Draft Cameron Peak Wildfire Water Quality Monitoring Recovery Plan

City of Fort Collins Utilities – April 7, 2021

Purpose

This plan summarizes water quality monitoring, analyses and reporting that the Water Quality Services Division and/or our regional partners will conduct on the Upper Poudre River during the recovery phase of Cameron Peak Wildfire. For the purposes of this plan, the recovery phase is defined as the period after the wildfire was considered fully contained on December 2, 2020. This document is intended to be iterative and will be updated as necessary during recovery.

Objectives

- Provide real-time water quality data to Fort Collins Water Production Division staff to support water treatment operations;
- Continue to monitor short-and-long term water quality trends in the City's Poudre River drinking water supply;
- Monitor the effects of storm events by sampling select water quality parameters at key locations immediately following precipitation events; and
- Address future source water quality concerns through targeted post-fire research and special projects

Upper Cache la Poudre Water Quality Monitoring Program

Water quality sampling has been scheduled as part of the 2021 Upper Cache la Poudre Water Quality Monitoring Program Operating Plan. Samples will continue to be collected monthly at long-term study locations that are both within and outside of the Cameron Peak Wildfire burn scar (Figure 1). These sites are well positioned to monitor key areas, such as the outflow of Chambers Lake (CHD and JWC); the mainstem Poudre River above the confluence with Joe Wright Creek (PJW) and below the burn scar (PBR); the Little South Fork Poudre River (SFM) and the cumulative impacts of the Cameron Peak Wildfire on water quality at the City's Poudre River intake (PNF). UCLP Program partners decided that there is no need to add additional study locations for the 2021 field season. The UCLP Program will be able to compare water quality data collected during the Cameron Peak Wildfire recovery to the program's long-term baseline to evaluate changes to water quality immediately following the fire and trends in recovery over time. Watershed Program staff were also successful in collecting water quality samples in November of 2020 across all UCLP sites, which will provide an important temporal snapshot of water quality conditions prior to spring runoff in 2021.

Water Quality Surveillance

The Watershed Program currently manages a water quality sondes that are seasonally installed on the Poudre River at the Manners bridge (~2 miles upstream of the City's intake). The Manners sonde was originally installed during the recovery phase of the 2012 High Park Fire and has continued to be maintained by the Watershed Program. The Watershed Program

installed a second water quality sonde on the mainstem Poudre just downstream of the town of Rustic at Indian Meadows (~20 miles upstream of the City's intake). The water quality sondes at the Manners bridge and Indian Meadows (Figure 1) will be used to monitor real-time water quality from just downstream of the burn scar to the City's intake at Gateway Park. Each of these sondes will be linked to the Water Treatment Plant's SCADA System and Contrail and will provide alerts to Operations and Water Quality Services Staff when water quality changes occur at these locations that exceed seasonal thresholds for conductivity, pH and turbidity.

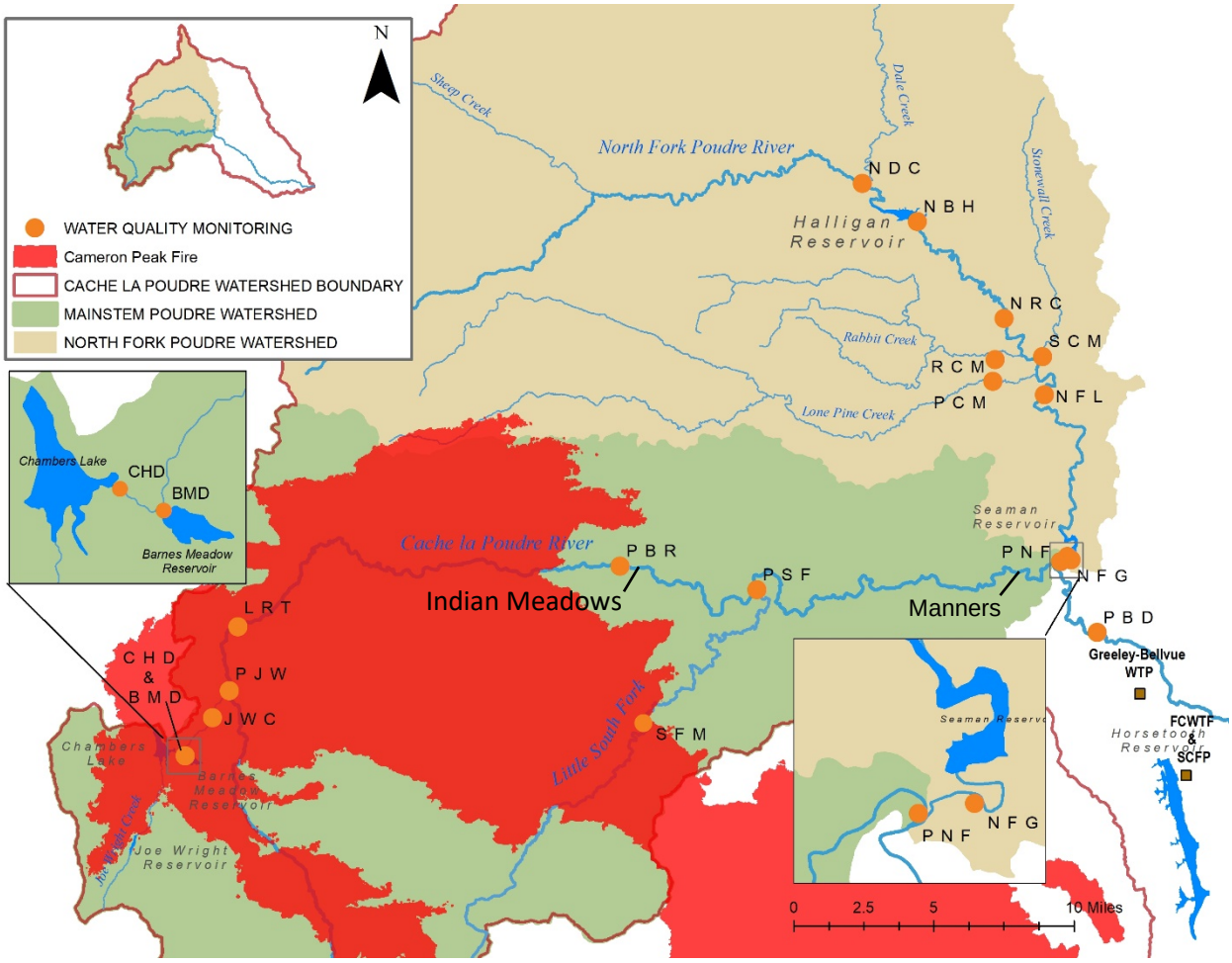

Figure 1. Map showing study site locations for the Upper Cache la Poudre Collaborative Water Quality Monitoring Program, Manners and Indian Meadows surveillance study locations and the Cameron Peak Fire burn scar.

Precipitation Event Sampling

Watershed Program staff will use water quality sonde alerts to determine when to collect water quality samples at PBR and PNF following precipitation and other events. Staff will also utilize an automated ISCO Water Sampler installed at the City's Poudre River drinking water intake (PNF) as a secondary method of collecting water samples following storm precipitation events. A turbidimeter installed at the City's intake will communicate directly with ISCO samplers, triggering them to sample when pre-established seasonal water quality thresholds are

exceeded. In 2021, Watershed staff anticipate installing a second ICSO Sampler at Indian Meadows and pairing it with turbidity thresholds at that location.

Water quality sondes and ISCO samplers will be removed from the river in the fall/early winter of 2021 when the river begins to form ice. At the elevation of the Cameron Peak Fire, precipitation events will most likely be in the form of snow during winter and the risk of precipitation runoff is low. Watershed staff will monitor snowpack and streamflows throughout the winter and into early spring to anticipate the beginning of snowmelt runoff in 2021. Water quality sondes at PBR and Manners, and ISCO samplers at PBR and PNF will be re-installed in 2022 prior to spring runoff and will be used to monitor water quality during runoff and spring and summer rain events. ISCO samples will serve as primary samples during off hours and will be homogenized and split for analyses and archiving. If field samples and ISCO samples are concurrently collected, field samples will serve as the primary sample and ISCO samples will be archived.

Sample Delivery and Analyses

Water samples will be analyzed at the City of Fort Collins Water Quality Laboratory. The Water Quality Lab utilizes an established quality assurance plan that is applied to all samples received and implements analytical QA/QC by measuring laboratory blanks, duplicates, replicates and spiked samples.

Water samples will be collected and immediately transported to the Water Quality Lab on ice by Watershed Program staff. Samples will be processed, preserved, and/or filtered by the Water Quality Lab and analyzed within the parameter's respective holding time. Results will be stored in the WQL Laboratory Information Management System (LIMS) database. Water samples will be analyzed for the parameters identified below, with the exception of field parameters.

Precipitation Event Water Quality Parameters

- Field parameters: temperature, pH, conductivity, dissolved oxygen and turbidity
- Metals (dissolved and total recoverable): aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver and zinc
- Nutrients: ammonia-N, nitrate-N, nitrite-N, Total Kjeldahl Nitrogen, Total Phosphorus and ortho- phosphorus
- Alkalinity and hardness
- Major ions (dissolved): sulfate, chloride, calcium, potassium, sodium, magnesium
- TOC

Table 1. Table showing precipitation event parameters and the purpose for sampling.

Parameter(s)	Purpose of Sampling
Field Parameters	Temperature, pH, conductivity, dissolved oxygen and turbidity are basic measures used to characterize overall water quality and will be useful when tracking the water quality impacts of storm events as well as recovery. Turbidity and pH are important parameters for water treatment; turbidity is expected to increase following storm events

Metals	Metals concentrations of Al, Mg and Fe following High Park Fire storm events were variable, with some high and some low concentrations. There is potential for these and other metals to increase due to post fire erosion and/or subsequent remobilization of ash and sediments from materials deposited in stream channels.
Major Ions	Analyzing samples for major ions will allow us to better understand what is driving conductivity concentration and allows for an ion balance calculation during laboratory QA/QC.
Nutrients	Concentrations of several nutrient constituents increased following during storm events following the High Park Fire. We will likely see a similar pattern following the Cameron Peak Fire.
Hardness and Alkalinity	Hardness determines the toxicity of metals to aquatic life and is a necessary to evaluate CDPHE metals standards. Hardness is expected to increase following storm events. Alkalinity is important because it measures pH buffering capacity in the watershed and during water treatment.
TOC	TOC concentrations will be expected to increase as organic materials are from the burned forest and washed into Poudre River drainages. TOC is an important constituent for water treatment due to concerns over DBP formation

Water quality samples analyzed by the Fort Collins Water Quality Laboratory will be reviewed by the Quality Assurance Coordinator to ensure data are free of sample contamination, analytical, and/or data entry errors. Data are considered provisional prior to data validation by the Quality Assurance and Quality Control Program Coordinator.

Safety

The safety of Watershed Program and other City staff during water quality sampling and related fieldwork during both the response and recovery phases of the Cameron Peak Wildfire is our first priority. There are a wide range of potential hazards during and following the fire; including falling trees, unstable terrain, wildfire smoke, debris flows and the risk of flash flooding and these risks should be mitigated and/or avoided. Staff should only access locations that are beyond the established incident boundary while the fire is active and should only enter the burn area when it has been deemed safe by Incident Command.

Post-fire Recovery Research and Special Projects

Smoke-Related Wildfire Compounds Special Study

Watershed staff recently helped lead the development of a smoke-related wildfire compounds special study as part of the Compounds of Emerging Concern Collaborative Water Quality

Monitoring Program. The purpose of the study is to: 1) develop improved analytical methods for the compounds listed below, including lower detection limits; 2) determine concentrations of these compounds at sites at locations throughout the east slope C-BT system and other source water sites of interest; and 3) to determine whether these compounds, if present in source water, are removed during water treatment at the FCWTF, Greeley's Boyd and Bellvue WTFs and the Town of Estes' WTF.

Compounds include:

- 1,2-BPCA (benzene dicarboxylic acid, also known as phthalic acid, which is also a contaminant from plastic pollution)
- 1,2,4-BPCA (benzene polycarboxylic acid)
- 1,2,3-BPCA (benzene polycarboxylic acid)
- 1,3-5-BPCA (benzene polycarboxylic acid)
- 3,5-PCA (pyridine carboxylic acid).

Watershed staff will be collecting raw water samples at PNF and from Sample Station #2 at the FCWTF. Northern Water will also be collecting surface and bottom samples from Horsetooth Reservoir at Soldier Canyon Dam and at the Hansen Supply Inlet Canal as part of this study (see East Troublesome Horsetooth Reservoir Water Quality Monitoring Plan). Samples were initially collected in November of 2020 and additional samples will be collected between April and September in 2021. Watershed staff will pair results from this study with data from odor profiles conducted at the FCWTF which may provide information on the relationship between smoke-related compounds and odors in finished water. A summary report will be completed at the conclusion of the study.

Cameron Peak Wildfire Post-Fire Science and Water Quality Monitoring Workgroup

Watershed staff continue to lead a regional cost-share collaborative workgroup focused on aligning several post-fire research studies with ongoing quality monitoring programs. Partners providing funding, analytical and/or staffing for these projects include: City of Fort Collins, City of Greeley, City of Thornton, Northern Water, USFS Rocky Mountain Research Station, Coalition for the Poudre River Watershed and the Water Research Foundation (pending grant award). Research projects being targeted are interrelated and intended to advance post-fire science, further our understanding source water quality impacts and develop strategies for management.

> ***Predicting Post Wildfire Nutrients, Pollutants and Ash Delivery after the Cameron Peak Fire with WEPP Watershed Technology*** *- P. Robichaud USFS Rocky Mountain Research Station, Moscow, Idaho*

The purpose of this study is to develop ash loading predictions for the several reservoirs and stream channels in the Poudre River drainage that were affected by the 2020 Cameron Peak Fire. The WEPPcloud-WATAR: Water Erosion Prediction Project cloud model - Wildfire Ash Transport And Risk (WATAR) will be used in this study to predict the probability of both ash and soil, and their respective attached potential pollutants to be transported from burned hillslopes into stream channels and reservoirs of the upper Poudre Watershed.

Specific tasks include:

- Calibrate WEPPcloud for the upper Cache la Poudre Watershed for unburned conditions by comparing outputs with existing USGS streamflow data, or if not available then from nearby streamgauge data.
- Run the WEPPcloud- WATAR model for the sub basins in the Cache la Poudre River drainage with the ash load map.
- Provide probabilistic output of ash nutrients and pollutants (P, N, C, Al, Si, Ca, Pb, Na, Mg, etc.).
- Compare model outputs with ash chemistry measured across burn severity gradients in small catchments burned by the Cameron Peak Fire in post-storm streamwater tributaries contributing to the Cache la Poudre River by others.
- Develop an ash loading map of the Cameron Peak Fire by stitching together several WorldView satellite images that were smoke covered or snow covered to provide as much coverage as possible for the entire burned area.
- Collaborate and compare model outputs with in-situ data collected by others (i.e. Chuck Rhoades at Rocky Mtn. Research Station-Ft. Collins, City of Ft. Collins, USGS) via ISCO samples or other collected data.
- Results will be presented at virtual/in person stakeholder meeting(s) and prepare a technical article.

The total cost for this project is $31,000, of which the Watershed Program is contributing $24,000 (program operating budget) and the City of Greeley is contributing approximately $7,000.

Quantifying Ash Mass, Chemical Composition and Delivery to the Poudre River Watershed after the Cameron Peak Fire – *Chuck Rhoades, USFS Rocky Mountain Research Station, Fort Collins, Colorado*

The primary goal of this work is to characterize the water quality threats from ash-associated inputs to reservoirs and streams across the CLP following the CPF. The study will develop local estimates of variability in post-fire ash mass and chemical composition that can be coupled to model predictions of the ash transport study described above to characterize probable ash-related consequences of the CPF on local surface water quality.

Specific project objectives include**:**

- Measure the mass and chemical composition on hillslopes in areas burned at high, moderate and low severity;
- Measure ash and dissolved chemical and nutrient constituents released by storm events in tributaries across a range of burn severity and elevation conditions and along the main stem and Little South Fork of the CLP; and
- Couple ash mass, chemical composition and downstream delivery to surface hydrology and ash transport predictions to estimate nutrient, C and metal inputs to reservoirs and streams throughout the CLP

Project deliverables include: **1)** installing a network of ash and streamwater sampling sites to quantify post-fire water quality effects; **2)** provide ash mass and composition data to validate modelled ash transport predictions; **3)** publish a scientific article on ash mass, elemental

composition and delivery to reservoirs and streams; and **4)** present study findings to local and national audiences.

Rocky Mountain Research Station, City of Greeley and City of Thornton are cost-sharing the $26,385 required for this project. Utilities' Watershed Program and City of Greeley staff will be providing field assistance for this project during the 2021 field season as additional in-kind contribution.

The effects of post-wildfires pollution on algal blooms in high mountain water supply reservoirs *– Matt Ross, Associate Professor, Colorado State University and FC Utilities Watershed Program*

Several high mountain water supply reservoirs in the Upper Cache la Poudre River Watershed (Poudre) capture and store water during snowmelt runoff that is later released from mid-summer through winter. Fort Collins Utilities Watershed Program and treatment staff as well as City of Greeley treatment staff have increasingly observed seasonal water quality degradation in the Poudre during releases that is likely related to reservoir algal blooms. These events are episodic and flashy, difficult to predict, and challenging to manage. Consequently, taste and odor compounds have periodically impacted finished water and resulted in customer complaints.

These problems are likely to get worse with the 2020 Cameron Peak Wildfire (CPF). Models predict significant post-fire sediment and ash erosion, and elevated nutrient loading into reservoirs. The consequences to both reservoirs and the downstream water quality is unknown. Fort Collins Utilities and the City of Greeley seek to better understand: 1) pre-fire reservoir water quality dynamics; 2) CPF post-fire pollution and increased risk of algal blooms; 3) reservoir impacts on downstream source water quality; and 4) tools and best practices for predicting and mitigating impacts.

Research Approach

Fort Collins Utilities' Watershed Program staff and Colorado State University Assistant Professor Matthew Ross have developed a novel research approach, including five phases:

1) Characterize water quality in reservoirs of the upper Poudre (current phase);
2) Use remote sensing to understand reservoir water quality history;
3) Determine whether post-fire pollution will increase the risk of algae blooms;
4) Determine reservoir controls on riverine and source water quality; and
5) Develop a decision support system for water providers

Possible Deliverables

A real-time monitoring network to develop a decision support system for understanding and predicting algal blooms in reservoirs and their controls on riverine and intake water quality.

Estimated Duration: Spring 2021-Fall 2022

Estimated Budget: $50,000 ($30,000 for 4 sondes, $20,000 analysis and sonde maintenance)

FC Utilities Watershed Program Staff and Prof Matt Ross submitted a research grant proposal for phase 1 of this project in April to the Water Research Foundation's Emerging Opportunities Grant Program. This grant program is catered toward innovative research that is time sensitive

in nature and has a relatively quick turnaround time to allow this work to be conducted in 2021. We expect to notified about whether received the grant in late April-early May. We will are also planning to pursue the WRF's Tailored Collaborative Grant and other grant funding opportunities to fund subsequent phases of this project. Northern Water and the City of Greeley are also contributing funding directly to this project in 2021.

Utilities Customer Communication

"Fireforest" - Cameron Peak Fire Visual Story Telling Project

This digital multimedia project, lead by Evan Barrientos, will help Coloradoans understand that fire is an essential part of the solution, that fire is a natural part of Colorado's forests, and that they have a natural ability to recover from it. It will also help Coloradans understand that not all fire is the same, and the right kind can promote forest health.

At the same time, severe fires *do* threaten the existence of Colorado's forests. So additionally, this project will advocate for supporting the urgent need to conduct forest thinning and prescribed burning on a large scale.

Project Objectives:
1. Show that fire's effects are diverse and can be both helpful and harmful.
2. Show how treated forests regrow after fire.
3. Document the long-term response of lodgepole and spruce-fir forests to the fire.
4. Illustrate the connections between fire, water quality, and restoration.
5. Show what forest restoration looks like and why it's needed.

Deliverables:

1. **Fire Effects Photo Essay** – Cameron Peak Fire's effects on vegetation by photographing unburned, low burn, moderately burned and severely burned areas; will highlight burn mosaic
2. **Poudre River Timelapse** - A long-term timelapse system will photograph the Poudre River and severely burnt slopes above it every daylight hour for several years and create timelapse video; will help illustrate the longevity of fire's impact on water quality, including erosion, turbidity, debris flows, etc.
3. **Repeat Photos** – repeat photo points and story maps will document lodgepole and spruce-fir forest response to fire; the process and stages of treating forests for wildfire mitigation; and comparison of impacts to treated versus untreated forests following the Cameron Peak Fire.
4. **Wildfire Mitigation Success Story** – Using photo and/or video to explain why a landowner or land manager chose to implement mitigation on their property, what steps were taken, how they altered fire behavior, and what they saved.

A new website will be created to house the above deliverables. The fire effects photo essay will also exist as a webpage with text and large photographs. The Poudre River timelapse will be embedded on a page with text explaining the links between fire and water quality. The repeat photos will be displayed as embedded ESRI StoryMaps. The success story will be published as either an embedded video or web article. This website will be freely available for forest restoration organizations to use in their outreach efforts.

Watershed Program and Utilities' Community Engagement staff believe that the images produced from this project will provide great value to the City and will help facilitate

communications with FC Utilities' customers and our community regarding the role of wildfire in our watershed and post-fire recovery following the Cameron Peak Fire.

The total budget for the project is $7,720, of which the Watershed Program is contributing $1,500 from its operating budget. The Coalition for the Poudre River Watershed and the Northern Colorado Fireshed Collaborative are jointly contributing an additional $1,500.