	2.1
EM11-072613	DS Cove CG	7/26/2013	11:05:52 AM	38.91016	105.45968	slight fish smell	CLEAR		2.09
EM12-072613	US Springer Gulch CG, just below bridge	7/26/2013	11:35:39 AM	38.92652	105.42536	NONE	CLEAR		2.09
EM13-072613	US Wagon Tongue Gulch trib. DS Springer Gulch CG	7/26/2013	11:44:28 AM	38.92708	105.42488	NONE	CLEAR	geese US	2.09
EM14-072613	DS Wagon Tongue Gulch trib.	7/26/2013	11:54:40 AM	38.92711	105.42409	NONE	CLEAR		2.09
EM15-072613	US Messenger Gulch PA	7/26/2013	12:08:37 PM	38.93294	105.41145	NONE	CLEAR		2.1
EM16-072613	US Messenger Gulch, DS Messenger PA	7/26/2013	12:15:03 PM	38.93337	105.41070	NONE	CLEAR		2.1
EM17-072613	DS Messenger Gulch	7/26/2013	12:26:38 PM	38.93421	105.40937	NONE	CLEAR		2.09
EM18a-072613	US 11-mile PA	7/26/2013	12:37:32 PM	38.93562	105.40650	NONE	CLEAR		2.09
EM18-072613	DS 11-mile PA	7/26/2013	12:45:50 PM	38.93650	105.40581	NONE	CLEAR	fishermen & kids US	2.1
EM19-072613	US O'Brien CG	7/26/2013	1:03:41 PM	38.95806	105.38949	NONE	CLEAR		2.1
EM20-072613	DS O'Brien CG	7/26/2013	1:10:39 PM	38.95882	105.38853	NONE	CLEAR		2.1
EM21-072613	US Camp Alexander	7/26/2013	1:27:44 PM	38.95796	105.37996	NONE	CLEAR		2.09
EM22-072613	US Riverside CG, DS Camp Alexander	7/26/2013	1:50:48 PM			NONE	CLEAR		2.1
EM23-072613	DS Riverside CG	7/26/2013	1:55:18 PM			NONE	CLEAR		2.09

Table 4

Sample ID	Site Description	Date	Time	pH	Temp (°C)	DO (%)	Cond. (mS/cm)	TDS	Algae Growth	T_Phosporous (mg/L) LQL=0.01	Nitrate Nitrogen (mg/L) LQL=0.02
EM06-091913	300 ft below dam, above bridge and caretaker house	9/19/2013	7:50:03 AM	7.83	16.3	N/A	225	144	HIGH	0.06	0.12
EM07-091913	US Spillway CG, DS caretaker houses	9/19/2013	8:07:35 AM	8.27	16.1	N/A	230	147	HIGH	0.03	0.11
EM08-091913	Above Lidlewild PA, below Spillway CG	9/19/2013	8:26:15 AM	8.24	15.7	N/A	235	150	HIGH	0.05	0.11
EM09-091913	DS Idlewild PA	9/19/2013	8:53:22 AM	8.33	15.8	N/A	230	147	MODERATE	0.05	0.13
EM10-091913	US Cove CG, below bridge	9/19/2013	9:08:01 AM	8.27	15.4	N/A	230	147	HIGH	0.03	0.1
EM11-091913	DS Cove CG	9/19/2013	9:18:42 AM	8.38	15.7	N/A	230	147	HIGH	0.04	0.13
EM12-091913	US Springer Gulch CG, just below bridge	9/19/2013	9:38:04 AM	8.41	14.8	N/A	225	144	MODERATE	0.04	0.13
EM13-091913	US Wagon Tongue Gulch trib. DS Springer Gulch CG	9/19/2013	9:51:41 AM	8.5	15.1	N/A	225	144	MODERATE	0.06	0.1
EM14-091913	DS Wagon Tongue Gulch trib.	9/19/2013	10:00:24 AM	8.38	15	N/A	230	147	HIGH	0.03	0.11
EM15-091913	US Messenger Gulch PA	9/19/2013	10:18:44 AM	8.36	14.8	N/A	225	144	MODERATE	0.07	0.12
EM16-091913	US Messenger Gulch, DS Messenger PA	9/19/2013	10:25:54 AM	8.35	14.8	N/A	230	147	MODERATE	0.07	0.13
EM17-091913	DS Messenger Gulch	9/19/2013	10:36:56 AM	8.54	15	N/A	230	147	MODERATE	0.04	0.11
EM18a-091913	US 11-mile PA	9/19/2013	10:55:29 AM	8.6	15.1	N/A	220	141	MODERATE	0.06	0.11
EM18-091913	DS 11-mile PA	9/19/2013	11:03:14 AM	8.59	15.3	N/A	220	141	MODERATE	0.07	0.11
EM19-091913	US O'Brien CG	9/19/2013	11:25:34 AM	8.61	15.1	N/A	220	141	MODERATE	0.07	0.1
EM20-091913	DS O'Brien CG	9/19/2013	11:33:45 AM	8.63	15.2	N/A	215	138	MODERATE	0.08	0.1
EM21-091913	US Camp Alexander	9/19/2013	11:45:33 AM	8.72	15.4	N/A	220	141	HIGH	0.08	0.12
EM22-091913	US Riverside CG, DS Camp Alexander	9/19/2013	11:54:21 AM	8.73	15.5	N/A	215	138	MODERATE	0.05	0.11
EM23-091913	DS Riverside CG	9/19/2013	12:04:30 AM	8.8	15.9	N/A	210	134	HIGH	0.08	0.11

Table 5

Sample ID	Site Description	Date	Time	Latitude	Longitude	Odor	Color	Notes	Flow (cfs)
EM06-091913	300 ft below dam, above bridge and caretaker house	9/19/2013	7:50:03 AM	38.90523	105.47376	NONE	CLEAR	Spillway is flowing	1.5
EM07-091913	US Spillway CG, DS caretaker houses	9/19/2013	8:07:35 AM	38.90651	105.47090	NONE	CLEAR	geese US	1.5
EM08-091913	Above Lidlewild PA, below Spillway CG	9/19/2013	8:26:15 AM	38.90533	105.46356	slight fish smell	CLEAR	log structures in stream	1.5
EM09-091913	DS Idlewild PA	9/19/2013	8:53:22 AM	38.90630	105.46188	slight algae/fish smell	CLEAR	fish visible in water	1.5
EM10-091913	US Cove CG, below bridge	9/19/2013	9:08:01 AM	38.90830	105.46067	NONE	CLEAR	Fishermen at location	1.5
EM11-091913	DS Cove CG	9/19/2013	9:18:42 AM	38.91010	105.45976	NONE	CLEAR	fisherman DS	1.5
EM12-091913	US Springer Gulch CG, just below bridge	9/19/2013	9:38:04 AM	38.92645	105.42539	NONE	CLEAR		1.5
EM13-091913	US Wagon Tongue Gulch trib. DS Springer Gulch CG	9/19/2013	9:51:41 AM	38.92705	105.42447	NONE	CLEAR		1.5
EM14-091913	DS Wagon Tongue Gulch trib.	9/19/2013	10:00:24 AM	38.92711	105.42411	NONE	CLEAR		1.48
EM15-091913	US Messenger Gulch PA	9/19/2013	10:18:44 AM	38.93284	105.41163	NONE	CLEAR		1.49
EM16-091913	US Messenger Gulch, DS Messenger PA	9/19/2013	10:25:54 AM	38.93341	105.41104	NONE	CLEAR		1.49
EM17-091913	DS Messenger Gulch	9/19/2013	10:36:56 AM	38.93358	105.41014	NONE	CLEAR	fire impact noticeable on trees	1.49
EM18a-091913	US 11-mile PA	9/19/2013	10:55:29 AM	38.93611	105.40621	NONE	CLEAR		1.49
EM18-091913	DS 11-mile PA	9/19/2013	11:03:14 AM	38.93645	105.40589	NONE	CLEAR		1.49
EM19-091913	US O'Brien CG	9/19/2013	11:25:34 AM	38.95800	105.38954	NONE	CLEAR		1.49
EM20-091913	DS O'Brien CG	9/19/2013	11:33:45 AM	38.95852	105.38882	NONE	CLEAR		1.48
EM21-091913	US Camp Alexander	9/19/2013	11:45:33 AM	38.95801	105.37993	NONE	CLEAR		1.48
EM22-091913	US Riverside CG, DS Camp Alexander	9/19/2013	11:54:21 AM	38.95997	105.37709	NONE	CLEAR		1.49
EM23-091913	DS Riverside CG	9/19/2013	12:04:30 AM	38.96292	105.37494	NONE	CLEAR	Fisherman DS	1.49

Table 5

ELEVEN-MILE CANYON RECREATION AREA
QUALITY ASSURANCE PROJECT PLAN

Prepared for

COALITION FOR THE UPPER SOUTH PLATTE
BOX 726
LAKE GEORGE, CO 80827
719-748-0033

Prepared by

Elizabeth Nielsen
Program Associate
&
Jara Johnson
Habitat and Monitoring Coordinator

COALITION FOR THE UPPER SOUTH PLATTE
BOX 726
LAKE GEORGE, CO 80827
719-748-0033

Date:

April 2013

TABLE OF CONTENTS

1.0 Project Management

1.1 Project Organization

The Coalition for the Upper South Platte (CUSP) is a nonprofit organization formed in 1998 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. We have strong programmatic capabilities when managing projects that range from the very large, multi-year endeavors to micro-projects. Just a few examples of our successful programs include running the Hayman Fire Recovery Assistance Center, completing a multi-year, multi-partner Trees for Trout project in Eleven-mile Canyon, our invasive weeds cost-share program and our extensive multi-partner efforts to mitigate the 2012 Waldo Canyon Fire. Specifically, our staff is comprised of highly qualified professionals who have been trained in proper data collection procedures to insure confidence in representative, precise, and accurate data quality. Our in-house GIS capability allows us to fully analyze data and prepare descriptive, geospatially accurate figures and result displays. Our organization has succeeded as a watershed group not only as a result of our projects and volunteers, but also from our excellent project management and accountability.

1.2 Problem Definition & Background

CUSP is conducting water-quality sampling along the South Platte River in the Eleven-mile Canyon Recreation Area in the summer of 2013 to assess possible causes of the algae blooms abundant in this area of the river. The South Platte River and its tributaries are a critical part of the Denver municipal water supply. Since 1998, CUSP has worked to protect the 2,600-square-mile watershed that reaches from the Continental Divide to Strontia Springs Reservoir, southwest of Denver. The watershed is a recreational mecca with over 1.6 million acres of public lands; it provides municipal water for about three quarters of Colorado's residents

Nutrient Loading

The Eleven-mile Canyon Recreation Area is located on the South Platte River in Park County near Lake George, CO. The bedrock of this semiarid area in the Rocky Mountains is decomposed granite that is highly erodible and results in sparse ground cover contributing to the area's erosive nature. Excess nutrients such as phosphorus, nitrogen and sediment can create a perfect environment for algae blooms. Phosphorous is a nutrient that is in short supply in most fresh waters and even a modest increase in phosphorus can set off a whole chain of undesirable events in a stream including accelerated plant growth, algae blooms, low dissolved oxygen, and the death of certain fish, invertebrates, and other aquatic animals (ESA). An increase in algae blooms in the South Platte River has the potential to reduce available oxygen leading to the death of aquatic animals such as fish and can increase the release of nutrients and toxic chemicals from sediments. Runoff and erosion from river banks, river beds, land clearing (deforestation), and sewage effluent are the major sources of phosphorus and nitrogen entering water ways. Phosphate attaches to sediments and when water

is low in dissolved oxygen (anoxic), sediment releases phosphate into the water column. This encourages the growth of algae. (ESA)

Springer Fire

One concern is increased sediment runoff as a result of the Springer Fire which burned in Eleven-mile Canyon between June 17th 2012 and June 23rd 2012 consuming 1,145 acres of forest (USDA 2012). According to the *Burned Area Report* produced by the USDA Forest Service on June 29th 2012, there are 9.8 miles of ephemeral and 1.6 miles of perennial streams within the fire perimeter. Adjacent to the fire perimeter to the SE lies 1.3 miles of the South Platte River. "Should runoff from the fire reach the South Platte River, nearly 100% of it would be transported through Messenger and Springer Gulches." (USDA 2012)

Vault/Pit Toilets

Eleven-mile Canyon State Park attracts well over 200,000 visitors each year and maintains vault/pit toilets close to the South Platte River. In 2011, CUSP submitted a proposal to the USDA Resource Advisory Committee (RAC) and secured grant funding to replace two out-of-date vault/pit toilets at the Spillway and Riverside Campgrounds along the South Platte River in Eleven-mile Canyon. Based on grab sample water quality monitoring conducted before the vault toilets were replaced, CUSP believed that the old toilets could be contributing nutrients to the river and adding to algae growth in the South Platte River in Eleven-mile Canyon. Two new vault toilets were installed in Eleven-mile Canyon State Park in the summer of 2012.

RAC funding is also being used to establish a water sampling program in the summer of 2013 to increase understanding of water quality impacts associated with human impacts, fire and sediment run-off in Eleven-mile canyon. CUSP will sample the South Platte River in Eleven-mile Canyon at 19 locations throughout the summer. This data will be used to assess possible contributions to algae blooms in the South Platte River and to decide next steps.

1.3 Project Description

General Overview of Project

The general scope of work to be conducted under this program includes:

- Development of sampling and quality assurance documents.
- Water quality testing at 19 locations on the South Platte River in Eleven-mile Canyon upstream and downstream of vault/pit toilet locations (both old and new), gulches possibly carrying sediment from the Springer fire, the Wagon Tongue sub-division, outflow from Camp Alexander Boy Scout Camp, and downstream of the Eleven-mile dam near Denver Water caretaker homes.
- Sample analysis will be performed by Colorado Analytical Laboratories, 4955 Yarrow Street, 240 South Main Street Brighton, CO 80601.

- Proper chain of custody and documentation will be provided.
- A final monitoring report will be completed that summarizing all of the work under this program.

Project Timetable

Activity	Projected Start Date	Anticipated Date of Completion
Task 1 - Review of Existing Data	March 2013	April 2013
Task 2 - Determination of Sample Locations	April 2013	April 2013
Task 3 - Development of the Sampling Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP)	March 2013	April 2013
Task 4 - Sampling of Surface and Groundwater Features	May 2013	September 2013
Task 5 - Reporting and Administration		

1.4 Data Quality Objectives for Measurement Data

The overall objective of the QAPP is to establish quality assurance criteria for all sampling and project activities so that data generated during the investigation is scientifically valid. Sample site selection, analytical methods, and QA activities are designed to support project objectives.

- Data Precision and Accuracy: Analytical goals for the precision and accuracy of samples analyzed by Colorado Analytical are addressed by the laboratory. Specific detection and reporting limits for each analyte are specified by the test method and are listed in Colorado Analytical result documentation. Analytical goals for water quality data collected using the HANNA HI9828 multiparameter meter with GPS are addressed in the instrument manual and specifications. The HANNA manual also specifies the measurement range for each water quality parameter. Precision is expressed as relative standard deviation and accuracy as absolute biases as percentage. Precision is the level of agreement among individual measurements of the same chemical or physical property.

- Representativeness: Sampling should be conducted to ensure that data accurately and precisely represent the area being studied. Sampling is intended to document nitrogen and phosphorus concentrations in the South Platte River through Eleven-Mile Canyon Recreation Area. It is acknowledged that sampling conducted during the 2013 field season is a snapshot in time and concentrations or mass loadings may not represent the maximum contaminant loading events. Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter

variations at a sampling point, or an environmental condition. The representativeness of the data will be determined by invalidating non-representative data or identifying data to be classified as questionable or qualitative through data validation procedures.

- Completeness and Comparability: Completeness is the percentage of all data collected which is acceptable. Experience gained during previous nonpoint source assessment suggests that 90 percent completeness or better is attainable (CDPHE, 1994). Comparability is the degree of confidence that data sets are comparable with each other. This is ensured by using standard procedures and standard reporting of data.

1.5 Training Requirements/Certification

CUSP is staffed by professional personnel having at least the following types of qualifications:

- Sufficient professional and supervisory stature to deal effectively with program participants and professional contacts.

- Knowledge gained through a combination of training and experience in a scientific analytical discipline and knowledge of data validation, quality assurance procedures, and problem solving.

- Knowledge of appropriate Federal laws, Environmental Protection Agency regulations and policies, and State Water Quality programs.

This document assumes that professionals collecting water samples have an understanding of the physical sciences, and have basic experience in field work (such as an undergraduate level field course), and have experience in the collection of surface and groundwater samples. This document is not all-inclusive and the authors cannot predict all circumstances and conditions that the professional may encounter in the field. The field professional is encouraged to make reference to industry accepted guidelines, the laboratory that will be processing the samples, peers, and supervisors as circumstances and conditions warrant.

1.6 Documentation and Records

Documentation of field work will be accomplished through the use of the program iCrop on a field iPad as well as a Garmin GPS unit and record guidelines will be as follows:

1. The iCrop form will include:
    a. Project Name
    b. Sample ID
    c. Site Description
    d. Date
    e. Time

f. pH
g. Temperature
h. Dissolved Oxygen
i. Conductivity
j. TDS
k. Odor
l. Color
m. Algae Growth
n. Notes
o. Latitude
p. Longitude

2. The iPad is water-resistant.
3. iCrop documents the time and date the information was entered.
4. iCrop documents the latitude and longitude of each location.
5. iCrop is password protected and accessed using a Username and Password which identifies the person authorized to make entries.
6. Entries shall be detailed enough for a person that was not in the field to understand the entry. Avoid slang or excessive use of acronyms or abbreviations. Make entries in plain English that can be easily understood and not misinterpreted.

Chain of custody forms supplied by the lab will be completed for each sampling location. Following each field event, field data will be uploaded to the CUSP database via the *Cloud*. All hard copy documentation will be stored at the CUSP office located in Lake George, CO for at least 7 years after completion of the project

2.0 Measurement/Data Acquisition

2.1 Sampling Process Design

Specific sample sites are listed at the end of this section in Table 1. Generally, the 19 locations we identified in the South Platte River in the Eleven-Mile Canyon Recreation Area will be sampled four times during the year, once in the spring of 2013 (tentatively mid-May), once in the summer of 2013 (tentatively in July), once in the fall of 2013 (tentatively September) and once during a summer rain event (to be determined). Monitoring sites are identified by GPS coordinates with a predetermined sample ID.

Sampling will be conducted by the CUSP designated field lead and at least one other individual, either volunteer or other CUSP staff. Access to all sampling sites will be obtained prior to commencement of field work. Notice will be given to property owners at least 48 hours prior to sampling events in the case of Denver Water Property. Property owners are encouraged to be on site during the sampling event. Samples taken elsewhere in the Canyon are on public property and

will not require license to enter documents but written or verbal agreements and notifications will be made to appropriate agency personnel.

Site safety will follow the CUSP safety policy and at the beginning of each sampling event a safety briefing will be performed by the field lead. The CUSP field lead will be certified in first-aid /CPR. Emergency contact information and MSDS sheets will be kept in a binder in the field vehicle as well as a first-aid kit. Prior to going into the field each day an e-mail will be sent to the CUSP office identifying sampling locations for the day, personnel going into the field, and estimated time of return, at the conclusion of each sampling event a phone call will be made to the CUSP office or appropriate CUSP individual such as the Executive Director confirming that personnel has made it out of the field. Samples will be delivered to the Colorado Analytical laboratory, located at 4955 Yarrow Street, 240 South Main Street Brighton, CO 80601, at the end of each sampling event to ensure that all sample holding times are met.

Sample ID	Location Description
EM06	300ft below dam, above bridge & caretaker house
EM07	Upstream of Spillway campground, downstream of caretaker houses
EM08	Above Idlewild picnic area, below Spillway campground
EM09	Downstream Idlewild picnic area
EM10	Upstream Cove campground, below bridge
EM11	Downstream Cove campground
EM12	Upstream Springer Gulch campground, just below bridge
EM13	Upstream of Wagon Tongue tributary, downstream of Springer Gulch campground
EM14	Downstream Wagon Tongue tributary
EM15	Upstream of Messenger Gulch picnic area
EM16	Upstream Messenger Gulch, downstream Messenger picnic area
EM17	Downstream Messenger Gulch
EM18a	Upstream of Eleven-Mile picnic area
EM18	Downstream of Eleven-Mile picnic area
EM19	Upstream of O'Brien campground
EM20	Downstream of O'Brien campground
EM21	Upstream of Camp Alexander property
EM22	Upstream of Riverside campground
EM23	Downstream of Riverside campground

Table 1: Identified Sample Locations

2.2 Sampling Methods Requirements

Decontamination will be required for all sampling equipment. The goal of equipment decontamination is to help ensure that the equipment is not a source of foreign substances that could affect the ambient concentrations of target analytes in samples or otherwise affect sample chemistry. Prior to each sampling event all equipment will be inspected for stains, cuts, or abrasions. The Hanna multiprobe will be serviced each month to ensure that all o-rings are lubricated and there are no cracks or crimps in rings, the dissolved oxygen membrane probe tip requires replacement

every 2 months or earlier if damaged and will be inspected prior to each sampling event to ensure that no air bubbles are present. All sampling equipment will be rinsed with DI water directly after use while equipment is still wet, additional cleaning procedures may be performed after rinsing. Sample bottles will be certified clean and prepped by Colorado Analytical; therefore there is no need for decontamination of this sampling equipment. Decontamination will focus on the Hanna multiprobe, grab samplers, waders and boots, and shovels or other equipment used for sample acquisition. No acid soak or rinse will be required for decontamination.

Following each sampling event, equipment will be cleaned and stored appropriately; no equipment will be stored dirty.

2.3 Sampling Handling and Custody Requirements

Sample labels will be affixed to the sample containers at the time of sampling. They will contain the following information:

- Sample identification
- Initials of sampler
- Sample location
- Analysis to be conducted
- Date and time of collection
- Preservatives, if any
- Name or organization

The sample labels will remain on the containers throughout the time they are retained.

A sample identification system will be used to identify each sample for chemical analysis and the management of data. The sample IDs allocated for this sampling effort will be used on all sample labels, field sheets, chain-of-custody records, and all applicable documentation used during the field sampling activities. A list of all sample IDs will be maintained in the iCrop sampling form.

Chain-of-Custody

A COC record will be completed for each shipment of samples to track the movement of samples to provide a written record of persons handling the samples and specify sample analyses. A COC record will accompany the field samples during shipment to and at the laboratory. The field sample team will be responsible for maintaining the chain-of-custody. The information provided on the COC record will include the following:

- Project name
- Signature of the sampler(s)
- Sampling station number or sample ID
- Date and time of collection
- Grab or composite designation

- Signature of individuals involved in the sample transfer
- Time and date of sample receipt
- Type of matrix
- Preservatives used
- Sample analysis methods required

COC records initiated in the field will be placed in a plastic bag and taped to the inside of the lid of the shipping containers used for sample transport from the field to the laboratory.

2.4 Instrument/Equipment Testing, Inspection, Calibration Frequency, and Maintenance Requirements

Prior to each site visit or sampling event, all equipment including pH and multi parameter probes, sample coolers, GPS units, cameras, decontamination equipment, and other sampling tools will be inspected. Battery checks will be performed on all electronic equipment the day prior to each sampling event to ensure ample time for battery charging, extra batteries will be included in the field equipment. The Hanna multi-probe will be calibrated the morning of each sampling event. The DO probe will be inspected to ensure there is no damage to the membrane, tips are replaced bi-monthly and manufacture solution is replaced monthly; DI tip and solution change will be recorded in the maintenance log book. The Hanna multi-probe is maintained with the manufacture maintenance kit supplied with the unit. The Hanna probe is calibrated using the HI-9282 quick calibration solution each sampling event, additionally pH 7.01, 10.01, and 4.01 buffers will be used periodically to ensure adequate pH calibration.

2.5 Data Management

Following each sampling event all field data will be entered into the appropriate spreadsheet and stored on the field coordinators computer files as well as the CUSP office database. At the end of each sampling day, electronic water sampling forms will be uploaded from the field monitoring iPad to the CUSP server via the *Cloud*. Field data spreadsheets will be kept in the same computer file as the COC forms, lab acknowledgments of sample receipts, and subsequent laboratory analysis results. Computer files stored in the CUSP documents and database are protected through routine system backups. Field data entered into spreadsheets will be checked against data collected through iCrop on the field monitoring iPad prior to report writing. Sampling locations and site contact information will be added to the ESRI ArcMap 10.1 GIS database with the appropriate metadata following standard CUSP GIS protocols.

3.0 DATA VALIDATION AND USABILITY

3.1 Data Review, Validation and Verification Requirements & Methods

All field data will be reviewed by the field coordinator to determine if the data meets QAPP objectives. Data validation will include a review of the field data entries using iCrop on the

monitoring iPad, field data spreadsheets and chain-of-custody records. All field data entered into electronic spread sheets will be checked against the field data entries on the monitoring iPad and field data sheets by the field coordinator, to validate and verify data.

4.0 References

Doyle, James E.; Meyer, Ken; Wegner, Steve; Fowler, Pat. 2007. Developing Monitoring Plans for Structure Placement in the Aquatic Environment – Recommended Report Format, Listing of Methods and Procedures, and Monitoring Project Case Studies. Accessed on April 1st 2013 at http://www.fs.fed.us/eng/pubs/pdf/Monitoring%20Plan/. USDA, USFA, National Technology & Development Program.

Ecological Society of America (ESA). Hypoxia. Washington, D.C. Accessed on April 1st 2013 at http://water.epa.gov/type/watersheds/named/msbasin/upload/hypoxia.pdf.

USDA, Forest Service. 2012. Burned-Area Report, (Reference FSH 2509.13)