Loveland Water and Power

Loveland Water and Power

Big Thompson River Watershed Source Water Quality Conditions

Fall 2024

January 15, 2025

Common Acronyms

CB-T	Colorado-Big Thompson Project
CPF	Cameron Peak Fire
CFS	Cubic Feet per Second
LWP	Loveland Water and Power
mg/L	Milligrams per liter (parts per million)
$CaCO_3$	Calcium carbonate
NTU	Nephelometric Turbidity Unit
North Fork	North Fork of the Big Thompson River
SU	Standard Units
SWMP	Source Water Monitoring Program
TOC	Total Organic Carbon
µg/L	Micrograms per liter (parts per billion)
µS/cm	Microsiemens per centimeter
WQL	Loveland Water and Power Water Quality Laboratory

Executive Summary

With a few exceptions, water quality conditions in Fall 2024 were notably similar to five-year average values of most parameters and some continued to show signs of recovery from the Cameron Peak Fire (CPF). Dry conditions persisted in Fall, although there was a substantial localized rain event on August 15 which increased the monthly total for precipitation but was not widespread enough to result in substantial runoff from the Alexander Mountain Fire. The relatively dry conditions translated to below-average turbidity levels at most sampling locations. Although most parameters were near five-year average values, somewhat low pH values were also present at most sampling locations. It is possible that these values reflect a continued decline in runoff contributions from the CPF and the lack of runoff from the Alexander Mountain Fire (AMF) as runoff from areas exposed to wildfire can be somewhat basic. In addition, the Fall 2024 manganese and orthophosphate concentrations in Miller Fork were substantially below the five-year average value. These results also reflect the reduction in contribution of the CPF because manganese and orthophosphate levels were substantially elevated at this location in the post-fire period. Copper and iron concentrations continued to be lower than the five-year average value which may reflect continued recovery from the CPF.

Loveland Water & Power drinking water intake. The Home Supply Canal visible on the far side of the Big Thompson River.

Loveland Water and Power Source Water Monitoring Program

The purpose of the Loveland Water and Power (LWP) Source Water Monitoring Program (SWMP) is to collect, analyze, and interpret water quality data of interest to drinking water, wastewater, recreation, and aquatic ecosystems. These data are used to identify and quantify current issues, document management successes, evaluate regulatory compliance, assess the appropriateness of current water quality standards, and identify issues that may present themselves.

One central component of the SWMP is the source water sampling and analysis accomplished by staff at the Loveland Water and Power Water Quality Laboratory (WQL). LWP has collected operational source water data for over 30 years and a more targeted set of parameters for nine years from the three water sources utilized for drinking water (Colorado-Big Thompson Project, Big Thompson River, and Green Ridge Glade Reservoir). The values for these targeted parameters are available in a short amount of time due to in-house laboratory capacity. Consequently, results can be used to inform more immediate water system operational decisions.

Water quality information is routinely collected from 15 sites. Of these sites, two are intake locations at the Loveland Water Treatment Plant (river intake and reservoir intake), two are tributary sites (Fall River and North Fork Big Thompson River), seven are associated with the Colorado-Big Thompson River project (CB-T), and four are mainstem river sites (Table 1, Figure 1). Three additional sites were added beginning in April 2023. One location is upstream of the Estes Park Sanitation District outfall (by the Rocky Mountain National Park visitor center). Another site added in spring 2023 is located on the North Fork, upstream of the confluence with Miller Fork. Miller Fork has been a substantial contributor of water affected by the Cameron Peak Fire (CPF) to the mainstem of the Big Thompson River. The site is located above the confluence of Miller Fork with the North Fork and assists in providing context for Miller Fork contributions. The final site is in Miller Fork itself, just above the confluence with the North Fork. All these sites are located upstream of the Loveland drinking water intake, and therefore, water quality results from these locations have implications for Loveland water treatment and drinking water quality.

Table 1. Big Thompson Watershed sampling location descriptions.

Site Name	Type	Description
S-BTR-10	River	Big Thompson River below Mary's Lake Bridge
S-BTR-15	River	Rocky Mountain National Park Visitor Center
S-BTR-20	River	Downstream of Olympus Dam
S-BTR-30	River	Big Thompson Mainstem above Confluence with North Fork
S-BTR-40	River	Mainstem Big Thompson at Narrows Park
S-BTR-50	River	Mainstem Big Thompson at Viestenz-Smith Park
S-BTT-10	Tributary	Fall River Court Bridge
S-BTT-15	Tributary	North Fork Big Thompson above Miller Fork Confluence
S-BTT-17	Tributary	Miller Fork at Streamside Drive
S-BTT-20	Tributary	North Fork Big Thompson at Storm Mountain Road
S-CBT-10	CB-T	Near Gate at East Portal
S-CBT-20	CB-T	Shore of Mary's Lake
S-CBT-30	CB-T	Shore of Pinewood Reservoir
S-CBT-40	CB-T	Shore of Flatiron Reservoir
S-CBT-50	CB-T	Downstream of Flatiron Reservoir
S-CBT-60	CB-T	Hansen Canal near Outlet to Green Ridge Glade Reservoir
S-LNN-10	Lab Line	River Line in Laboratory
S-LNN-20	Lab Line	Reservoir Line in Laboratory

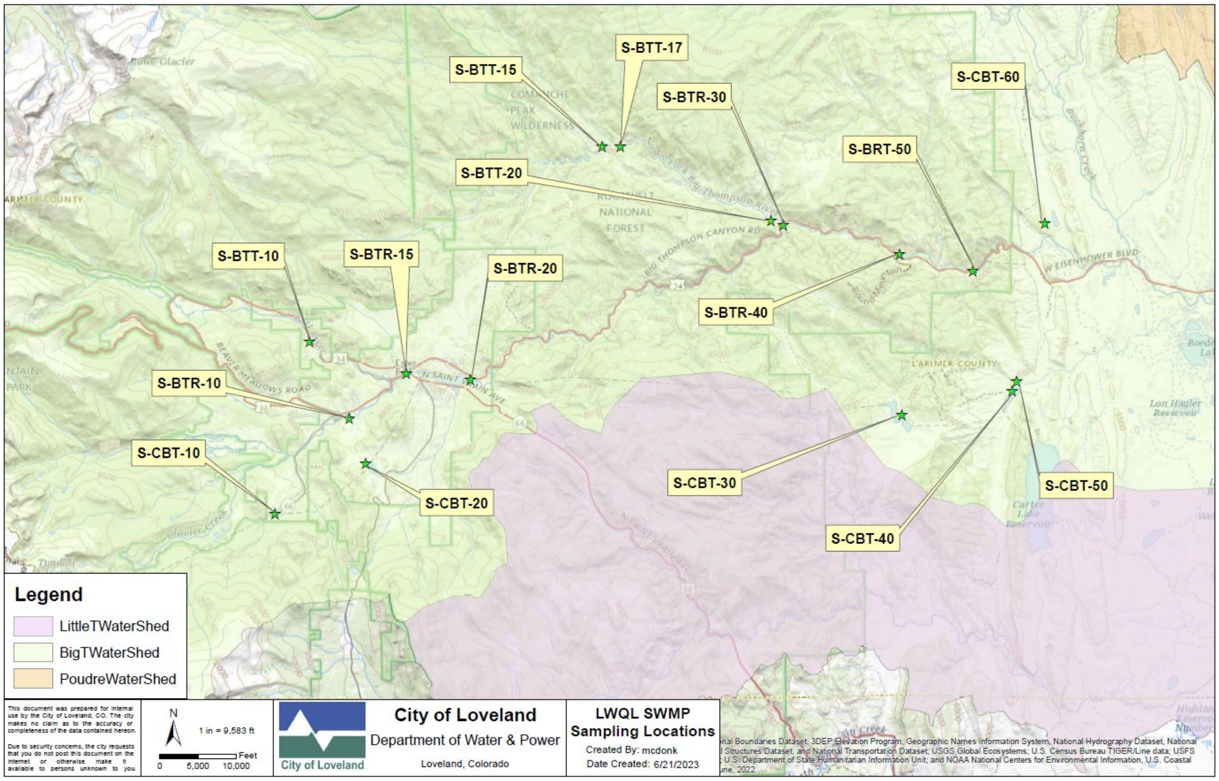

Figure 1. 2024 Source Water Monitoring Program water quality sampling sites.

Objective

The objective of these seasonal reports is to describe notable events and summarize important water quality parameters for those interested in the water quality of the Big Thompson River. These reports do not summarize all the water quality data collected by the WQL and do not represent a quantitative statistical or regulatory analysis of the data.

Evaluation of current data with historical data provides the opportunity to understand recent conditions relative to the previous five-year period and to established water quality standards. While water quality conditions have changed on time scales greater than five years, this relatively short period provides context for recent conditions. Comparisons for the three sites that were sampled beginning in 2023 are included, but 2024 data are compared only to the previous year. Examination of longer-term trends and conditions can be found in LWP Big Thompson River Annual Reports. Figures associated with each water quality parameter are color-coded to represent different components of the source water system. Sites with the same color are likely to be more similar than sites of different colors. In the figures, blue bars indicate sites located in the mainstem of the Big Thompson River, light blue bars indicate sites that are in tributaries to the Big Thompson River, and aqua blue bars represent sites located in the Colorado-Big Thompson Project.

The results and findings presented in this report only represent source water and not the treated drinking water delivered to our customers. Drinking water information and the annual Consumer Confidence Report are on our website. (https://www.lovelandwaterandpower.org/waterquality)

For this report, the term "fall" is defined as the months of August, September, and October. Post-runoff and flow dropping toward baseflow conditions drive water quality during this period. Average values were calculated from all samples collected during these months in 2024 and compared to the average value of all samples collected during these months from 2019 through 2023.

Summary Conditions

The diminishing effects of the CPF and the lack of effects of the AMF resulted in good water quality conditions throughout the fall.

Fall 2024 water quality conditions were generally similar to average values recorded in the previous five-year period although differences were apparent for some parameters and at a few specific sampling locations. These differences mostly reflect continued recovery from the CPF and the lack of contribution (to date) of the AMF. This observation aligns with general observations of the recovery of watersheds from wildfire, as water quality conditions can return to baseline conditions within a few years or as many as 15+ years post-wildfire depending on the characteristics of the wildfire and the parameter (Rust et al. 2018; Paul et al. 2022).

Similarly, while the effects of the AMF are anticipated, the relatively dry fall resulted in minimal runoff associated with the AMF burn scar and minimal effects on water quality parameters. Water quality changes caused by the AMF burn scar are expected to occur primarily during spring runoff and summer monsoon season in 2025.

Generally, total copper concentrations tend to increase in a post-fire environment (Rust et al. 2018). Still, like most water quality effects of wildfire, these results are very location-specific, with results in some watersheds decreasing post-fire and others increasing. In the case of the CPF in the Big Thompson watershed, total copper concentrations declined, and these lower concentrations persisted. This result is one of the few positive effects of the CPF on water quality. These impacts were particularly notable in the area surrounding the North Fork. Sampling from additional sites in the North Fork Watershed in 2023 demonstrates that many of the changes in water quality in the Big Thompson River originated in the Miller Fork due to the CPF.

Similarly, total iron concentrations increased substantially after the CPF but have since declined and were below the five-year average value in fall 2024. While significant changes in iron concentrations are not common (Rust et al. 2018), they were apparent in the CPF and this result indicates continued recovery from CPF.

Water Quality Parameters

Precipitation

The amount of precipitation is directly proportional to the amount of water present in the Big Thompson River. In addition, the amount of precipitation can indicate the relative quality of the water, as large rain events and runoff often result in increased turbidity and decreased water quality. Precipitation in the fall of 2024 was generally low. There was a substantial localized rainfall event on August 15, 2024 that produced 1.3 inches of rain at the Bear Lake Natural

Resources Conservation Service Snow Telemetry station, which resulted in an elevated August precipitation value (Figure 2), however, this storm almost entirely missed the AMF burn scar. Therefore, water quality effects of this storm were minimal. The overall low amount of precipitation in fall 2024 increased the potential for additional fire activity. Fortunately, no additional wildfire activity occurred.

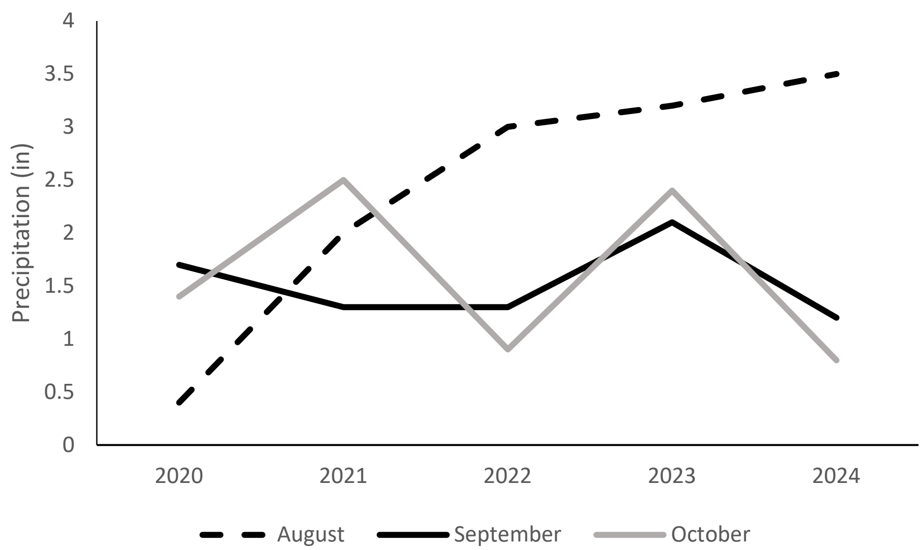

Figure 2. Monthly precipitation by year at the Bear Lake Natural Resources Conservation Service Snow Telemetry (SNOTEL) station.

Temperature

Aquatic organisms have preferred temperature ranges. These ranges can vary widely, and species with similar temperature tolerances are often associated with one another. Some organisms require relatively cold water to survive, particularly during spawning, egg/larval growth, and development. Consequently, elevated water temperatures can cause mortality and reduced reproduction and growth. Conversely, water temperatures can be too low for optimal growth and survival of some species, particularly those found in the lower reaches of the Big Thompson River.

In addition, temperature is of interest to water treatment operators because the temperature of the water influences the speed at which chemical reactions used to treat drinking water occur. Chemical reactions generally are slower in colder water.

Similar to summer 2024 temperatures, fall 2024 temperatures were close to five-year average values, which indicates relatively high temperatures compared to values over a longer time (water temperatures during the five-year reference period included the fourth, sixth, and ninth warmest years on record in Colorado, 1886-present; Figure 3).

Big Thompson River near the Loveland Water & Power drinking water intake.

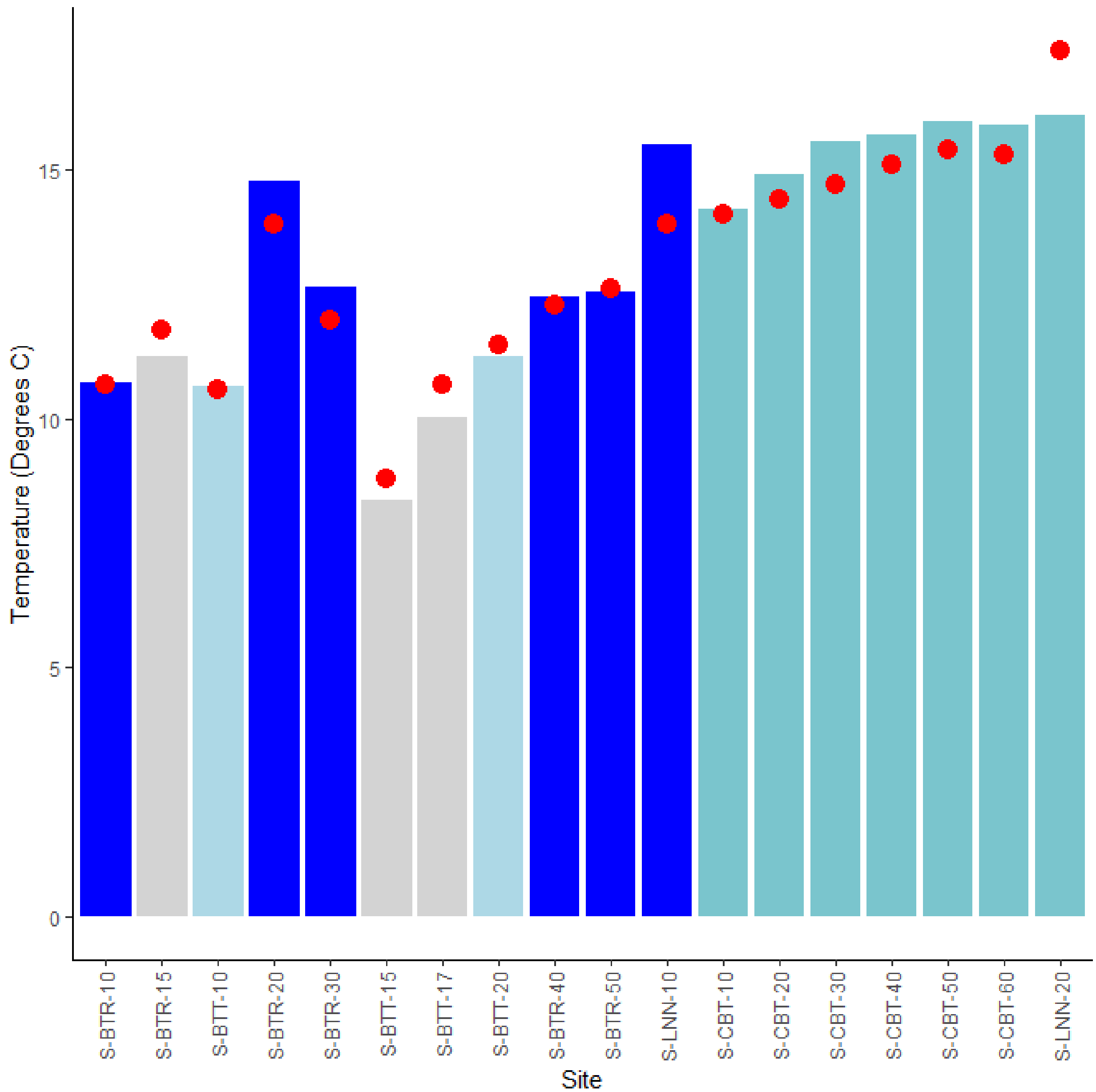

Figure 3. Average water temperature values for August through October 2019-2023 and the 2024 average value (red dot) at sites included in the LWP SWMP. Blue bars indicate mainstem sites, light blue bars indicate tributary sites, and aqua bars represent Colorado-Big Thompson sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023 values.

Turbidity

Turbidity is a general measurement of water clarity, measured as NTU (Nephelometric Turbidity Unit). Water with higher turbidity levels has a greater number of suspended particles and is less clear. Elevated turbidity has negative impacts on municipal water treatment plants and aquatic communities. LWP alters the location of water collection to avoid high levels of turbidity as it is an indicator of high sediment load. Turbidity levels are also positively associated with total organic carbon (TOC) levels, which require additional water treatment efforts.

Elevated turbidity can have negative direct and indirect effects on aquatic organisms and can be associated with high concentrations of some metals. Elevated turbidity and suspended sediment can also negatively affect the density and species richness of macroinvertebrates. Growth of trout species, such as rainbow trout (*Oncorhynchus mykiss*), is negatively associated with increased turbidity, and increased turbidity can also lead to increased mortality. Effects of elevated turbidity become more severe with longer exposure.

Turbidity levels in the fall of 2024 were near five-year average values at many sites but notably lower in the North Fork and mainstem sites downstream of the confluence with the North Fork (Figure 4). These results are similar to those recorded in summer 2024 and reflect both continued recovery from the CPF and the relatively dry conditions documented in the fall of 2024. Relatively low precipitation generally translates to lower flows, which in turn decreases erosive capacity. Decreased turbidity in the North Fork and mainstem sites downstream are primarily the result of substantially higher turbidity values at these sites in the years immediately following the CPF.

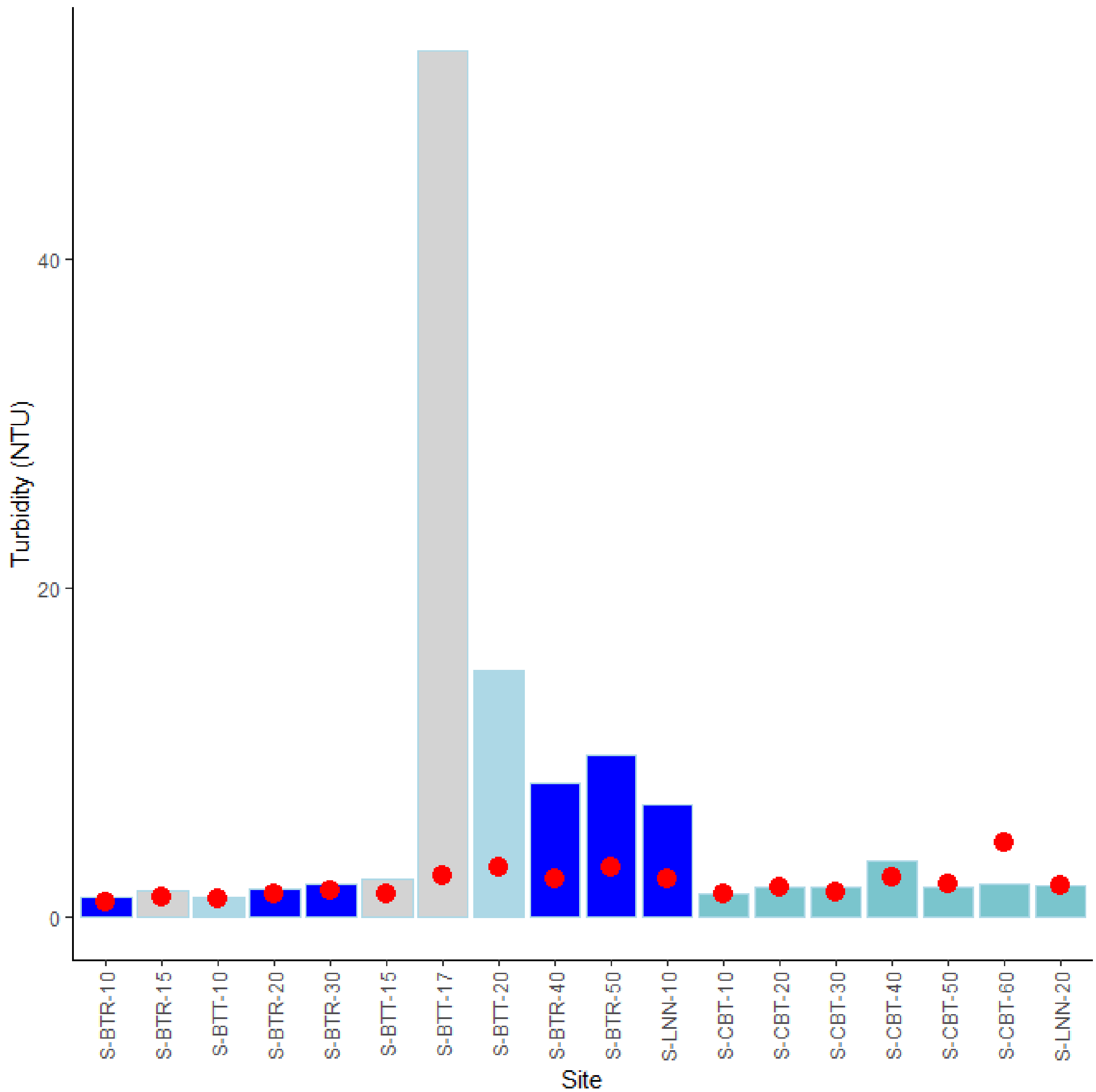

Figure 4. Average turbidity values for the months of August through October 2019-2023 and the 2024 average value (red dot) at sites included in the LWP SWMP. Blue bars indicate mainstem sites, light blue bars indicate tributary sites, and aqua blue bars represent Colorado-Big Thompson sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023 values.

pH

The pH value (SU, Standard Units) indicates how acidic or basic water is. A pH value of 7 is considered neutral, with lower values considered acidic and higher values considered basic. Colorado Regulations 31 and 38 establish a pH of 6.5 as a minimum and 9 as a maximum to protect aquatic life. A maximum pH of 9 is also the Colorado Regulation 31 standard for drinking water supplies. The pH level impacts the efficacy of alum coagulation in drinking water treatment, with the optimal range falling between 6 and 8. Outside this pH range, coagulation is less efficient in removing particles in the water.

Mean pH values were somewhat lower than the five-year average values at most sites in the fall of 2024 (Figure 5). These results are similar to those documented in spring and summer 2024 and are substantially lower than those documented in summer 2023. The lower values are consistent with watershed recovery from wildfire as white ash from wildfires is generally basic (Rodela et al. 2022). Since all the sites are receiving lower amounts of ash from the CPF and the East Troublesome Fire, it is reasonable to expect pH levels to continue to decline.

North Fork of the Big Thompson River

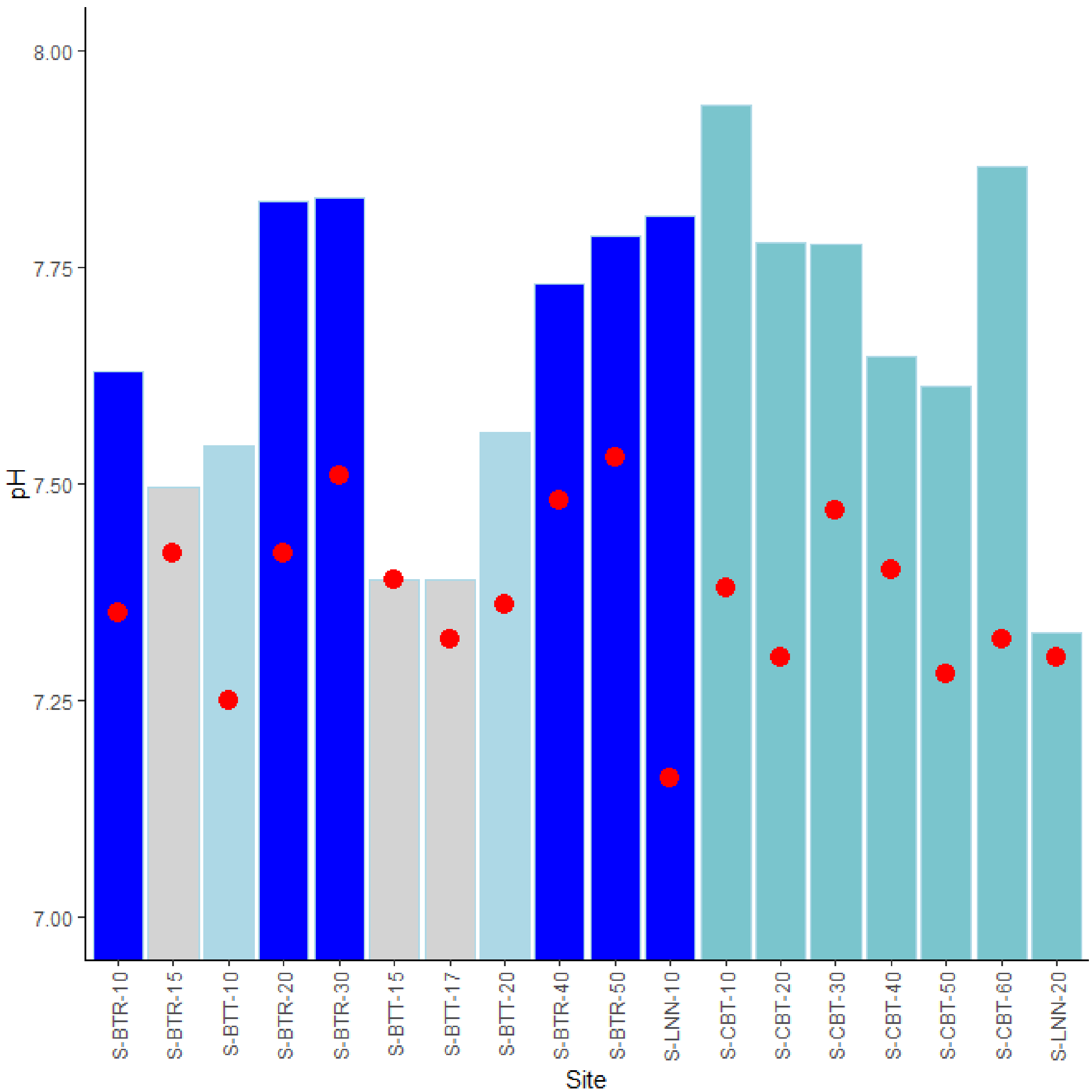

Figure 5. Average pH values for August through October 2019-2023 and the 2024 average value (red dot) at sites included in the LWP SWMP. Blue bars indicate mainstem sites, light blue bars indicate tributary sites and aqua-blue bars represent Colorado-Big Thompson sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023 values.

Dissolved Oxygen

Dissolved oxygen levels are important to aquatic life and drinking water facilities and are affected by factors including temperature, altitude, turbulence, and biological activity. Turbulent cold water at a low altitude can have higher dissolved oxygen levels than still, warm water at a higher altitude. Biological activity (particularly photosynthesis) can increase dissolved oxygen during the day as photosynthesis occurs and decrease dissolved oxygen levels at night when respiration dominates. Biological activity often has no net effect on dissolved oxygen levels, but it can increase the daily range of values, with wider ranges being associated with more biological activity.

Virtually all aquatic organisms require dissolved oxygen to survive, with the necessary concentration differing by species. For example, many fish species in the upper portion of the Big Thompson River have evolved to live in cold water streams and require higher concentrations of dissolved oxygen (e.g., cutthroat trout, *Oncorhynchus clarkii*) than those that evolved to persist in the lower warm water portion of the river (e.g., plains killifish, *Fundulus zebinus*). Aquatic organisms can experience mortality if the dissolved oxygen levels drop below their threshold level for even a short time. Although some life stages require higher dissolved oxygen levels, a minimum threshold to support most aquatic life is approximately 6 mg/L (ppm, parts per million). In addition, dissolved oxygen levels regulate the degree to which some elements (like manganese) remain in solution. Relatively high dissolved oxygen levels allow these elements to precipitate out of the water column, making drinking water treatment easier.

Fall 2024 dissolved oxygen levels were generally near five-year average values across sites (Figure 6). All measured dissolved oxygen concentrations were above concentrations to support most aquatic life. Although dissolved oxygen concentrations were generally near historical values, the Fall 2024 dissolved oxygen concentration at the Reservoir Laboratory Line (S-LNN-

20) was notably above the five-year average. The cause of this observation is unclear although dissolved oxygen levels at this site vary dramatically depending on the depth of the intake gate. If the intake gate is at or below the thermocline in Green Ridge Glade Reservoir, dissolved oxygen levels are likely to be relatively low, while if it is above the thermocline, they are likely to be relatively high.

Side channel near Loveland Water & Power drinking water treatment plant.

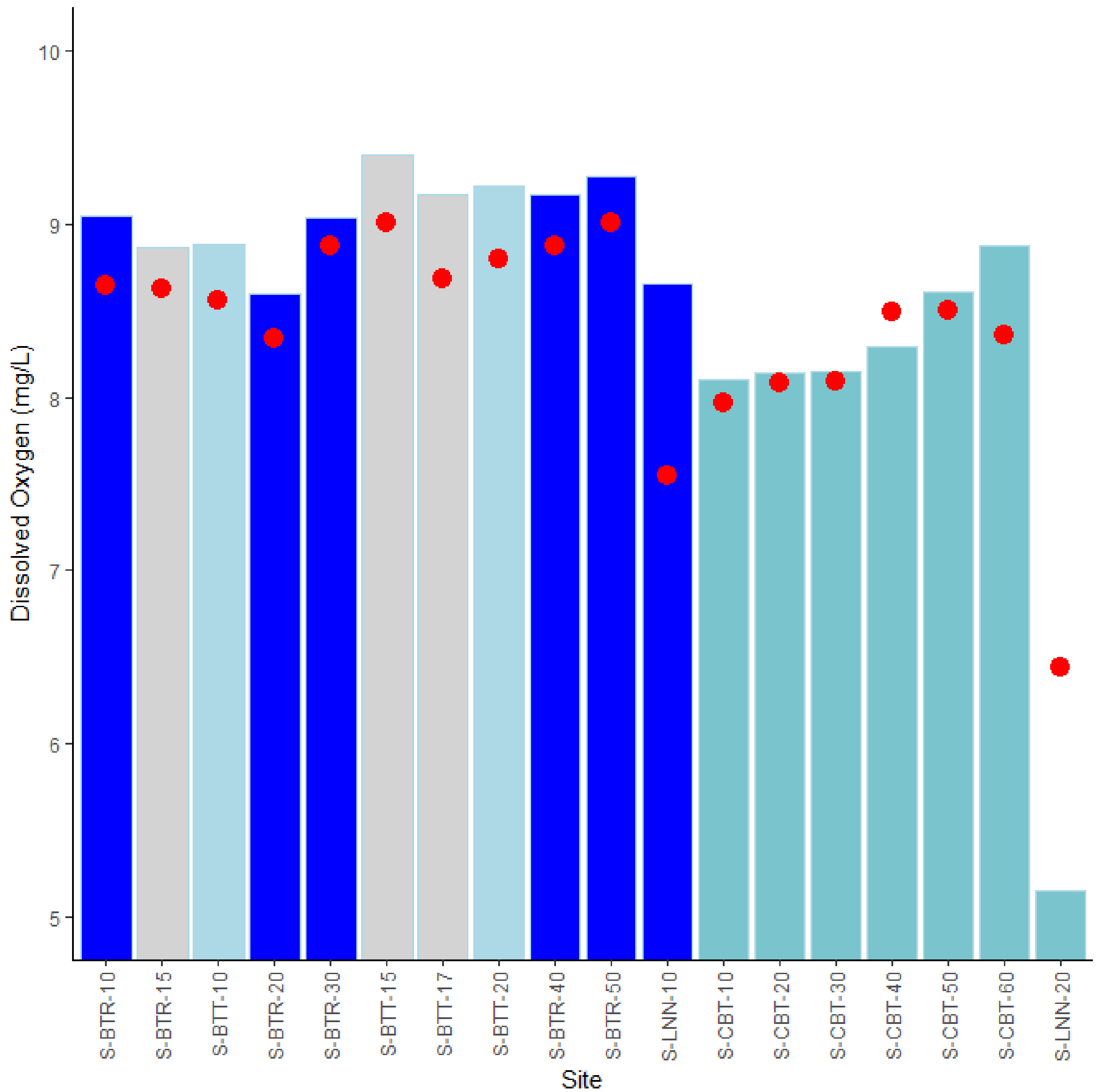

Figure 6. Average dissolved oxygen values for the months of August through October 2019-2023 and the 2024 average value (red dot) at sites included in the LWP SWMP. Blue bars indicate mainstem sites, light blue bars indicate tributary sites and aqua-blue bars represent Colorado-Big Thompson sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023.

Alkalinity

Alkalinity is a measure of the ability of water to neutralize acid and resist declines in pH and is largely determined by the amount of calcium carbonate in water. Calcium carbonate provides buffering capacity to protect aquatic life from acidic conditions and decreases the ability of water to corrode distribution pipes. Conversely, water treatment plants (including Loveland Water and Power) often use flocculation techniques to purify water, and these techniques are often optimized by altering the pH (Naceradska et al. 2019). High alkalinity makes this pH adjustment more complex and requires higher doses, while low alkalinity can cause incomplete chemical reactions and poor flocculation.

Fall 2024 alkalinity measurements were similar to those from the previous five years (Figure 7). However, the fall 2024 value in Miller Fork (S-BTT-17) is substantially higher than it was in fall 2023. This result is consistent with recovery from wildfire, as alkalinity values generally decline after a wildfire (Rust et al. 2018) and increase during recovery.

Big Thompson River at Viestenz-Smith Park.

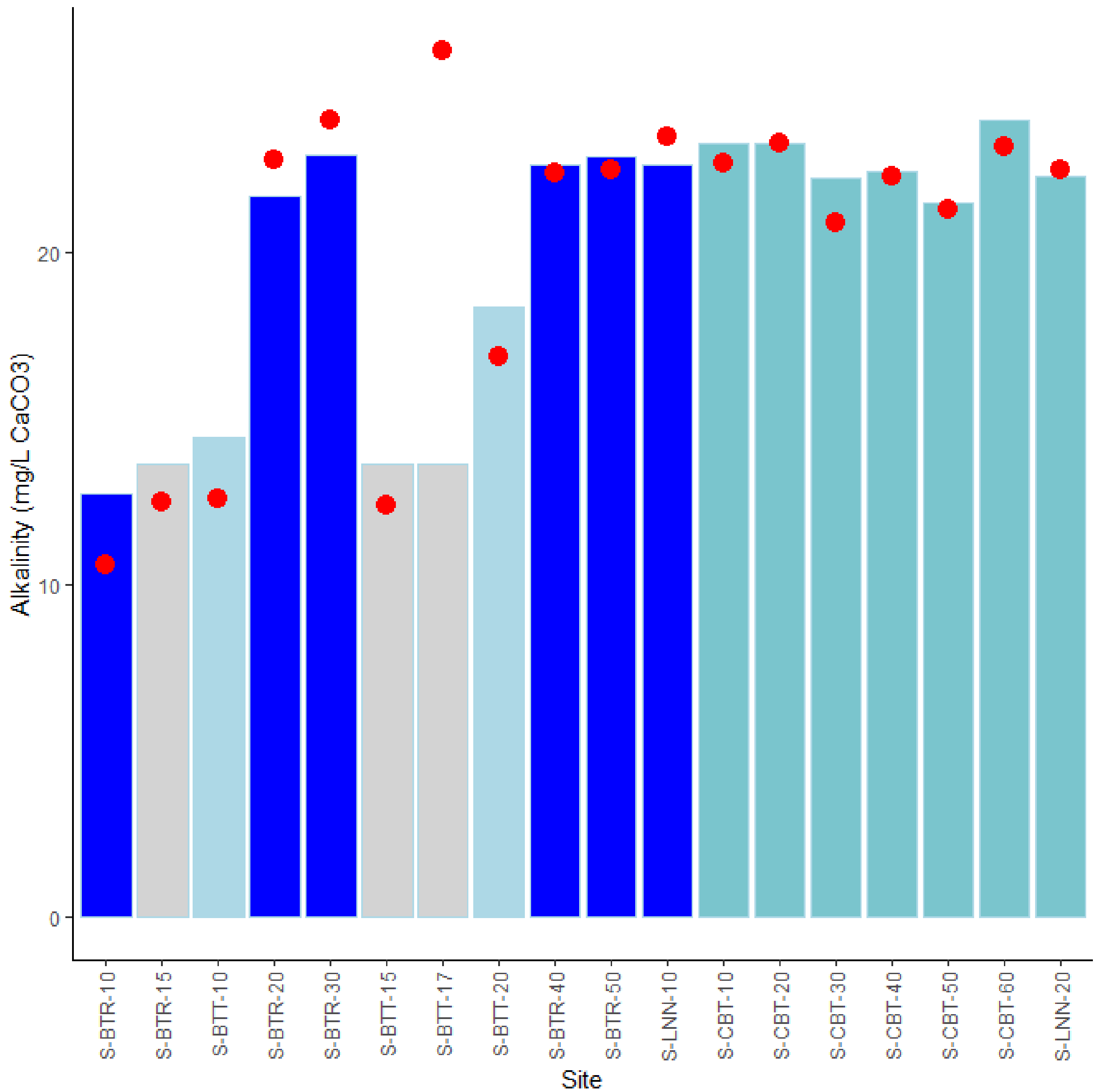

Figure 7. Average alkalinity values for August through October 2019-2023 and the 2024 average value (red dot) at sites included in the LWP SWMP. Blue bars indicate mainstem sites, light blue bars indicate tributary sites and aqua-blue bars represent Colorado-Big Thompson sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023 values.

Manganese

Manganese is an element that is considered beneficial to human health at low levels and is one of the least toxic elements. However, elevated levels can cause non-health-related effects such as bad taste and staining of clothes and plumbing fixtures. Elevated manganese levels can also cause problems for water distribution systems. Specifically, manganese may cause buildup in water distribution pipes. The relative toxicity of manganese to aquatic life is based on the hardness of the water, but manganese levels of concern to aquatic life are much higher than those present in the Big Thompson River.

Fall 2024 manganese concentrations were substantially lower than the five-year average values at all sites. This result is a welcome change from very elevated manganese levels experienced at sites downstream of the CPF in recent years. Fall 2024 average values were substantially lower than concentrations measured in fall 2023 and summer 2024. However, the CPF influence can still be observed in the slightly elevated manganese concentration in Miller Fork (site S-BTT-17) relative to other sampling locations. Increased manganese levels have been associated with the post-wildfire effects, and the fact that they appear to be declining is consistent with the ongoing recovery of the watershed from the CPF. Elevated manganese levels are also associated with runoff events and high turbidity. Universally low manganese concentrations are consistent with the relatively low turbidity and dry conditions in fall 2024.

The EPA has a “secondary” standard of 0.05 mg/L (ppm) for manganese. This level does not make water unsafe to drink, but the water may be aesthetically unpleasing due to a reddish/black/brown color, which can stain laundry, plumbing, sinks, and showers. Mean fall 2024 manganese concentrations were well below this standard at all sampling locations.

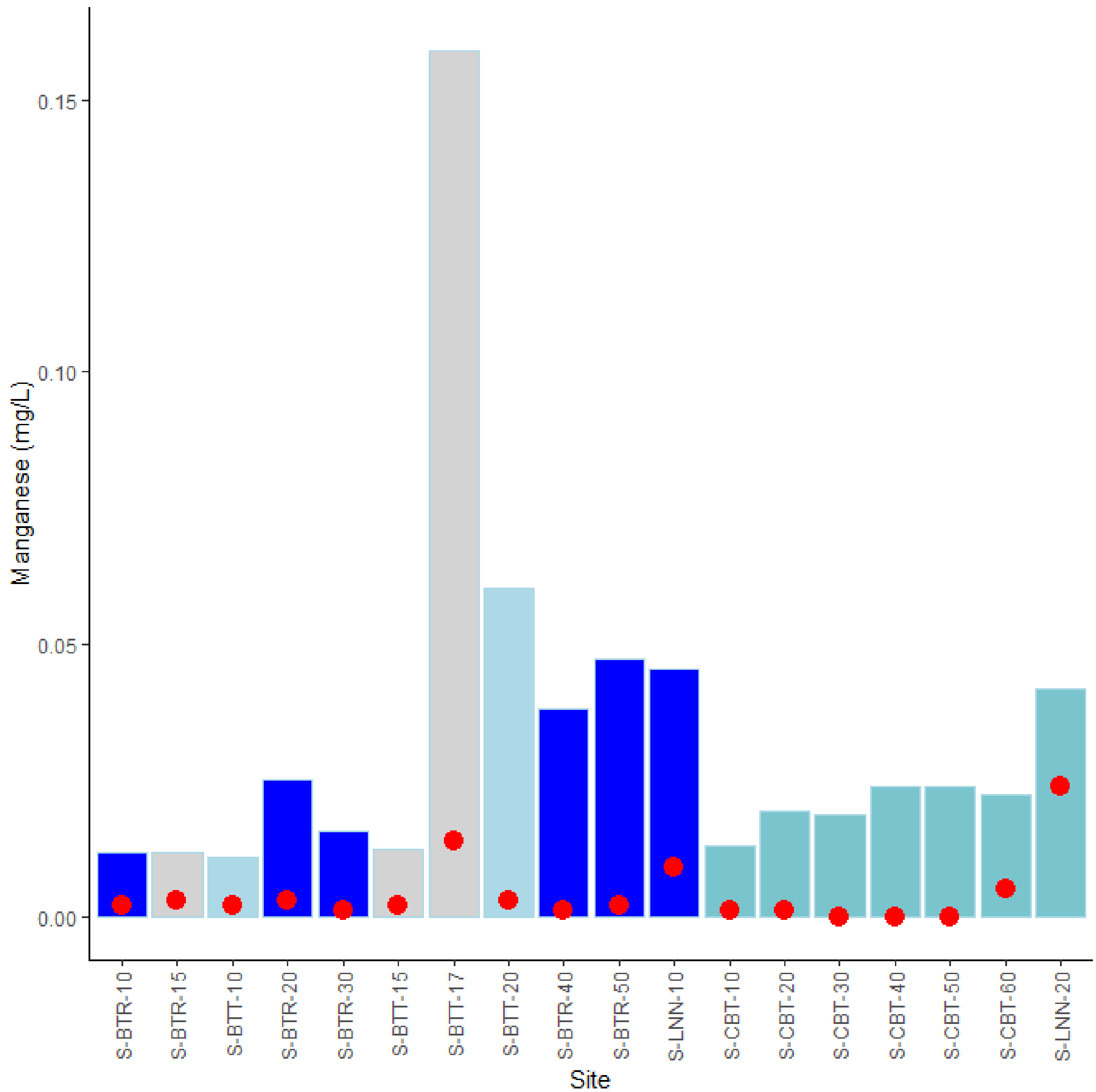

Figure 8. Average manganese values for August through October 2019-2023 and the 2024 average value (red dot) at sites included in the LWP SWMP. Blue bars indicate mainstem sites, light blue bars indicate tributary sites and aqua-blue bars represent Colorado-Big Thompson sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023 values.

Copper

Copper is of interest primarily due to its potential effects on aquatic life. While copper is an essential nutrient, it can cause chronic and acute effects to aquatic life at higher concentrations. Acute effects include mortality; chronic effects include reduced survival, growth, and reproduction. Copper toxicity is determined in part by the hardness of the water. Copper toxicity to aquatic organisms is lower when hardness is higher because dissolved copper is less bioavailable when hardness is high.

Total copper levels in the fall of 2024 were below five-year average values (Figure 9), and total copper levels were generally lower in the post-CPF period. While these lower levels indicate continued effects of the CPF, they are also positive from a water quality perspective and represent one of the few positive outcomes of the CPF. There was a dramatic decrease in total copper concentration in spring 2021 at locations impacted by the CPF. These lower levels seem to persist.

Aerial view of the Big Thompson River at Viestenz-Smith Park.

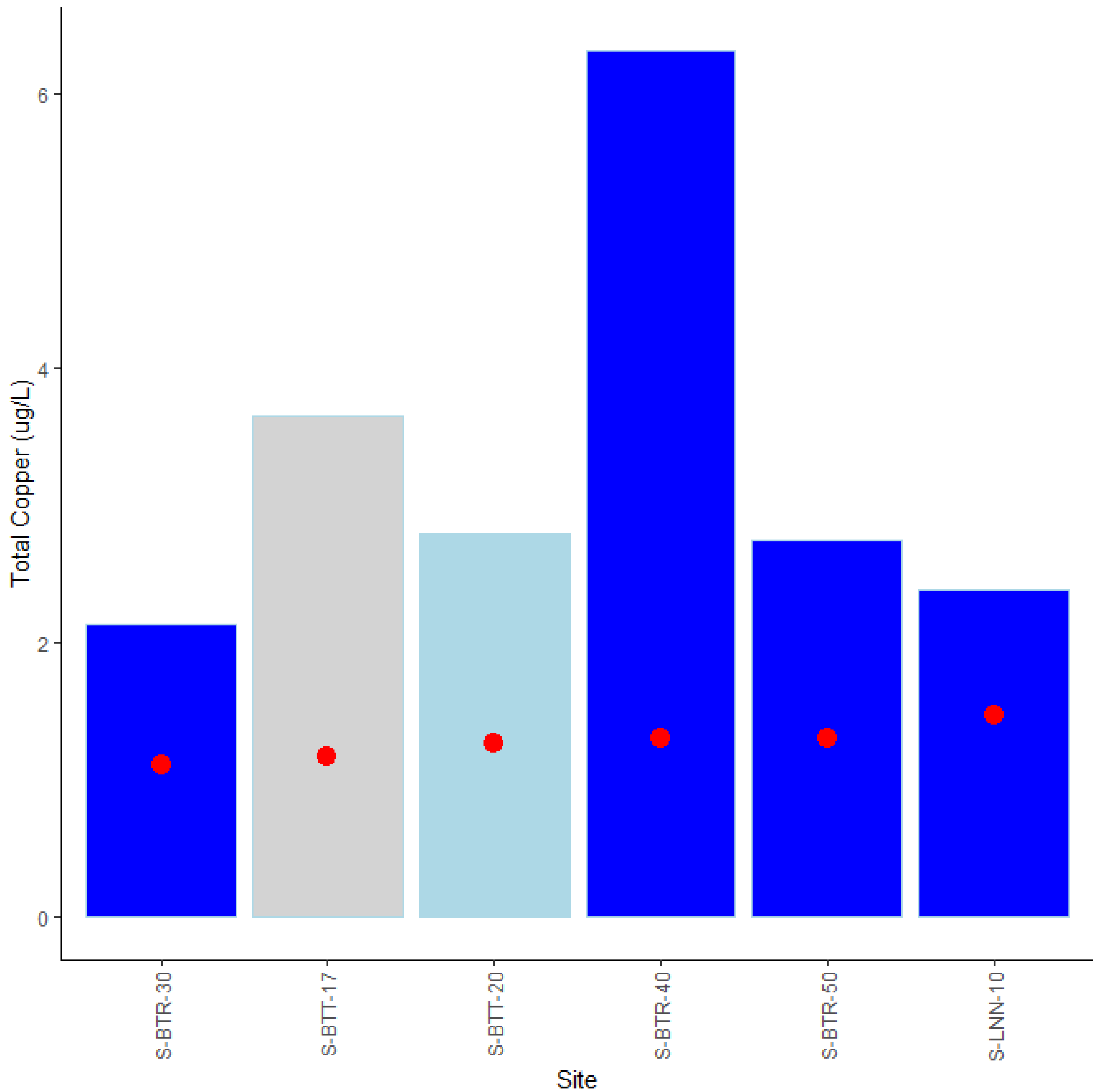

Figure 9. Average total copper values for August through October 2019-2023 and the 2024 average value (red dot) at sites included in the LWP SWMP. Light blue bars indicate tributary sites, and blue bars indicate mainstem sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023 values.

Iron

Iron is common in surface water, although it is usually present at levels harmless to people and aquatic life. However, water discoloration and staining issues can occur in water with dissolved iron levels greater than 3,000 μg/L (ppb), and the drinking water standard is a 30-day average value of 300 μg/L (ppb). Detrimental effects to aquatic life can occur when levels of dissolved iron are above 1000 μg/L (ppb). The levels of dissolved iron that can affect aquatic life are dependent, in part, on the hardness of the water. Less dissolved iron is necessary to negatively impact aquatic life in water with lower hardness values than in water with higher hardness values.

Average total iron concentrations in fall 2024 were generally below five-year average values at all sites (Figure 10). The area in the North Fork watershed above the sampling site was one of the most severely burned during the CPF in the fall of 2020, and total iron levels have been elevated at this location in the years post-fire. The fact that fall 2024 concentrations were substantially below the five-year average value at the North Fork sampling location (S-BTT-17) and were similar to other sampling locations indicates that the watershed is continuing to recover from the fire. Total iron concentrations were substantially below the five-year average concentrations in the fall of 2024 as well.

Aerial view of the Big Thompson River at Viestenz-Smith Park.

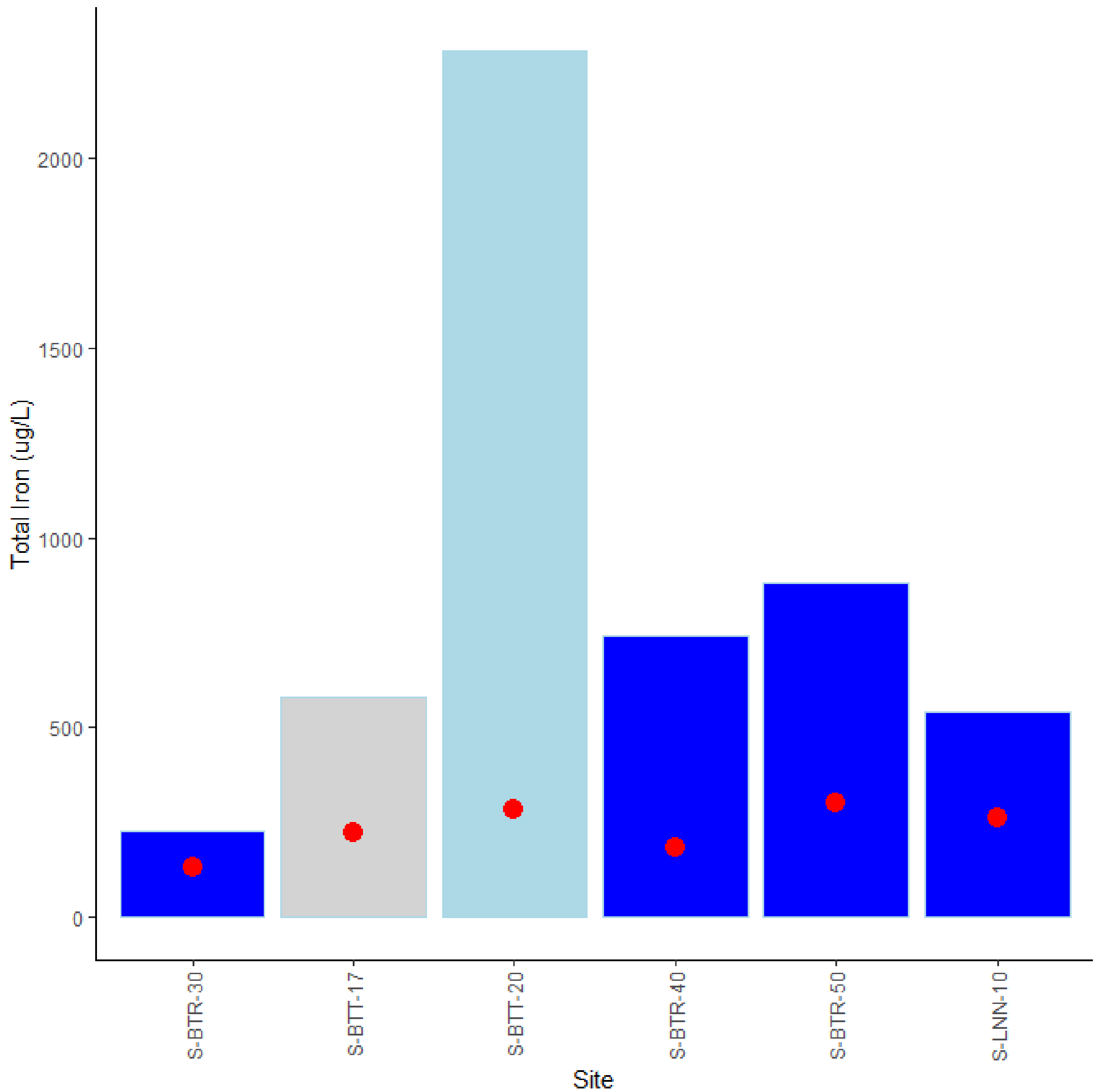

Figure 10. Average total iron values for August through October 2019-2023 and the 2024 average value (red dot) at sites included in the LWP SWMP. Light blue bars indicate tributary sites, and blue bars indicate mainstem sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023 values.

Nitrate

Nitrate and nitrite are of interest due to their role in aquatic plant growth and their potential effects on human health. Nitrate, along with ammonia, is a form of nitrogen that is available for immediate uptake by algae and is, therefore, of interest due to its role in determining the productivity of a given water body. At higher concentrations (e.g., >10 mg/L (ppm)), nitrate can be of concern in drinking water because it can reduce the oxygen-carrying capacity of hemoglobin in humans and create a condition known as methemoglobinemia, particularly in those under two years of age. Nitrite is also available for uptake by algae but is rarely present at high concentrations.

Except for the Miller Fork site (S-BTT-17), nitrate concentrations in fall 2024 were near or below five-year average values. Values at the Miller Fork site (S-BTT-17) were lower than average and indicate continued recovery from the CPF given that elevated nitrate can and has been an effect of the CPF (Rust et al. 2018). We have documented elevated nitrate as a continuing effect of the CPF in previous seasonal and annual reports, and below-average values are another positive indication that the Big Thompson watershed is recovering from the CPF.

Fall River just upstream of Fall River Court Bridge.

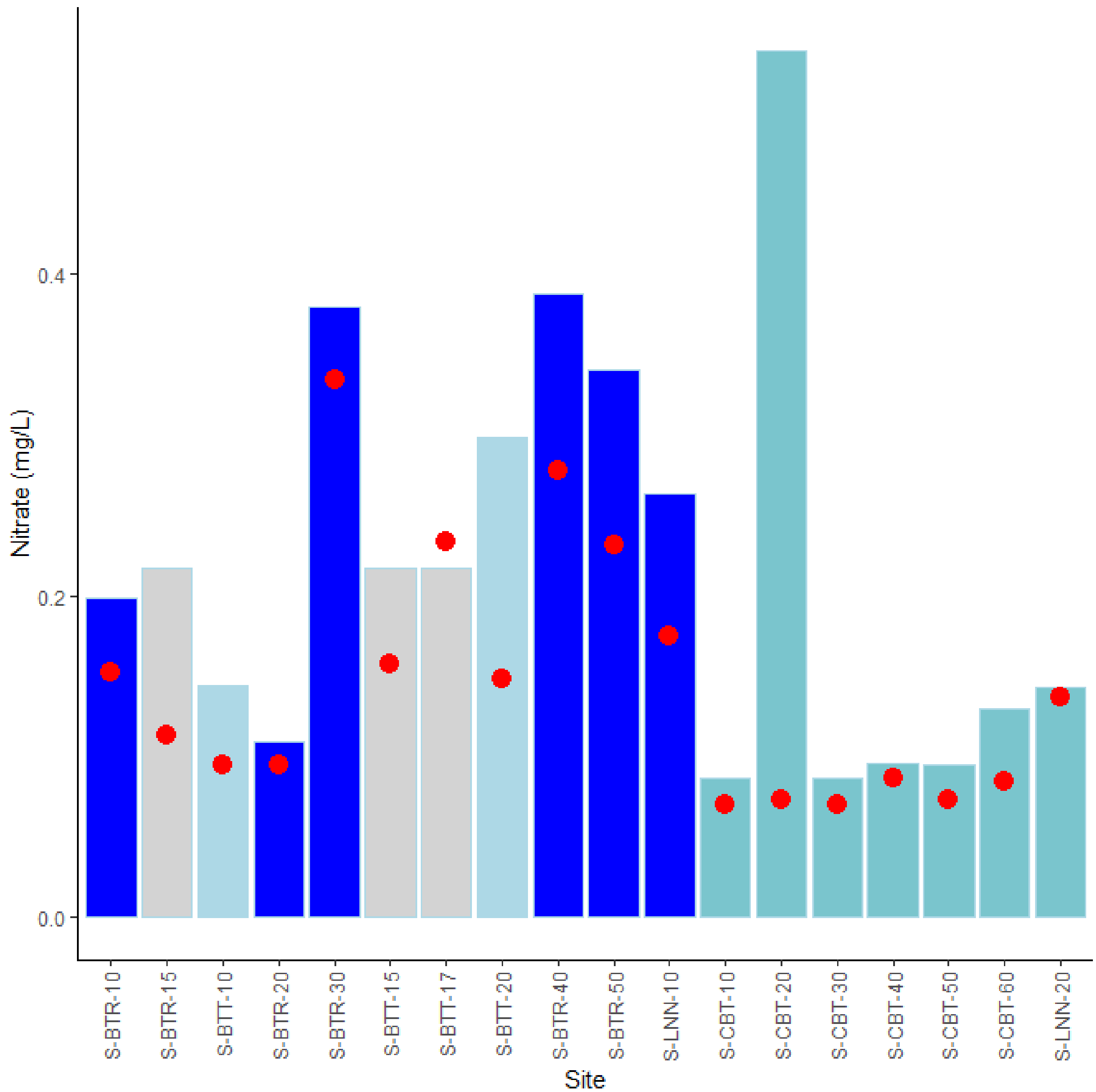

Figure 11. Average nitrate values for August through October 2019-2023 and the 2024 average value (red dot) at sites included in the LWP SWMP. Blue bars indicate mainstem sites, light blue bars indicate tributary sites and aqua-blue bars represent Colorado-Big Thompson sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023 values.

Orthophosphate

Orthophosphate is a dissolved form of phosphorus and is the only form that is immediately available for uptake by algae. Orthophosphate concentrations often limit algal populations and are a concern because some algal species produce toxins that negatively affect drinking water taste and odor. Sources of orthophosphate include the decay of plant debris and other organic matter; the minerals that make up rocks, soils, and sediments in the watershed; wastewater treatment plant effluent; failing individual sewage disposal systems; runoff from fertilized agricultural lands and urban areas; and erosion of stream channels, dirt roads, construction sites, and other land surfaces.

Similar to summer 2024, fall 2024 orthophosphate concentrations were generally low compared to the five-year average values for most sites (Figure 12). This result is positive from a water quality perspective. These low and declining orthophosphate concentrations were observed throughout last year and hopefully will persist.

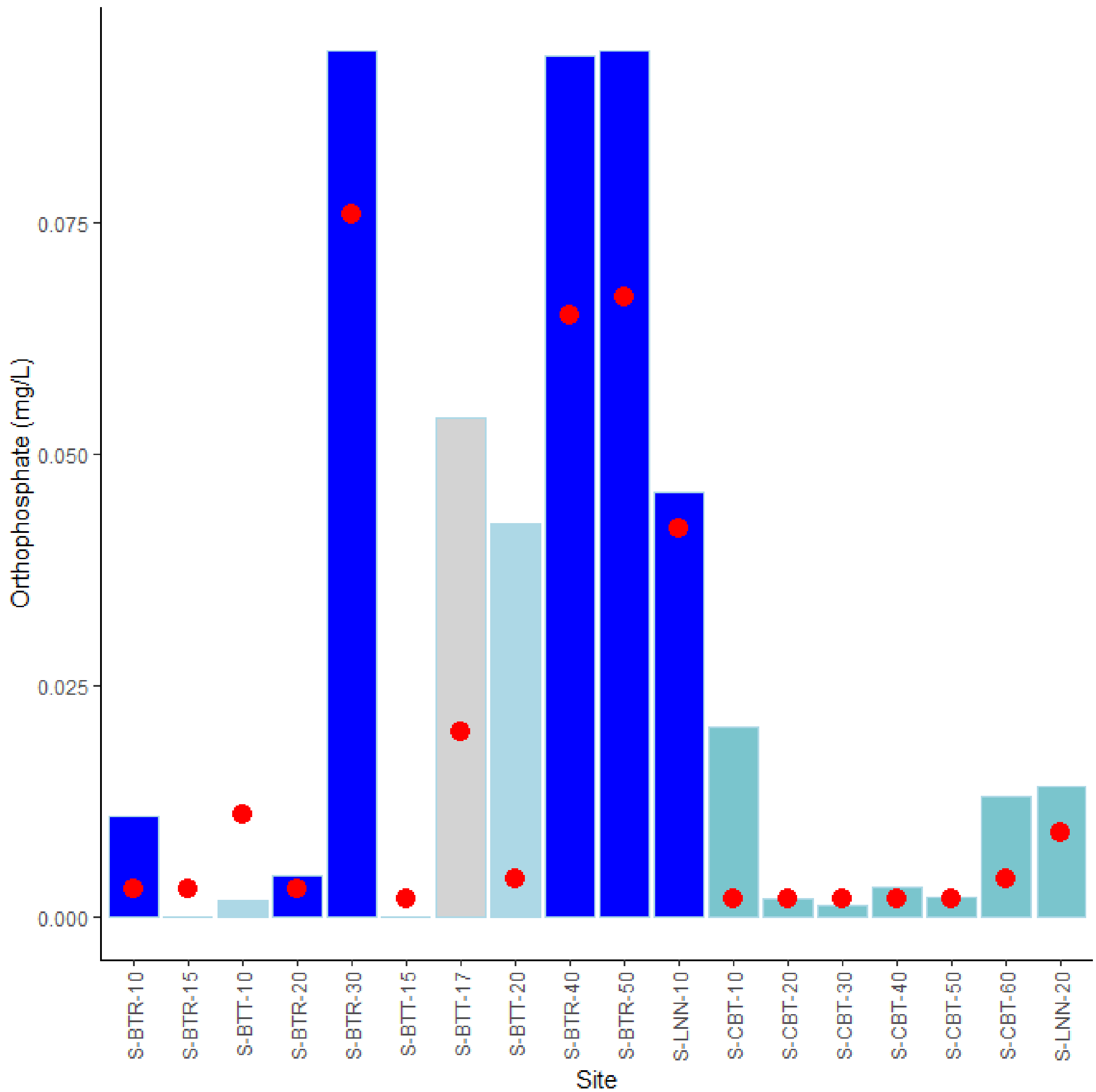

Figure 12. Average orthophosphate values for August through October 2019-2023 and the 2024 average value (red dot) at sites included in the LWP SWMP. Blue bars indicate mainstem sites, light blue bars indicate tributary sites and aqua-blue bars represent Colorado-Big Thompson sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023 values.

Total Organic Carbon (TOC)

TOC is a measure of the amount of dissolved and particulate organic matter in a water sample. Organic carbon compounds result from decomposing organic matter such as algae, terrestrial plants, animal waste, detritus, and organic soils. The higher the carbon or organic content of a water body, the more oxygen is consumed as microorganisms break down the organic matter.

Although TOC is not a direct human health hazard, the dissolved portion of the TOC can react with chemicals (chlorine and others) used for drinking water disinfection to form disinfection by-products (Allen et al. 2022) that are regulated as potential carcinogens (e.g., chloroform, $CHCl_3$). As such, TOC levels are of concern to drinking water treatment facilities.

Fall 2024 TOC values were similar to five-year average values at nearly all sites (Figure 13). Organic carbon may be reduced in severely burned areas compared to unburned areas immediately after a fire (Rhoades et al. 2019) and has generally been low at sites most affected by the CPF (S-BTT-15, S-BTT-17, and S-BTT-20). The somewhat low TOC concentrations at these sites in Fall 2024 suggest that while CPF recovery is apparent, there are still observable fire effects on water quality.

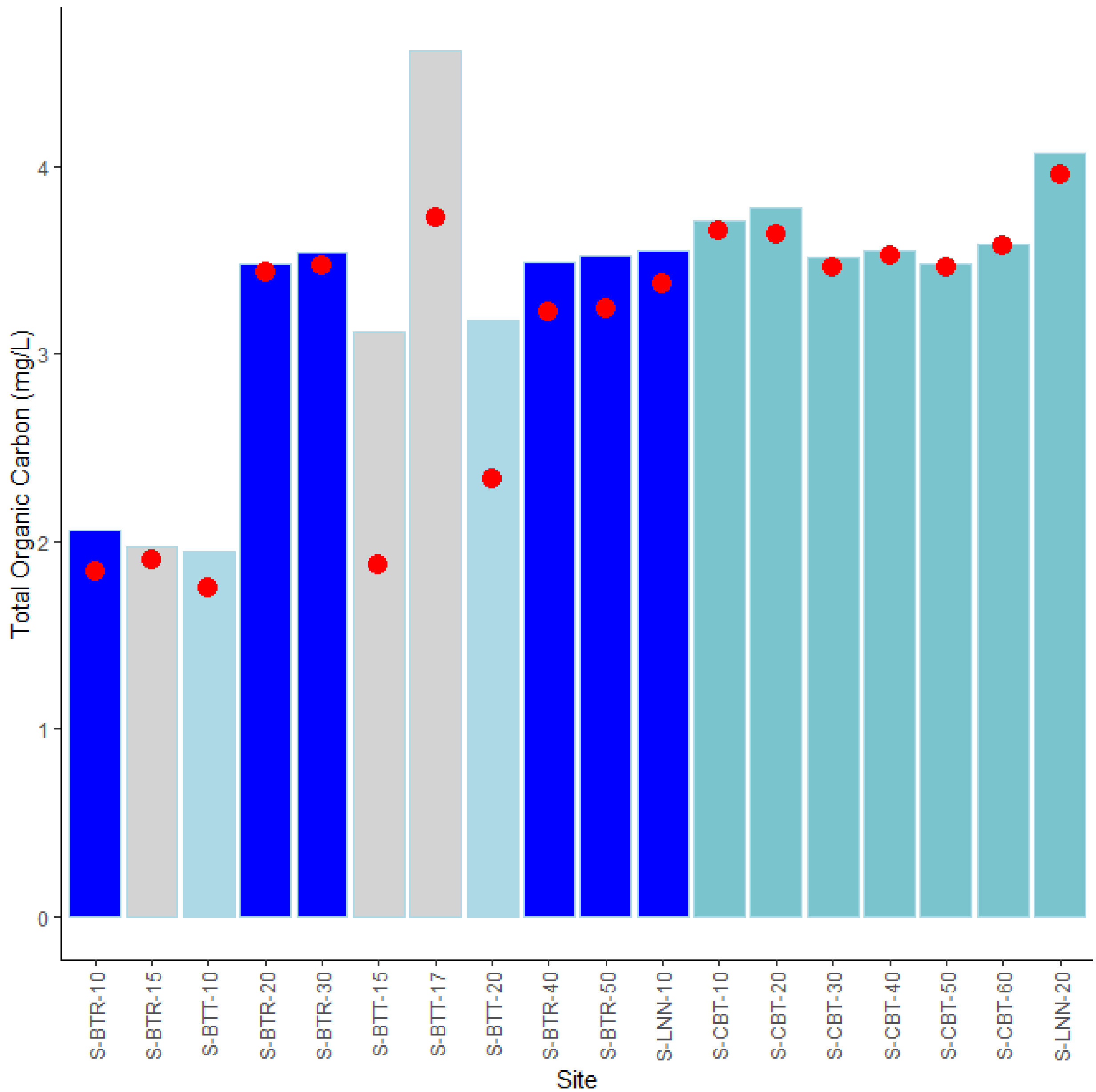

Figure 13. Average total organic carbon values for August through October 2019-2023 (blue bar) and the 2024 average value (red dot) at sites included in the LWP SWMP. Blue bars indicate mainstem sites, light blue bars indicate tributary sites and aqua-blue bars represent Colorado-Big Thompson sites. Grey bars indicate sites where data collection began in 2023. In these cases, the grey bar represents average 2023 values.

Conclusions

Fall 2024 water quality measurements were generally near five-year average values and some continued to provide indications that the water quality effects of the CPF are beginning to dissipate and the watershed is recovering from the fire. Continued dry conditions resulted in increased wildfire risk, but fortunately no additional fires of substance occurred. Some CPF fire effects are still apparent and will likely continue for 2-5 years or more. The continued improvement of some water quality parameters, such as turbidity, manganese, iron, and orthophosphate, is a welcome observation both in terms of drinking water quality and the environment for aquatic communities in the Big Thompson River. The long-term consequences of several parameters affected by fire (although at decreasing magnitude), such as increased nitrate concentrations at the Miller Fork site (S-BTT-17) and decreased copper concentrations, are currently unknown. LWP is now focusing efforts on mitigating the effects of the AMF as well as reducing the likely impact of the next wildfire in the Big Thompson Watershed by partnering with groups like the Big Thompson Watershed Coalition and the Larimer Conservation District to conduct forest management projects, primarily through tree thinning (Figure 14). The purpose of these projects is to reduce the overall occurrence of wildfires and the severity of their impact for those that do occur. Perhaps even the AMF was less severe than it could have been in part due to past forest management activities. Although water quality continued to be relatively good despite the fire effects, we expect that these efforts, along with natural regenerative processes, will continue to result in improved water quality in the coming years. In addition, LWP is working with the Natural Resources Conservation Service to utilize Emergency Watershed Protection funds to construct projects (such as v-weirs and contour felling) in the upland area of the AMF that will act to reduce the magnitude of the water quality impacts of the AMF.

Figure 14. An example of forest management in the Big Thompson River watershed. The forest on the left side of the road has been thinned to historic tree density. The forest on the right side of the road has not been treated.

References

Allen, J.M., Plewa, M.J., Wagner, E.D., Wei, X., Bokenkamp, K., Hur, K. Jia, A., Liberatore, H.K., Lee, C.T., Shirkhani, R., and Krasner, S.W. 2022. Drivers of disinfection byproduct cytotoxicity in US drinking water: should other DBPs be considered for regulation? Environmental Science & Technology 56: 392-402.

Naceradska, J., Pivokonska, L., and Pivokonsky, M. 2019. On the importance of pH value in coagulation. Journal of Water Supply: Research and Technology-Aqua 68: 222-230. https://doi.org/10.2166/aqua.2019.155

Paul, M.J., LeDuc, S.D., Lassiter, M.G., Moorhead, L.C., Noyes, P.D., and Lebowitz, S.G. 2022. Wildfire induces changes in receiving waters: a review with considerations for water quality management. Water Resources Research 58. https://doi.org/10.1029/2021WR030699

Rhoades, C.C., Chow, A.T., Covino, T.P, Fegel, T.S. Pierson, D.N., and Rhea, A.E. 2019. The legacy of a severe wildfire on stream nitrogen and carbon in headwater catchments. Ecosystems 22: 643–657.

Rodela, M.H., Chowdhury, I., and Hohner, A.K. 2022. Emerging investigator series: physiochemical properties of wildfire ash and implications for particle stability in surface waters. Environmental Science: Processes & Impacts 24: 2129-2139.

Rust, A.J., Hoque, T.S, and McCray, J. 2018. Post-fire water-quality response in western United States. International Journal of Wildland Fire 27: 203–216.

Office
Loveland Service Center
200 North Wilson Avenue
Loveland, CO 80537
Public Water System Identification
Number: CO0135485
Office Hours: 8 a.m. to 5 p.m.
Monday-Friday

Contact Us
(970) 962-3000
LWPInfo@cityofloveland.org
www.lovelandwaterandpower.org

Loveland Water and Power