Collaborative Upper Cache la Poudre Monitoring Program

SOURCE WATER MONITORING

The Upper Cache la Poudre (UCLP) Watershed Collaborative Monitoring Program was established in 2008 between the City of Fort Collins, the City of Greeley and Tri-Districts, to help meet present and future drinking water treatment goals.

Water quality monitoring of our raw, Cache la Poudre River drinking water supply is conducted from April through November. Monitoring sites are strategically located throughout the UCLP. Water quality data provide valuable information about the health of our source watershed and raw water supply.

The 2016 Fall Water Quality Update provides a seasonal summary of water quality conditions in the UCLP Watershed by highlighting precipitation and streamflow conditions, as well as water quality during the fall season (October and November).

Routine water quality monitoring results are reported for six key monitoring sites located throughout the UCLP watershed, which capture water quality conditions above and below major tributaries and near water supply intake structures ***(Figure 1)***.

More information is available at *fcgov.com/source-water-monitoring*.

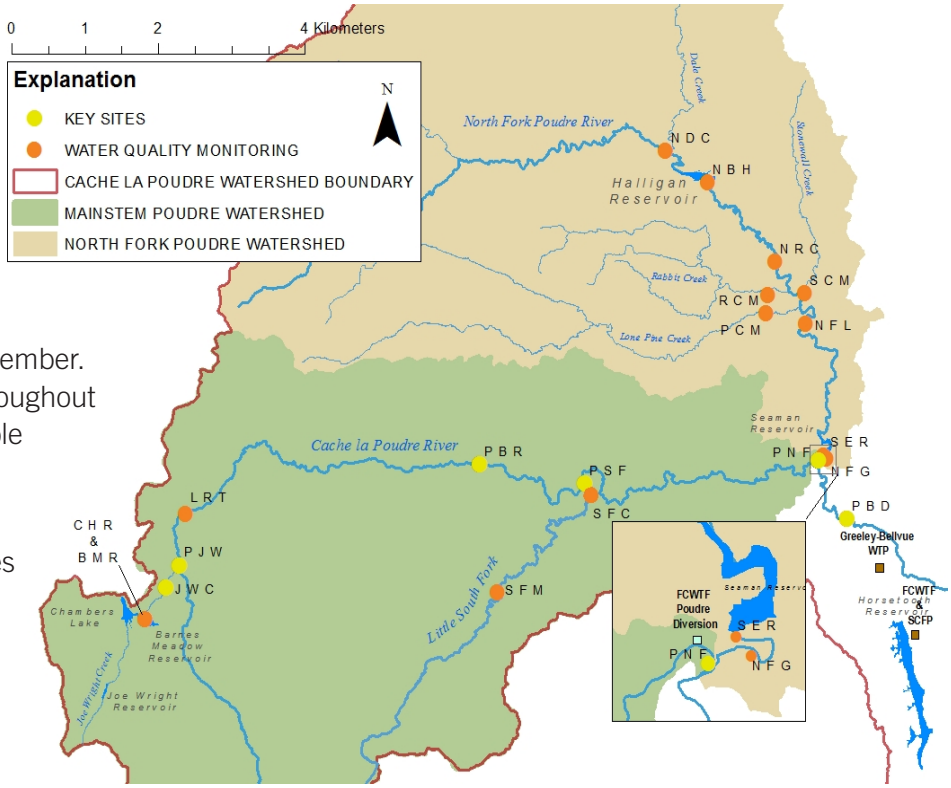


Figure 1 *- Upper Cache la Poudre Collaborative Monitoring Program sampling locations*

JWC - Joe Wright Creek above the confluence with the Poudre River
PJW - Poudre River above the confluence with Joe Wright Creek
PBR - Poudre River below the Town of Rustic
PSF - Poudre River below the confluence with the Little South Fork
PNF - Poudre River above the confluence with the North Fork at the City of Fort Collins' Intake
PBD - Poudre River below the confluence with the North Fork at the Bellvue Diversion

PRECIPITATION AND STREAMFLOW CONDITIONS

Early summer drought conditions continued to impact the UCLP watershed through the fall season. Total precipitation measured below average, ending the 2016 water year (***Figure 2a***) with "moderate" drought conditions developing near lower elevations by late September (***Figure 3***).

The 2017 water year started out with near average precipitation, but dropped below average in late October with dry conditions persisting through mid-November (***Figure 2a***). A winter storm in late-November finally brought much needed snow to the upper watershed, but did not alleviate the on-going drought conditions (***Figure 3***).

Total monthly precipitation was below average in October and in November (***Figure 3b***). By December 1, cumulative precipitation totaled 6.4 inches, which was 83 percent of average (7.7 inches) (***Figure 3a***).

Streamflow in the UCLP watershed decreased to baseflow (low flow) conditions by early September and remained below average through November (***Figure 2c***). The daily average streamflow on October 1 was measured at 38 cubic feet per second (cfs), which was 38 percent of the historical average (99 cfs). By November 30, streamflow was measured at 50 cfs, which was slightly below the historical average of 53 cfs. The below average streamflow conditions, which began in early July, were a result of the persisting drought conditions throughout the watershed.

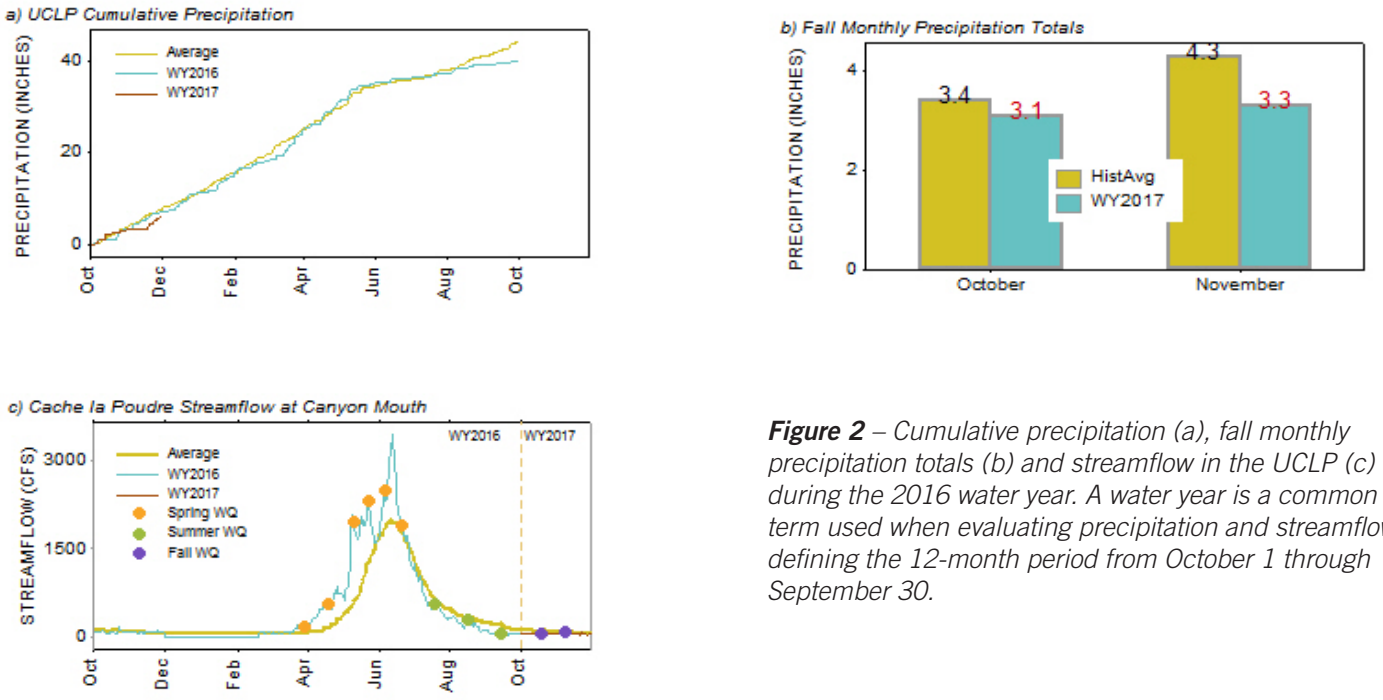
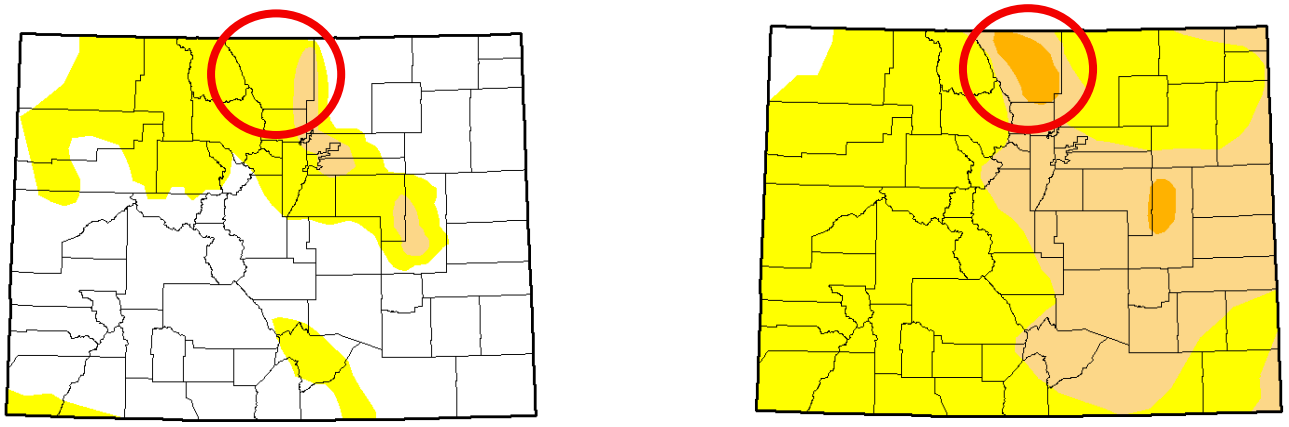


Figure 2 *– Cumulative precipitation (a), fall monthly precipitation totals (b) and streamflow in the UCLP (c) during the 2016 water year. A water year is a common term used when evaluating precipitation and streamflow defining the 12-month period from October 1 through September 30.*

PRECIPITATION AND STREAMFLOW CONDITIONS CONTINUED

U.S. Drought Monitor - Colorado



September 27, 2016 **November 29, 2016**

D0 Abnormally Dry | D1 Moderate Drought | D2 Severe Drought | D3 Extreme Drought | D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary.

Figure 3 *- Drought conditions throughout Colorado measured by the U.S. Drought Monitor on September 27, 2016 (left) and November 29, 2016 (right). Note: Larimer County is outlined in red circle.*
Image from http://droughtmonitor.unl.edu.

WATER QUALITY INDICATORS

The Upper Cache la Poudre Collaborative Water Quality Monitoring Program tests for several key water quality indicators, including pH, conductivity, temperature and turbidity ***(Table 1)***. These key measurements provide a snapshot of water quality conditions, which are useful to identify trends or changes in water quality. Significant changes in water quality may provide an early warning of potential water pollution.

Table 1 - *Water quality indicators measured as part of the Upper Cache la Poudre Collaborative Water Quality Monitoring Program.*

Water Quality Indicator	Explanation
Temperature	Water temperature influences other water quality parameters and is a major driver of biological activity and algal growth in rivers, including certain phytoplankton species that produce the taste and odor compound, geosmin.
pH	pH is an important water quality parameter to monitor, as it influences the solubility and biological availability of chemical constituents, including nutrients and heavy metals. pH near 7 is considered neutral, with more acidic conditions occurring below 7 and more basic, or alkaline, conditions occurring above 7.
Conductivity	Conductivity is an index of dissolved ionic solids in water. Hardness is an index of the total calcium (Ca) and magnesium (Mg) in water.
Turbidity	Turbidity is monitored to track changes in water clarity. Clarity is influenced by the presence of algae and/or suspended solids introduced to surface waters through various land use activities, including runoff and erosion, urban stormwater runoff and drainage from agricultural lands. For water treatment, turbidity is an important indicator of the amount of suspended material that is available to harbor pollutants, such as heavy metals, bacteria, pathogens, nutrients and organic matter.

Fall water quality monitoring captures water quality conditions during early baseflow conditions that begin in early fall and continue through winter. Baseflow conditions are not influenced by direct runoff during the fall and winter seasons, so streamflow experiences little change and usually results in stable and reliable water quality until snowmelt runoff begins in early April.

All water quality indicators during the 2016 fall monitoring season were within the range of values observed over the long-term monitoring record. (***Figure 4***). Indicators were measured above the long-term median at all key sites, with the exception of turbidity. Turbidity was low throughout the watershed (below 2 NTU). Water temperature, specific conductivity, and pH followed expected seasonal trends, but were greater than the long-term fall median. Annual and seasonal variability in source water quality is not unusual. Since these changes were observed watershed-wide, it suggests environmental factors - including drought and low streamflow - may be the driving factor.

Preparing to measure streamflow on the Poudre River above the confluence with Joe Wright Creek on October 17. The electro-magnetic velocimeter measures the velocity of charged particles in the river to compute streamflow.

WATER QUALITY INDICATORS CONTINUED

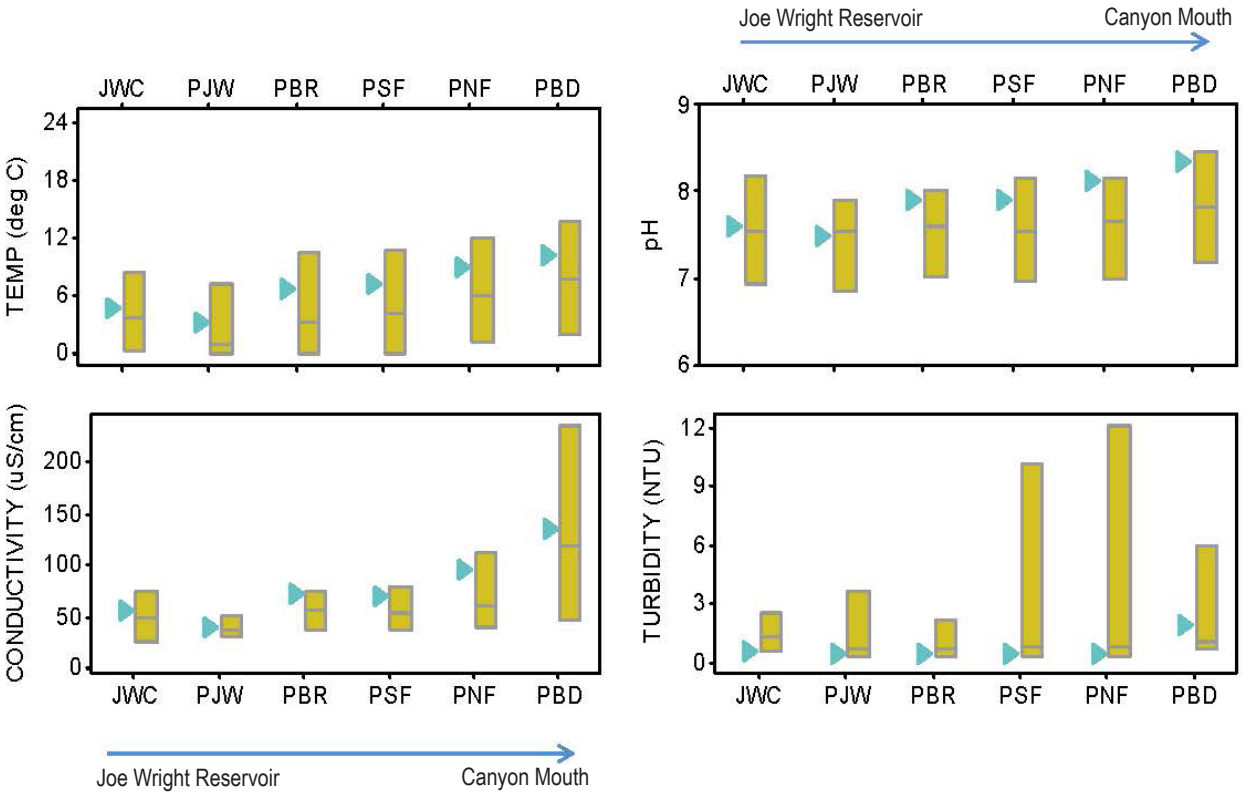
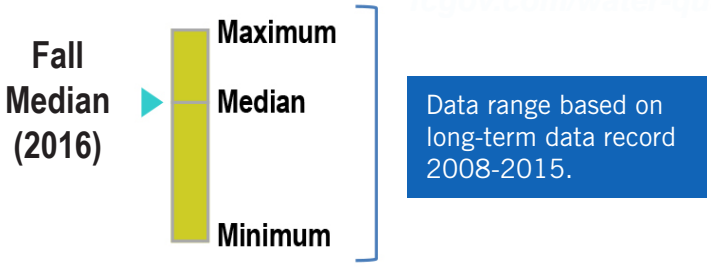


Figure 4 *– Water quality indicator data collected at key monitoring sites during Fall (October and November) 2016.*

Graphic Explanation



All water quality indicators were *within the range of values* observed over the long-term monitoring record.

MICROORGANISMS

Coliforms are types of bacteria found naturally in plant and soil material. They can also be found in the digestive tract of animals, including humans.

Disease causing bacteria or pathogens can be introduced to the raw drinking water supply from fecal contamination. Although the water treatment process effectively eliminates pathogens, source watershed monitoring can provide indication of changes in the activity and location of pathogen sources over time.

Through the Upper Cache la Poudre Collaborative Monitoring Program, the raw Poudre River water supply is routinely tested for the presence of bacterial contamination. This is done by measuring the total amount of coliforms, an indicator organism for the presence of pathogenic bacteria.

In addition, *Escherichia coli (E. coli)* is measured and used as an indicator of human or animal fecal waste pollution, since the source of origin is more specific than total coliforms.

E. coli **and total coliforms remained within the range of values seen in previous years, but were slightly higher than the long-term median.**

In the fall of 2016 *E. coli* and total coliforms (T. coli) counts remained within the range of values seen in previous years, but were slightly higher than the long-term median (***Figure 5a and 5b***). The slightly higher counts are likely attributed to lower than normal streamflow. As expected, T. coli cell counts increased with decreasing elevation with 65 cells/mL measured at PBR compared to 780 cells/mL at PBD. T. coli organisms are found naturally in the environment and this spatial trend illustrates the influence of contributing watershed area on T. coli dynamics within the UCLP watershed. Spatial trends in *E. coli* were less apparent, but slightly increased below the confluence with the North Fork Cache la Poudre River. The low cell counts in both T. coli and *E. coli* over the fall season indicate minor bacterial, human, or animal waste contamination and high water quality within the UCLP watershed during this time of year.

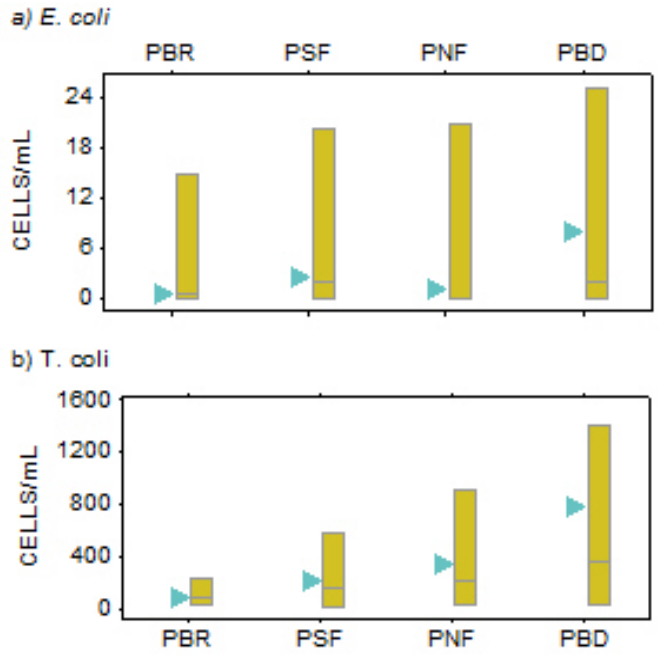


Figure 5 *– E. coli (a) and (b) T. coli counts on the Poudre River during the 2016 fall season.*

TASTE AND ODOR COMPOUNDS

Geosmin is a naturally occurring organic compound which introduces an earthy odor to water that can be detected by the most sensitive individuals at concentrations as low as 4 nanograms per liter (ng/L) or 4 parts per trillion (ppt). These compounds do not pose a public health risk, but it is of concern because its detectable presence can negatively affect customer confidence in the quality of drinking water. Geosmin is monitored at PBR and PNF during routine UCLP monitoring events.

Geosmin concentrations observed at PBR and PNF were below the taste and odor threshold of 4 ng/L in October. Concentrations were measured slightly above detection (1 ng/L) at PBR in November, but were not detected at PNF. Environmental conditions within the UCLP watershed, specifically cold water temperatures and low nutrients, limit the proliferation of geosmin producing algae; however, there have been episodic occurrences of elevated geosmin throughout the Upper CLP watershed, which makes it important to routinely track geosmin as an early warning for water treatment operations.

Monitor Date	Geosmin (ng/L)	
	PBR	PNF
10/17/2016	<1.0	<1.0
11/7/2016	1.15	<1.0

Table 2 *– Poudre River geosmin concentrations (ppt) during the fall of 2016 at Poudre above the North Fork (PNF) and Poudre below Rustic (PBR) monitoring locations.*

Geosmin and other taste and odor compounds are extracted from UCLP samples utilizing solid-phase micro extraction (SPME). The samples are exposed to specially coated fibers held in the SPME device. The device is then introduced directly into a gas chromatograph/mass spectrometer (GC/MS) (pictured above) for analysis.

EMERGING CONTAMINANTS

Contaminants of emerging concern (CEC) and their presence in drinking water have recently received national attention. CEC are trace concentrations (at the ng/L or ppt level, or less) of the pharmaceuticals, personal care products (PCPs), endocrine disrupting chemicals (EDCs), and pesticides and herbicides.

In 2008, Northern Water initiated an emerging contaminant study to determine the presence of these compounds in waters of the CBT system. In 2009, the program was opened up as a regional collaboration, and in that process, two monitoring sites on the UCLP, the Poudre River above the North Fork and the North Fork below Seaman Reservoir (PNF and NFG, respectively) were added to the study with funding provided by the City of Fort Collins and the City of Greeley.

The Cache la Poudre River watershed is a popular area for fly fishing and other recreational opportunities. Recreation in the UCLP watershed is a potential source of contamination to the raw drinking water supply.

Samples were collected once in February, June and August to assess seasonal influences of spring runoff, recreational activities, weed management activities and streamflow conditions. Samples were analyzed for 140 PCPs/pharmaceuticals, herbicides/pesticides and hormones.

No detections of these compounds were observed in February or June, but four compounds were detected above the reporting limit in August. The herbicide 2,4-D was detected slightly above the reporting limit (5 ng/L) measured at a concentration of 8.6 ng/L. 2,4-D is an herbicide commonly used to control terrestrial and aquatic broadleaf weeds, and the presence of 2,4-D in the Poudre River is likely associated with road management or other activities in the basin. At such low concentrations and rapid biodegradation rates in water, the detection of 2,4-D is considered a low risk to the Poudre drinking water supply. Caffeine, N,N-Diethyl-meta-toluamide (DEET), and sucralose (artificial sweetener) were detected in low concentrations (<100 ng/L) on the North Fork Cache la Poudre River indicating the presence of recreational activities on the North Fork. These compounds were likely diluted below the confluence with the Mainstem Poudre since the concentrations were near the detection limit.