GRAND COUNTY

LEARNING BY DOING

2021 ANNUAL OPERATIONS REPORT

January 26, 2022

Introduction

Learning By Doing (LBD) Operations Guidelines require that each year the Operations Subcommittee submit an Operations Report to the LBD Management Committee. This report summarizes 2021 LBD-related operations, including:

- Denver Water's Moffat Collection System spill bypasses[1] totaling approximately 18,900 acre-feet (af) during runoff season including unplanned bypasses[2] in June to mitigate high water temperatures, 348 af from Williams Fork Reservoir to mitigate high water temperatures, and maintenance bypasses totaling 7,104 af for projects at the East Portal and in the Moffat Tunnel.
- Northern Water's Municipal Subdistrict (Subdistrict) Windy Gap voluntary bypasses of approximately 6,200 af to mitigate high water temperatures
- River District's Wolford bypass and release from storage of approximately 1,150 af to mitigate high water temperatures
- Release of 5,412 af from the Endangered Fish Pool in Granby Reservoir for the Upper Colorado River Endangered Fish Recovery Program (Recovery Program).

The LBD Cooperative Effort is a commitment by LBD entities to restore or enhance the condition of the aquatic environment, where possible, in Grand County. The Cooperative Effort Area (CEA) includes the Colorado, Fraser, and Williams Fork River basins, upstream of the Colorado River confluence with the Blue River. A map of the Fraser River Collection System (**Attachment A**), a map of the Colorado River from Granby Reservoir to the Williams Fork River (**Attachment B**), and a list of LBD water sources and quantities offering flexibility (**Attachment C**) can be found at the end of this report.

2021 Snowpack and Water Supply Forecasts

Figure 1 is a map depicting NRCS April 1, 2021 Snow Water Equivalent (SWE) for SNOTEL sites in Colorado. A graph of the 2021 Snow Water Equivalent at SNOTEL sites above Kremmling versus time is shown in **Figure 2**. The Colorado Basin River Forecast Center

[1] "Voluntary/environmental bypasses" are releases pursuant to the CRCA; "required bypasses" are releases pursuant to a permit or ROD; "maintenance bypasses" are releases to allow for maintenance; "spill bypasses" are releases as a result of a full reservoir or system constraint (full East Slope reservoirs).

[2] Bypasses that at the time were considered "voluntary" but were recolored as "spill bypasses" later due to availability of native South Boulder Creek water filling Gross and Ralston Reservoirs

(CBRFC) April 1, 2021 Most Probable Runoff Forecast at Kremmling was 67 percent of average (580 thousand acre-feet [kaf], see evolving forecast graph, **Figure 3**). The actual runoff at Kremmling was 61 percent of average (528 kaf).

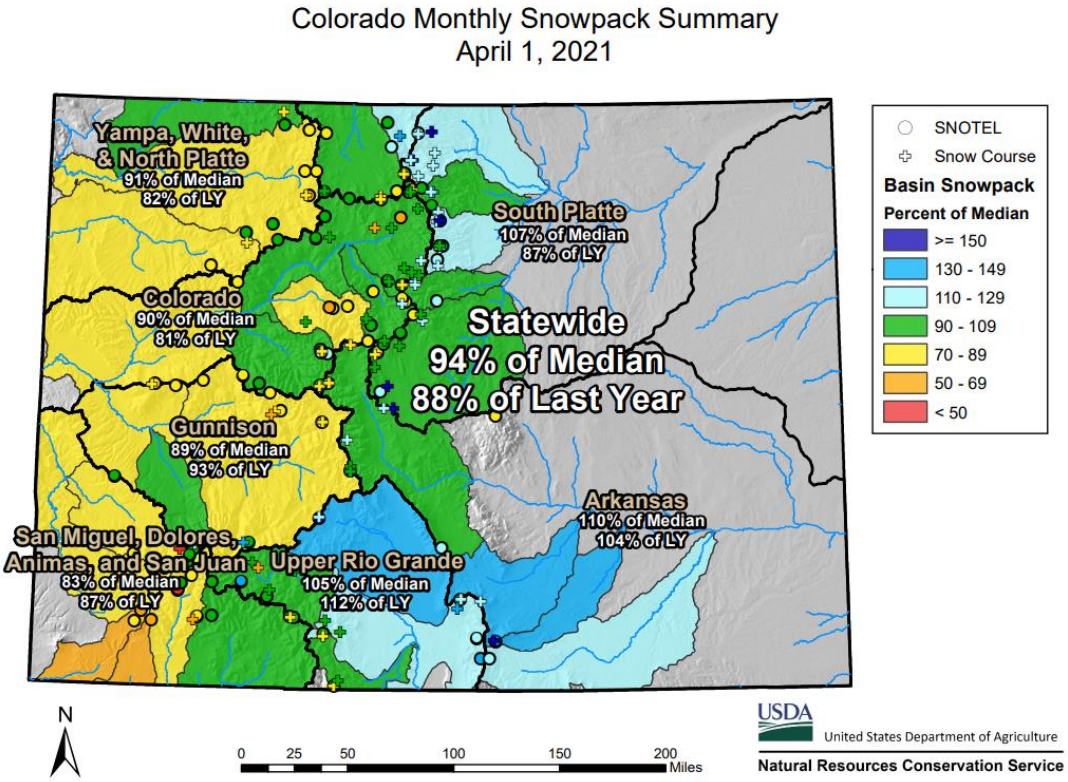
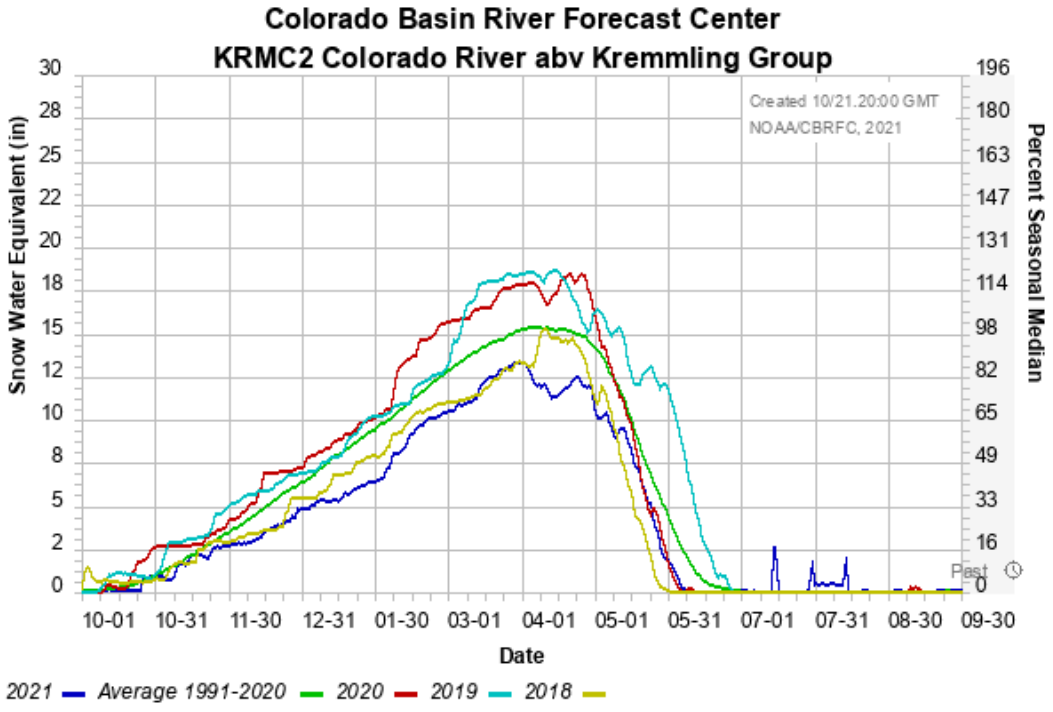
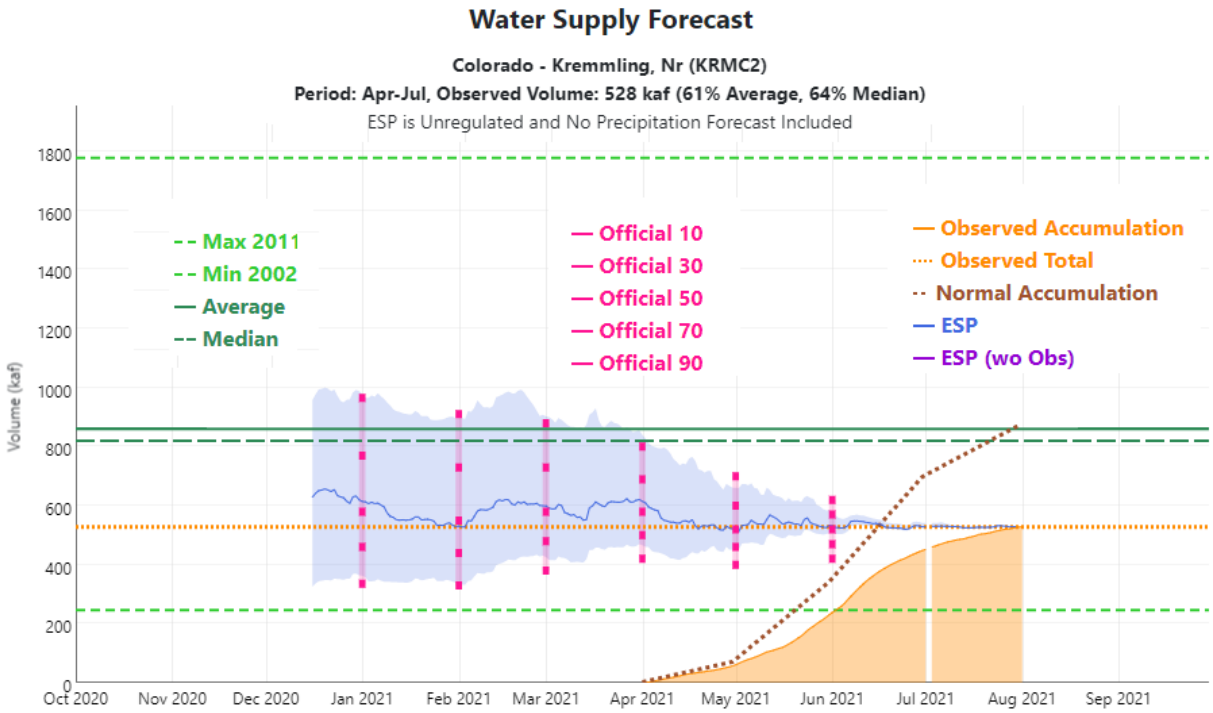


Figure 1: NRCS April 1, 2021 Snowpack Summary for Colorado



Figures 2: CBRFC 2021 Evolving Snowpack (Snow Water Equivalent) above Kremmling



Figures 3: CBRFC 2021 Evolving Water Supply Forecast at Kremmling

CBRFC April 1 forecasts in the Upper Colorado River Basin above Lake Powell (UCRB) were well below average and dry conditions in April contributed to reduced June 1 forecasts, see **Figure 4**. April through July runoff in the LBD CEA was 74 percent of average, with Williams Fork and Fraser basins at 65 and 82 percent of average, respectively.

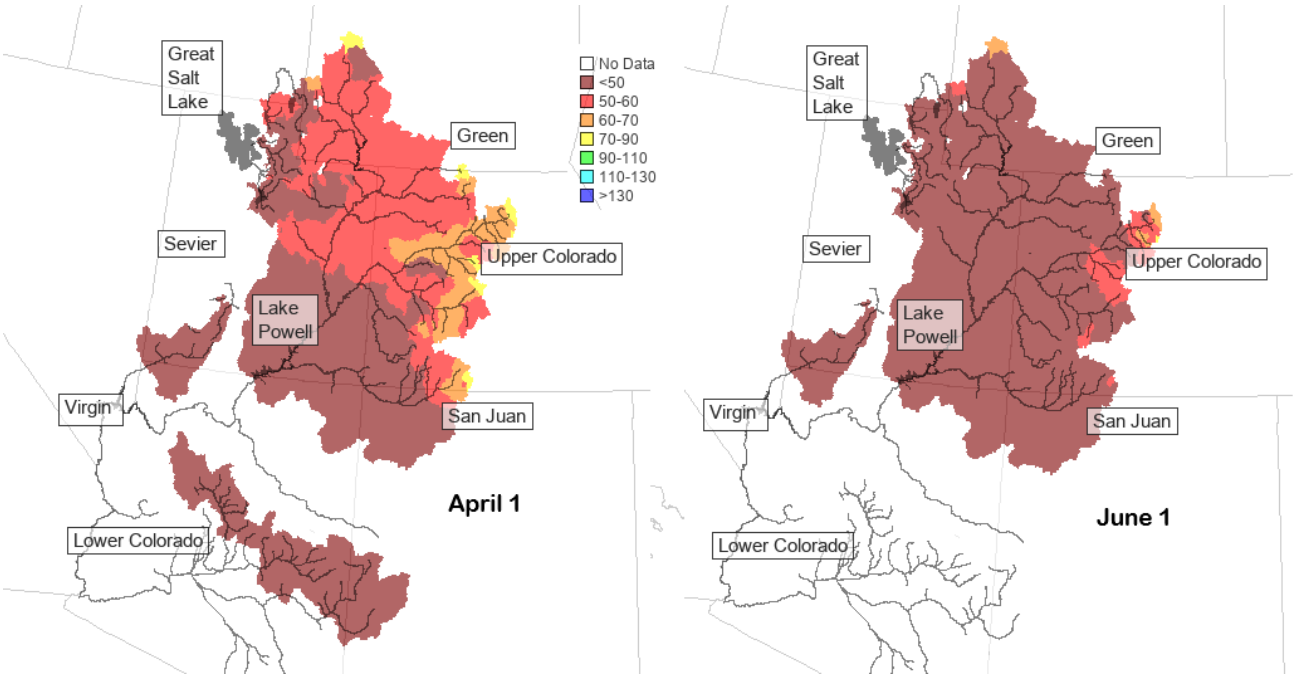


Figure 4: CBRFC April 1 and June 1, 2021 Water Supply Forecasts as a Percent of Average

The UCRB experienced an above-average summer 2021 monsoon season, which brought some temporary relief to aquatic environments but did not significantly benefit water supplies. April to July inflow to Lake Powell was 31 percent of average, the second driest runoff on record behind 2002. However, locally intense rain events in July, August and late September mobilized debris in fire-scarred areas in Grand County, Glenwood Canyon and on the Roan Plateau, causing damage to infrastructure, closures to I-70, and fish kills in localized waters including the mainstem Colorado River. Maps depicting monthly precipitation as a percent of average in the UCRB in Colorado are shown in **Figure 5**.

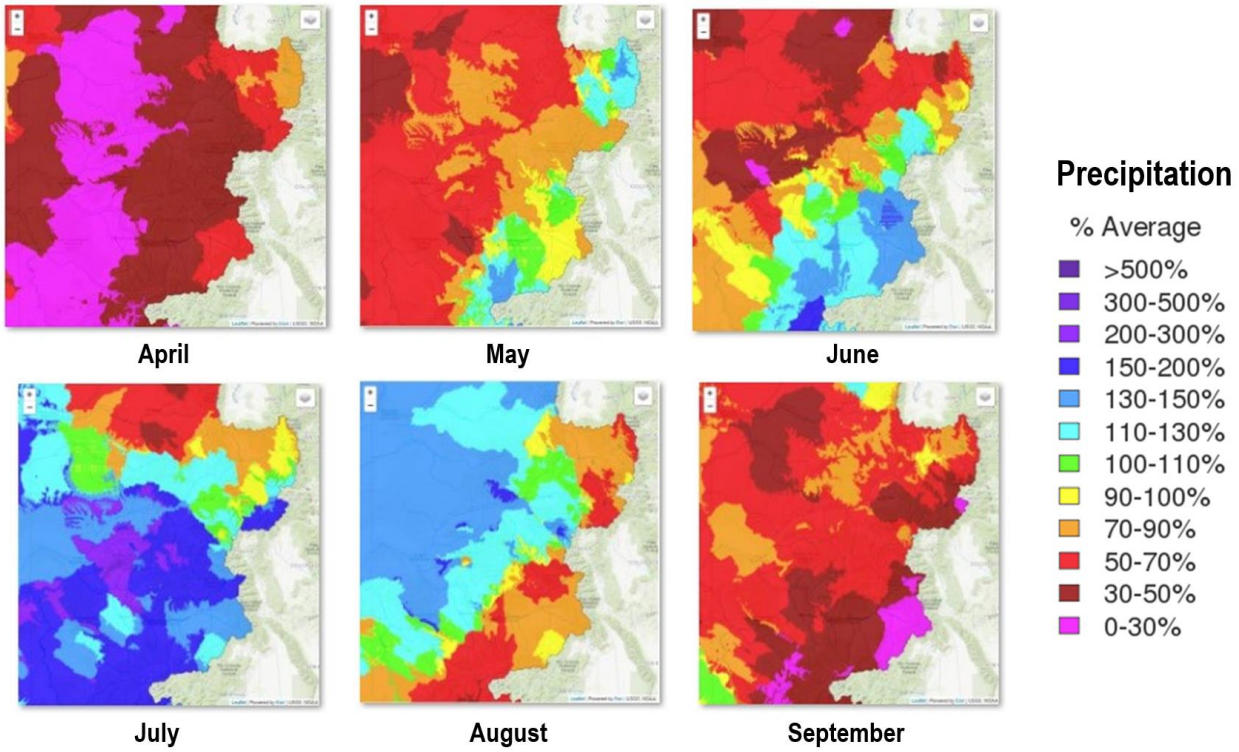


Figure 5: Maps showing April through September 2021 Average Monthly Precipitation in the Upper Colorado Headwaters in Colorado

Runoff Operations

The LBD Operations Subcommittee held weekly teleconference calls to discuss runoff operations beginning May 4, 2021. Discussion focused on the obvious challenges to both Runoff and In-season operations brought about by multiple factors, including what turned out to be a season long outage at the Shoshone power plant beginning in early April, poor runoff conditions, and the potential for debris flows (over 90 percent of the Willow Creek basin was burned by the 2020 East Troublesome fire). The Shoshone Outage Protocol (ShOP) was implemented to assure historic bypasses from upstream reservoirs were released, but a Cameo call during the last half of April precipitated by Grand Valley irrigation startup operations underscored the severity of the drought. **Figure 6** shows streamflows and administrative status during runoff at the USGS gage Colorado River near Dotsero.

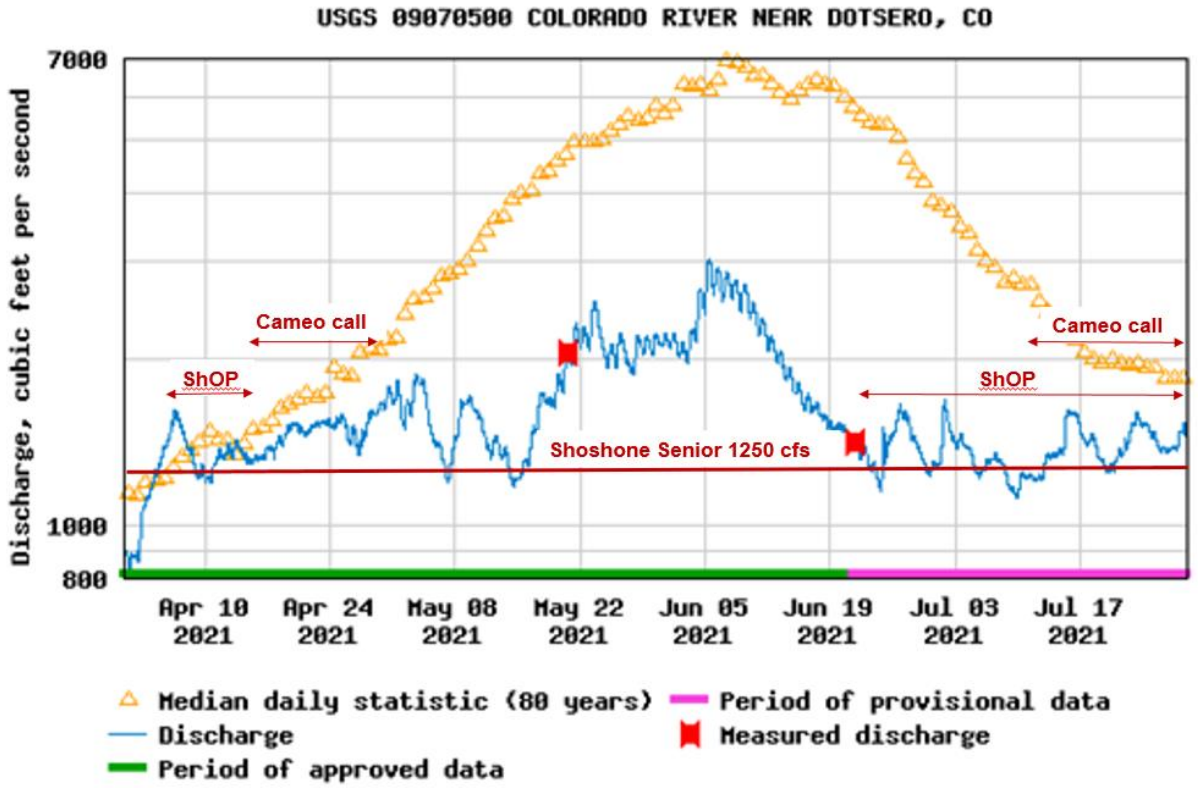
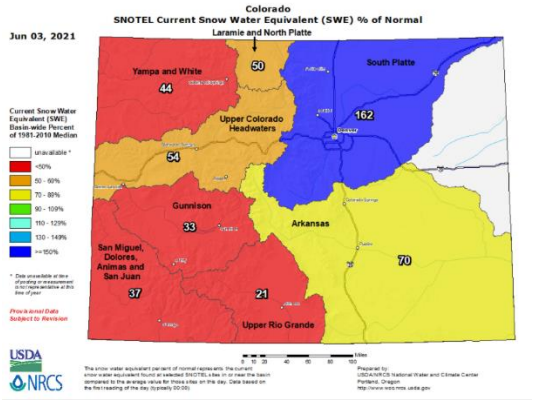
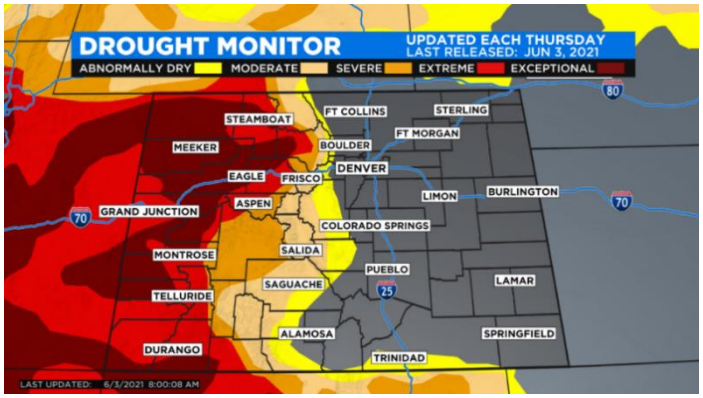


Figure 6: Graph of Streamflow at the USGS gage at Colorado River near Dotsero and Administrative Status

The Fraser River was identified as the highest priority for spill bypasses, however Denver Water reported that all water available to the Moffat Collection System was expected to be diverted in May and June. Extremely dry conditions in the Blue River basin resulted in minimum releases from Green Mountain Reservoir throughout the runoff season (see **Figure 15**), and what turned out to be the largest Substitution year ever. Granby and Williams Fork Reservoirs were not expected to fill, and Windy Gap was expected to pump all available water.

In June, a perfect storm of well below average runoff, an extremely hot and dry climate, and multiple in-basin and trans-basin diversions in the UCRB caused water temperatures on the Colorado River below Kremmling to reach critical levels for coldwater fish. On June 4th streamflow below Kremmling was 320 cfs and water temperatures peaked at 71 °F. For reference, commercial whitewater guiding operations below Kremmling are feasible when flows are above 600 cfs, and CPW has stated that coldwater fish begin to experience stress effects at temperatures in the high 60's °F. Colorado River administration in the form of the Shoshone Outage Protocol (ShOP) was not anticipated for several weeks. The River District held that the disparity of fortunes on the West and East Slopes in early June, shown in **Figures 7 and 8**, should provide flexibility for transmountain diverters to respond to deteriorating aquatic conditions in the Upper Colorado River.





Figures 7 and 8: Snowpack and Drought Conditions in Colorado published June 3rd, 2021

On Saturday, June 5th, in a coordinated effort to mitigate combined impacts, the River District bypassed an additional 50 cfs from Wolford Reservoir, Denver Water bypassed an additional 100 cfs in its Fraser River Collection System, and the Subdistrict bypassed an additional 50 cfs at Windy Gap Reservoir, for a combined 200 cfs of additional water in the river benefiting the Colorado River below Kremmling. Peak water temperatures were reduced a few degrees at the Kremmling gage, with flows maintained at 500 cfs for several days. River conditions improved but remained stressed. The Subdistrict continued bypassing water at Windy Gap Reservoir through June 21, when pumping ended for the season (**Figure 9**). On June 11, The Municipal Subdistrict began releasing its bypassed water early in the morning so that the bulk of the water would reach the Kremmling area between noon and 8 pm, which is the time frame that corresponds with peak water temperatures. **Figures 10 and 11** show streamflow and water temperature at Colorado River near Kremmling and the timing of water temperature mitigation efforts.

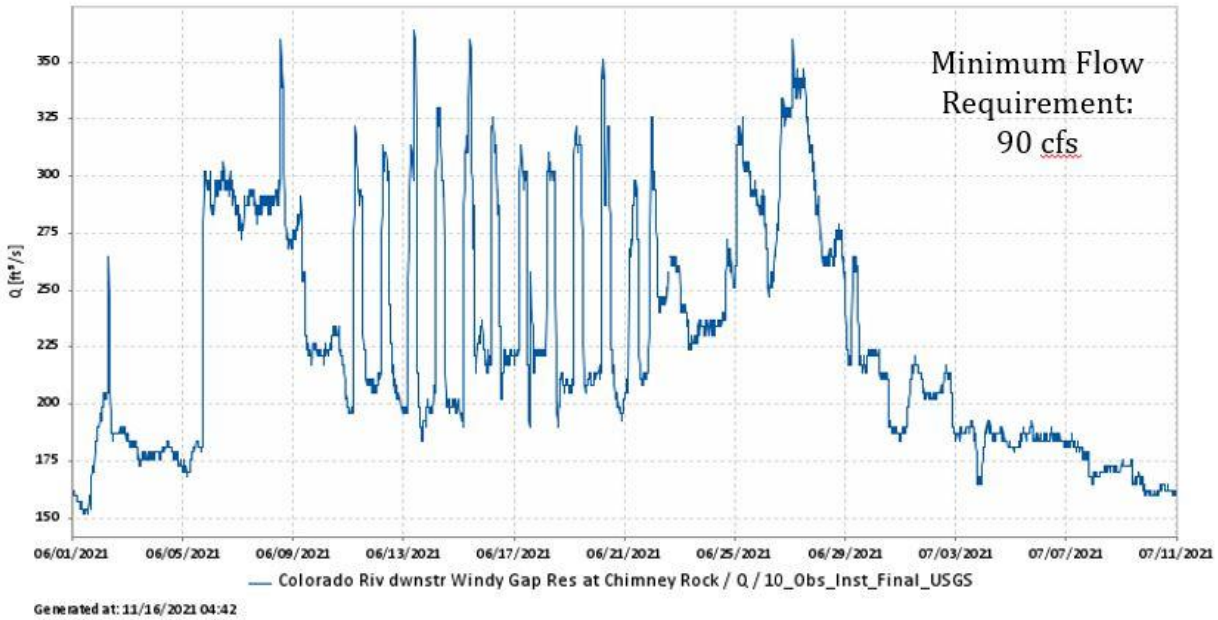


Figure 9: Graph of Streamflow on the Colorado River downstream of Windy Gap near Chimney Rock, showing the period of increased bypasses from June 5 through June 21, including bypass cycling from June 13 through 21.

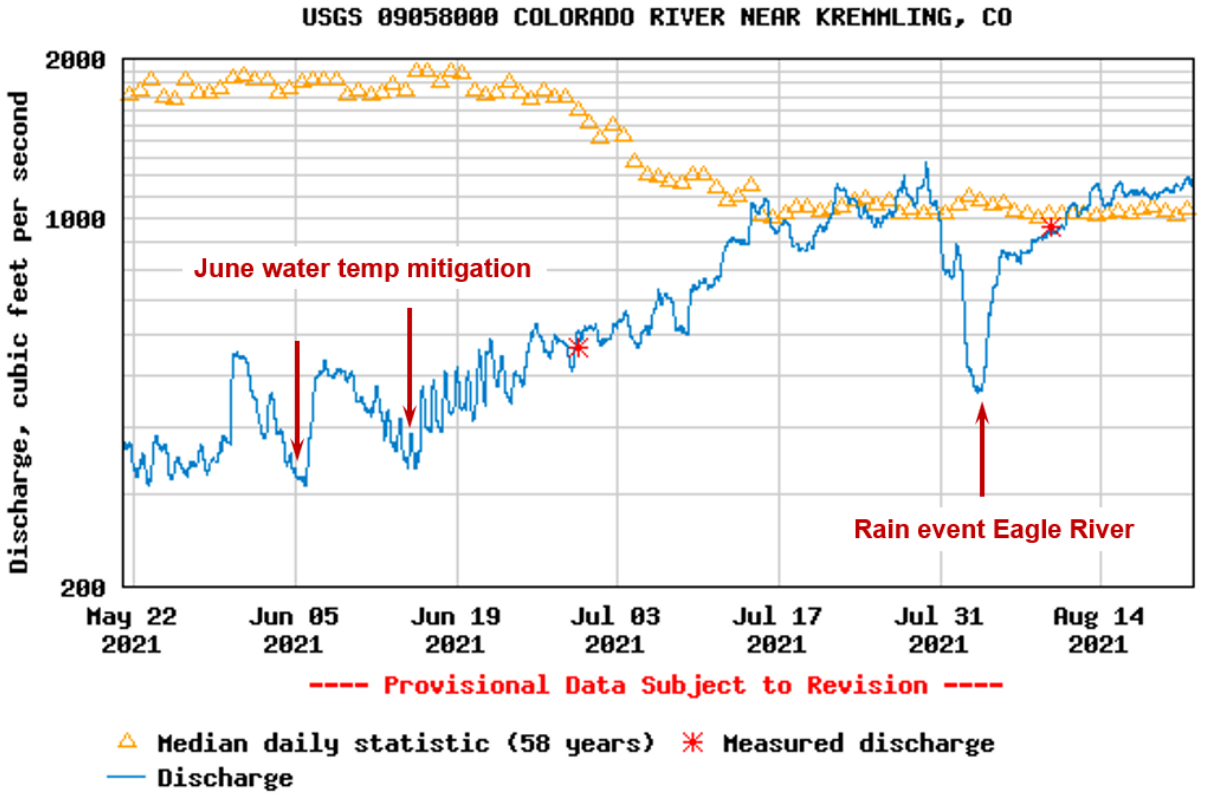


Figure 10: Graph of Streamflows at the USGS gage at Colorado River near Kremmling

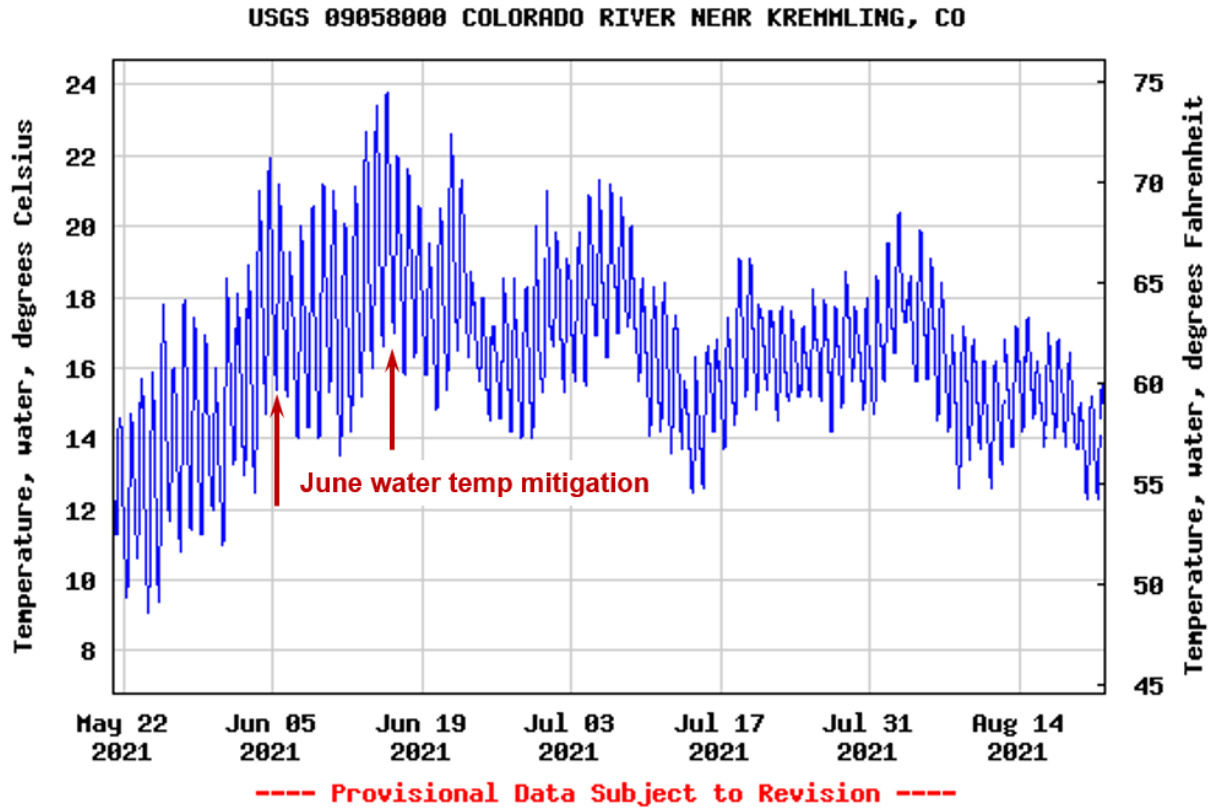


Figure 11: Graph of Water Temperatures at the USGS gage at Colorado River near Kremmling

On Sunday June 13th, the River District again reached out to Denver Water and the Subdistrict of Northern Water for additional bypasses to mitigate the declining flow and rising water temperatures on the Colorado River. Streamflow below Kremmling had dropped to 400 cfs and water temperatures peaked at 74° F (24°C). On June 15th, the River District began releasing an additional 35 cfs from storage in Wolford Mountain Reservoir, Denver Water bypassed an additional 23 cfs at Williams Fork Reservoir, and the Subdistrict continued its bypasses and daily cycling operation of 120 cfs for 8 hours targeting peak afternoon temperatures. **Figures 12, 13 and 14** show mitigation efforts by Denver Water at the St. Louis Creek diversion bypass and the Subdistrict at Windy Gap pump plant and below Windy Gap Reservoir[3].

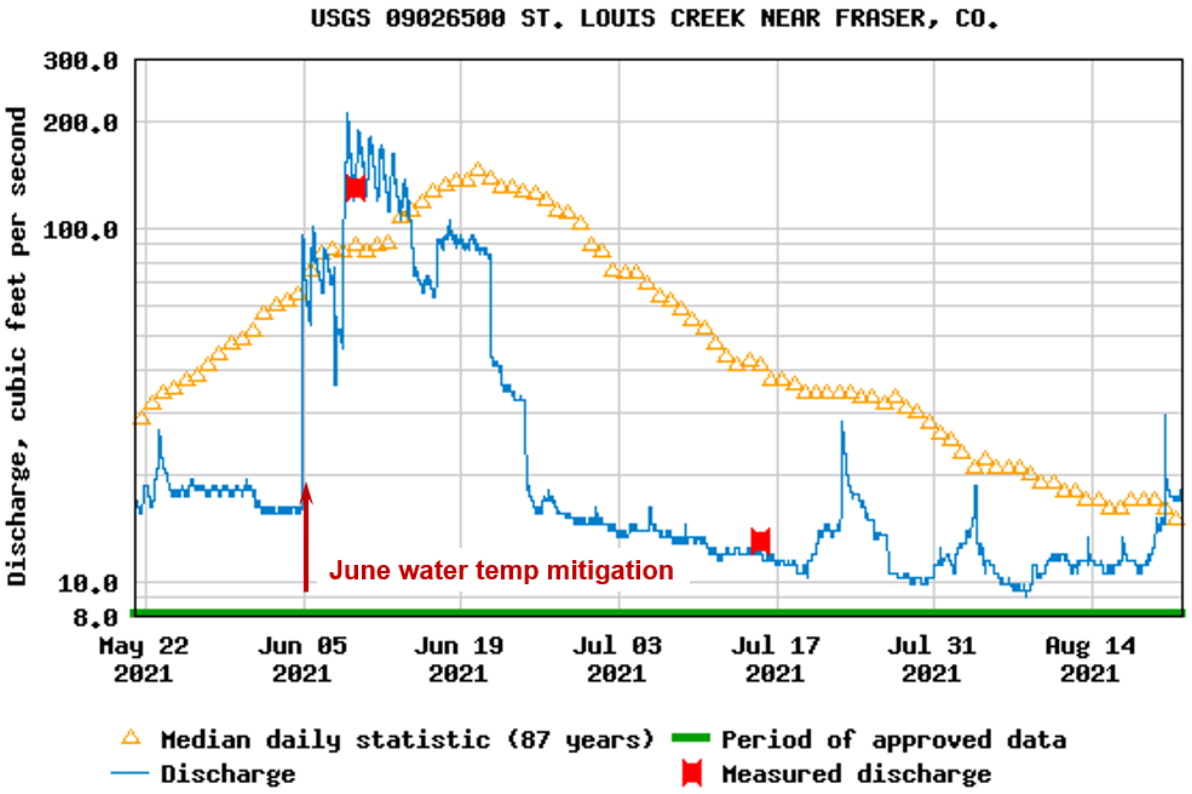


Figure 12: Graph of Streamflow at the USGS gage at St. Louis Creek near Fraser

[3] As Denver Water increased voluntary/enhancement bypass flows in the Fraser River basin, the Municipal Subdistrict made corresponding changes to ensure the water was delivered to the targeted stream reach.

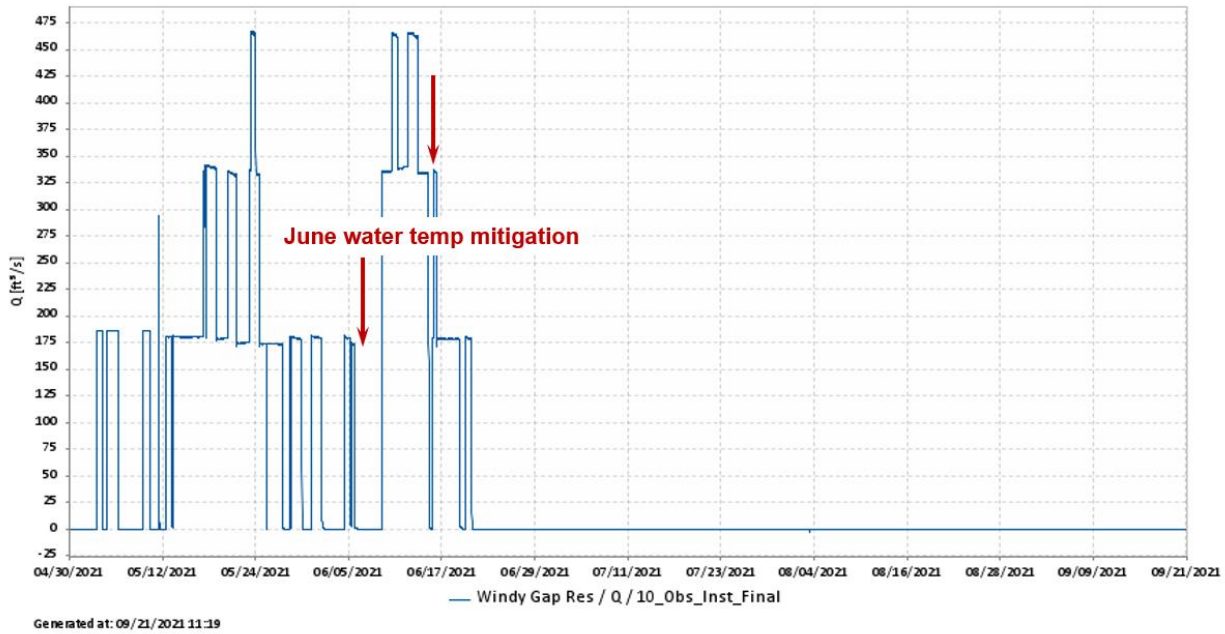


Figure 13: Graph of Pumping from Windy Gap Reservoir into Granby Reservoir (Northern Water)

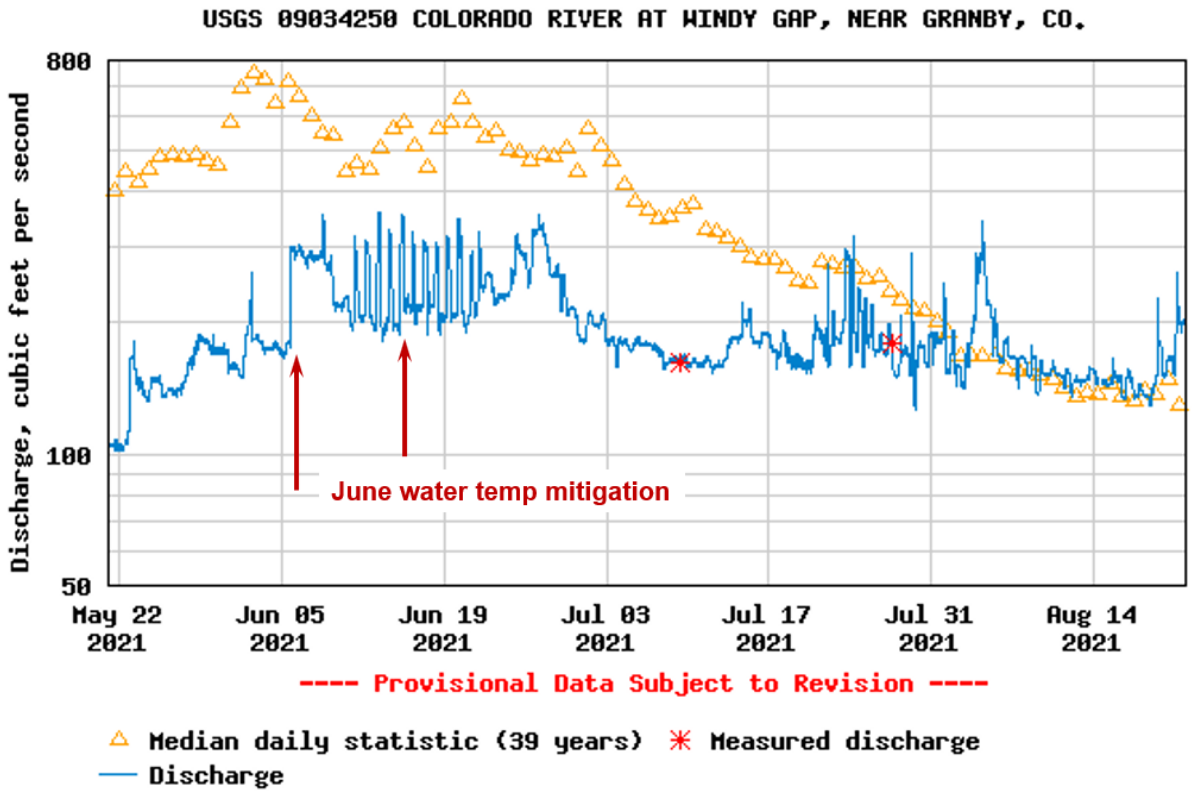


Figure 14: Graph of Streamflow at the USGS gage at Colorado River at Windy Gap near Granby

Despite these measures, the intense climate and severely depleted runoff caused an exceedance of the State chronic water temperature standard for aquatic life in the Colorado River downstream of Kremmling in late June. There were multiple reports of fish kill below Kremmling as air temperatures reached 90 °F in Granby. River conditions remained stressed with continuing environmental, recreational, and economic impacts. Colorado Parks and Wildlife implemented voluntary fishing closures on various sections of the Colorado River downstream of Kremmling in early July.

During this period, snowmelt increased, and more east slope priority water became available to Northern Water and Denver Water. As a result, Northern Water reduced Adams Tunnel diversions and Denver Water bypassed additional water in the Fraser Collection System. However, Northern Water continued to store CBT inflow (less minimum bypasses) at Willow Creek and Granby Reservoirs.

On June 28th ShOP operations brought some relief in the form of additional bypasses at Williams Fork Reservoir, and GMR achieved an administrative fill, triggering its participation in ShOP. **Figures 15, 16 and 17** show operations below Williams Fork, Wolford Mountain and Green Mountain Reservoirs, respectively. In July a shift in weather brought additional relief in the form of cooler temperatures and precipitation, but the long-term outlook continued to be dryer and warmer than average conditions. **Figures 18 through 21** are graphs of Maximum Weekly Average Temperatures (MWAT) or Daily Maximum Temperatures (DM) for locations in the Fraser River Basin and Colorado River near Kremmling. compared to Colorado temperature standards for protection of aquatic life. The MWAT temperature standard, or chronic standard, provides the temperature range for optimal growth, survival, and reproduction of a fish species; when water temperature exceeds this threshold, it does not generally cause mortality. The DM temperature standard, or acute standard, is the threshold where mortality can occur.

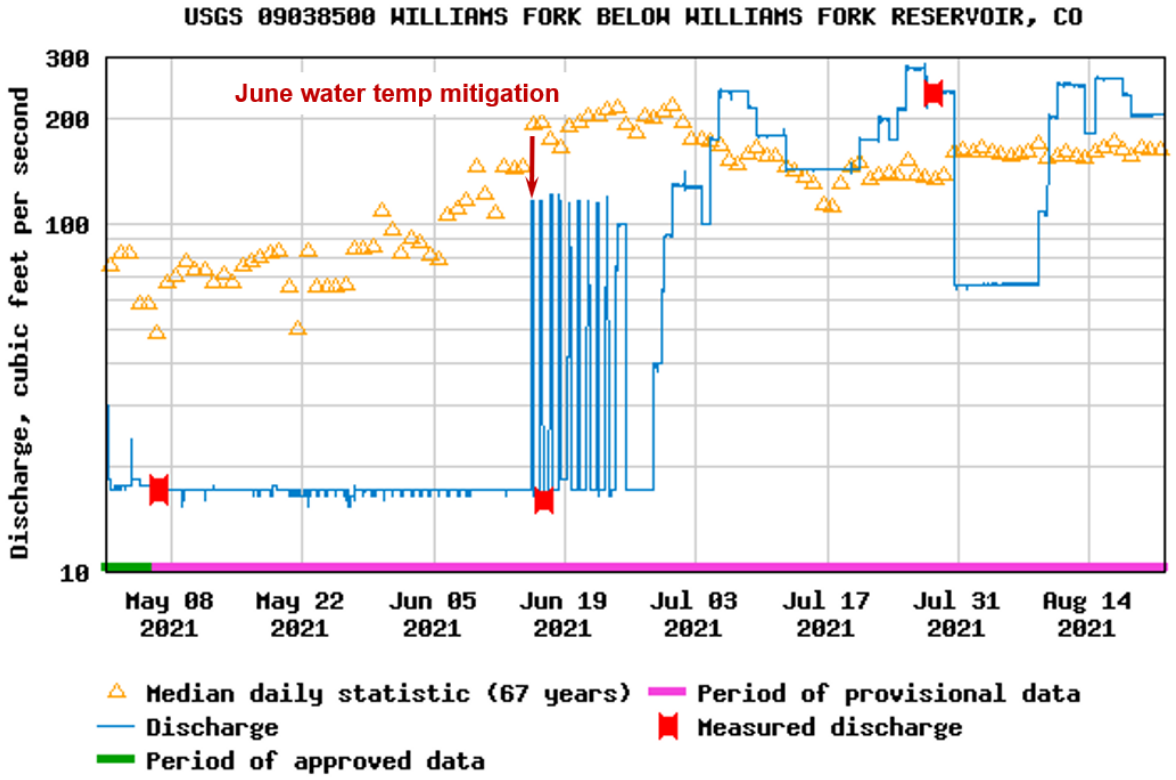


Figure 15: Graph of Streamflows at the USGS gage at Williams Fork below Williams Fork Reservoir

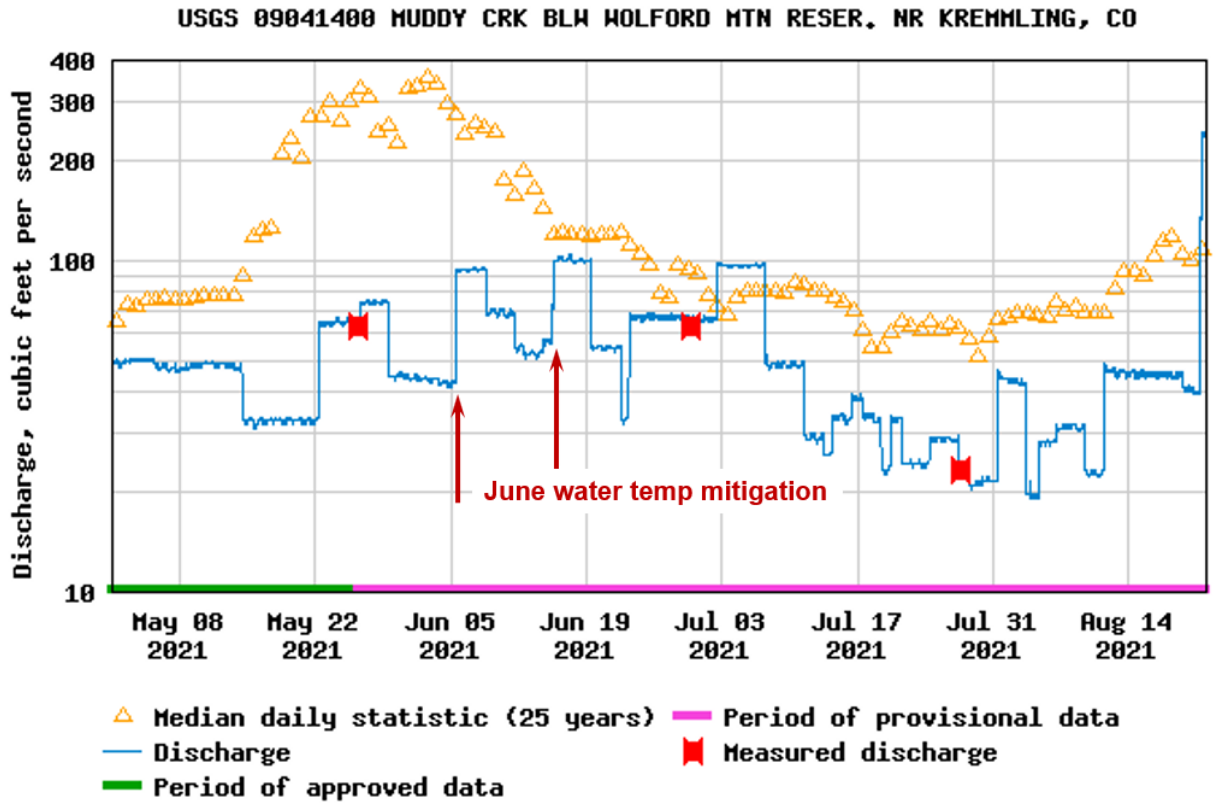


Figure 16: Graph of Streamflows at the USGS gage at Muddy Creek below Wolford Mountain Reservoir

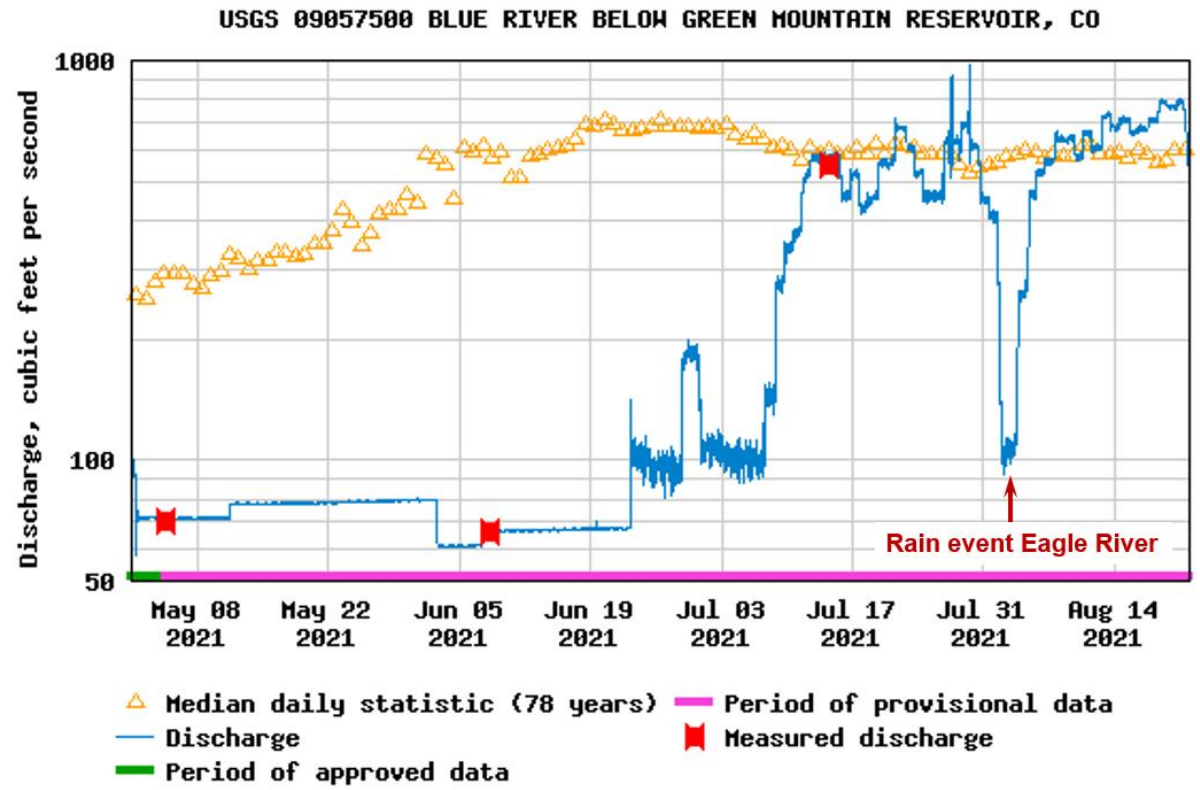


Figure 17: Graph of Streamflows at the USGS gage at Blue River below Green Mountain Reservoir

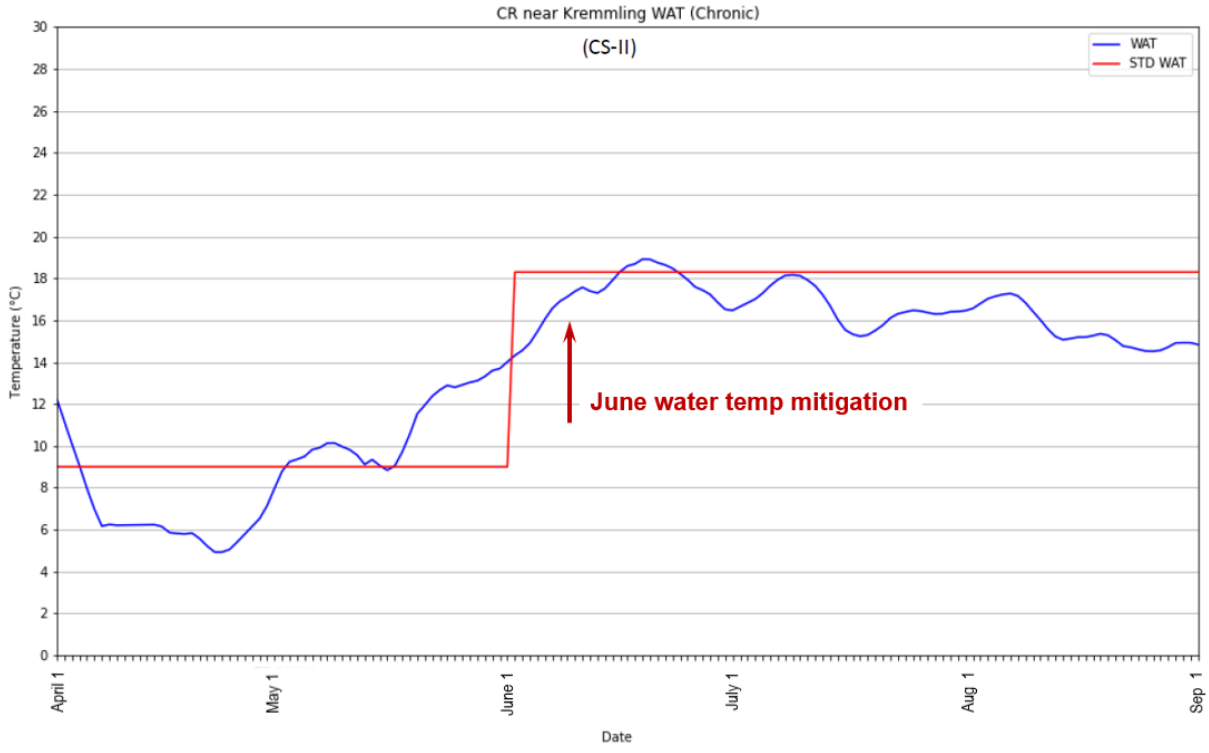


Figure 18: Graph of Maximum Weekly Average Temperatures (MWAT) at Colorado River near Kremmling, showing exceedances of the Water Quality Control Division Chronic Temperature Standard

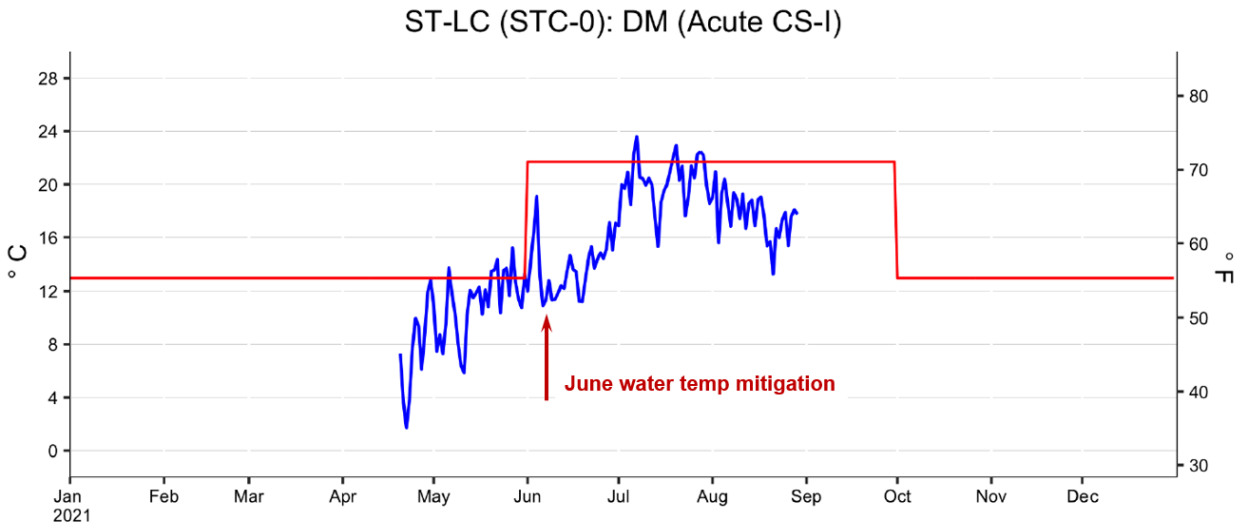


Figure 19: Graph of Daily Maximum Temperatures (DMT) at St. Louis Creek near Fraser, showing exceedances of the Water Quality Control Division Acute Temperature Standard

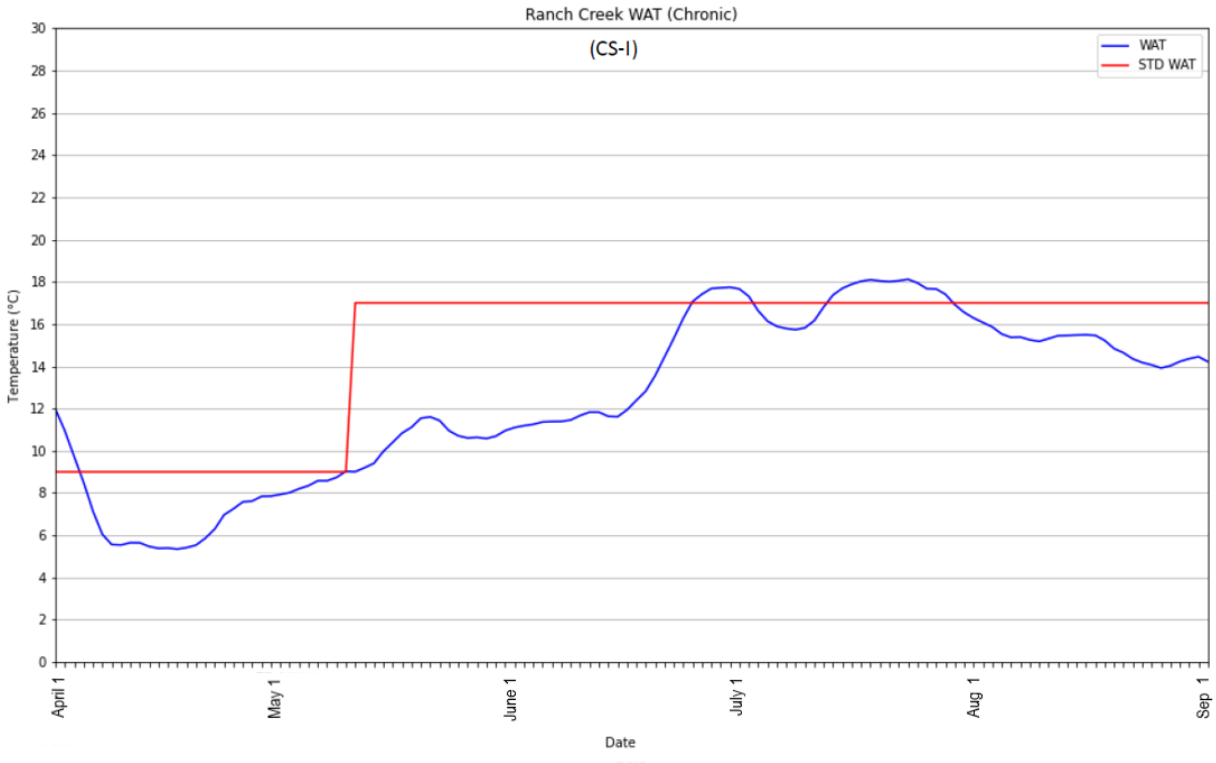


Figure 20: Graph of MWAT at Ranch Creek near Fraser, showing exceedances of the Water Quality Control Division Chronic Temperature Standard

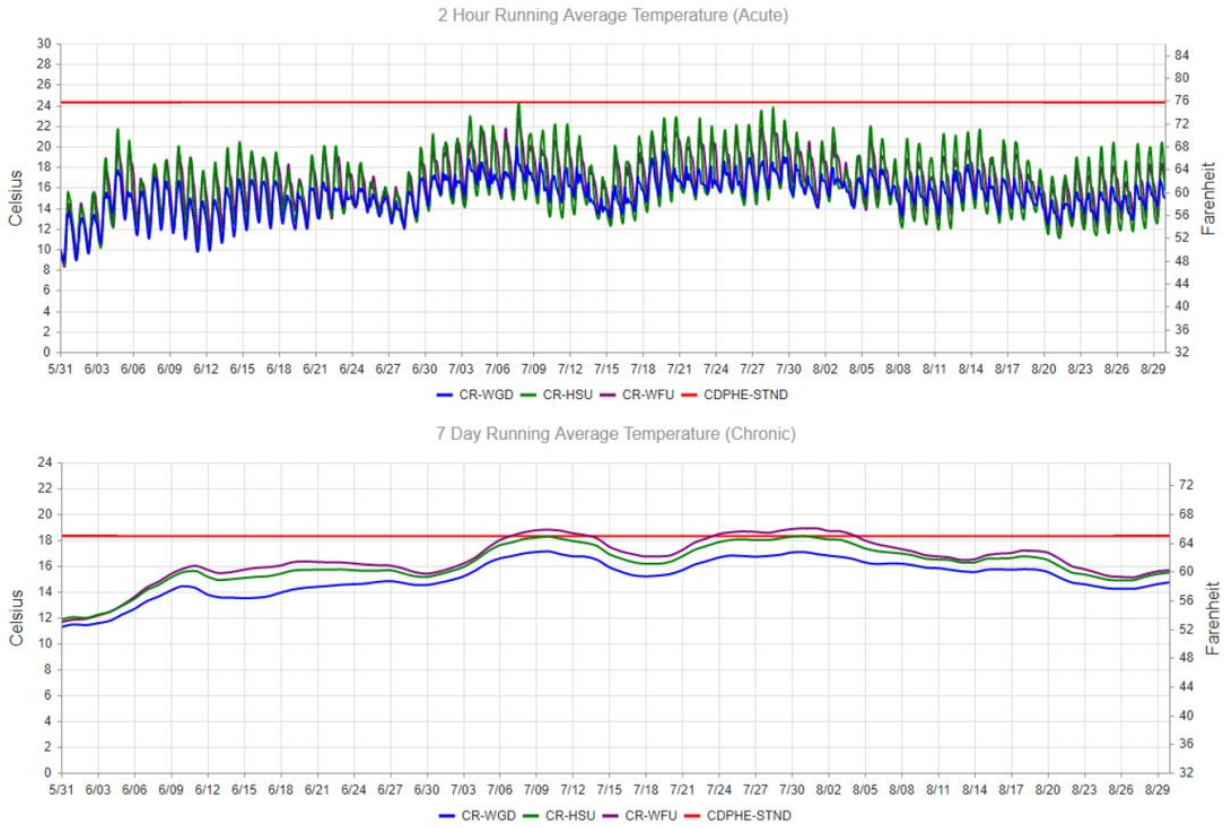


Figure 21: Graphs of 2 hour and 7 day Running Average Water Temperatures at Colorado River below Windy Gap, Hot Sulphur Springs and at Williams Fork (NCWCD)

Denver Water Operations

Figure 22 shows 2021 Moffat Tunnel diversions. Denver Water bypassed (water temperature mitigation, maintenance and spill) about 11,000 af in June (**Figure 23**). A full review of Denver Water Operations can be found in Attachment D.

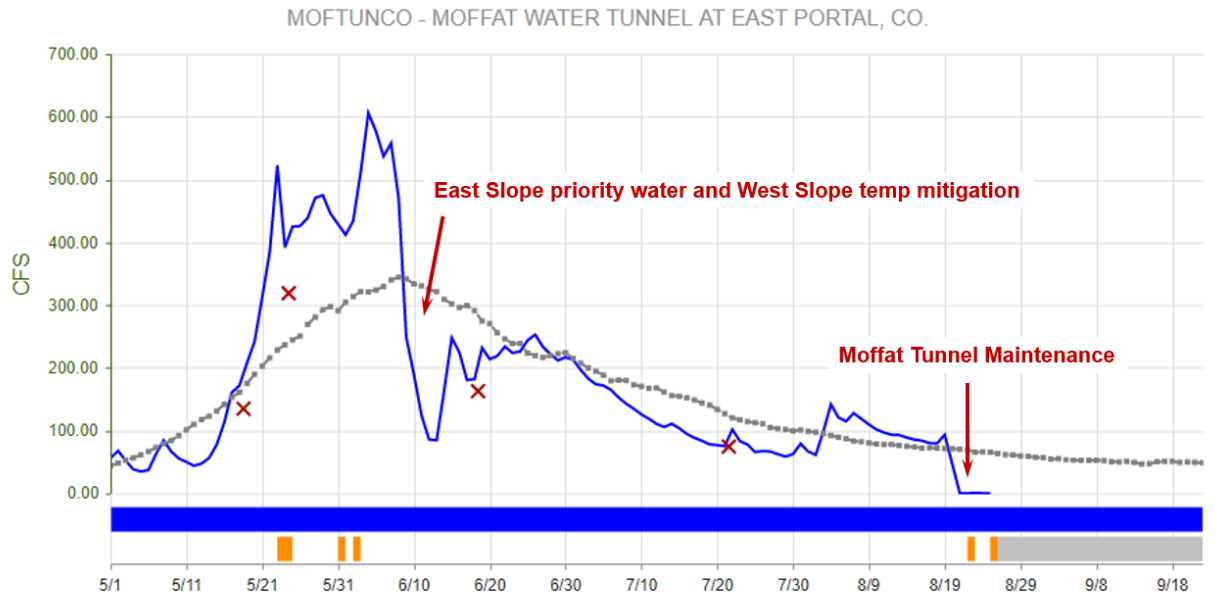


Figure 22: 2021 Moffat Tunnel Diversions

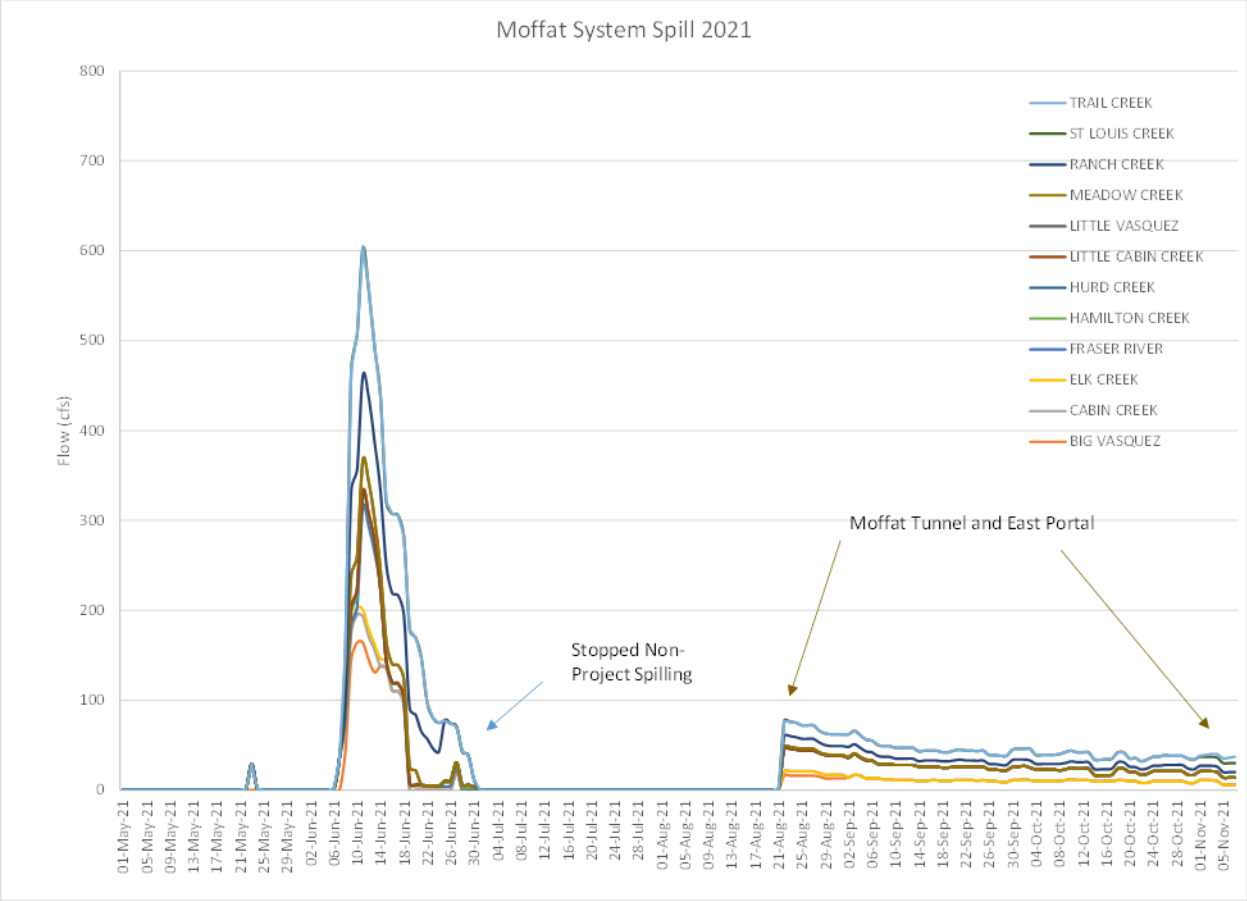


Figure 23: Denver Water Moffat System Bypasses (Maintenance and Spill) in 2021

Moffat Bypass Prioritization

Except for 2012, Moffat Collection System spill bypasses occurred in every year since 2005 (**Figure 24**). In 2016 and 2017, the Operations Subcommittee targeted Cabin, Vasquez, and Trail Creeks for voluntary spill bypasses. Trail Creek was chosen because it had fewer spill bypasses in the recent past. 2018 voluntary spill bypasses targeted Big Vasquez, St Louis, and Trail Creeks. In 2019 spill bypasses targeted Ranch and St Louis Creeks. In 2020 Moffat spill bypasses began in Cabin, Hurd, and Hamilton Creeks. In terms of prioritization of spill bypasses on Ranch Creek tributaries, all else being the same, it makes sense to spill bypass higher up in the valley. Cabin Creek makes more sense geographically than Trail Creek because Ranch Creek starts its slow, flat section where Cabin Creek joins Ranch Creek. Cabin Creek also contains a conservation population of Colorado River Cutthroat Trout downstream of the diversion that would benefit from the additional water.

The Grand County Stream Management Plan recommended flushing flows at different points in the Fraser River basin: Fraser River (80 cfs), St. Louis Creek (70 cfs), Vasquez Creek (50 cfs), and Ranch Creek (40 cfs). At the request of the U.S. Forest Service, a flushing flow was added on Cabin Creek (40 cfs). These flows were made conditions of the 404 Permit for the Moffat Project. Flushing flow targets were achieved at all locations except Cabin Creek. Ultimately, assessment of the effectiveness of these spill bypasses and prioritization of spill bypass locations requires a quantitative analysis based on field studies. LBD is considering implementing sediment sampling to monitor sediment transport. Denver Water provided flushing flow information (i.e., location, flow rate, duration) corresponding with each stream that has a permit-required flushing flow (**Attachment D**).

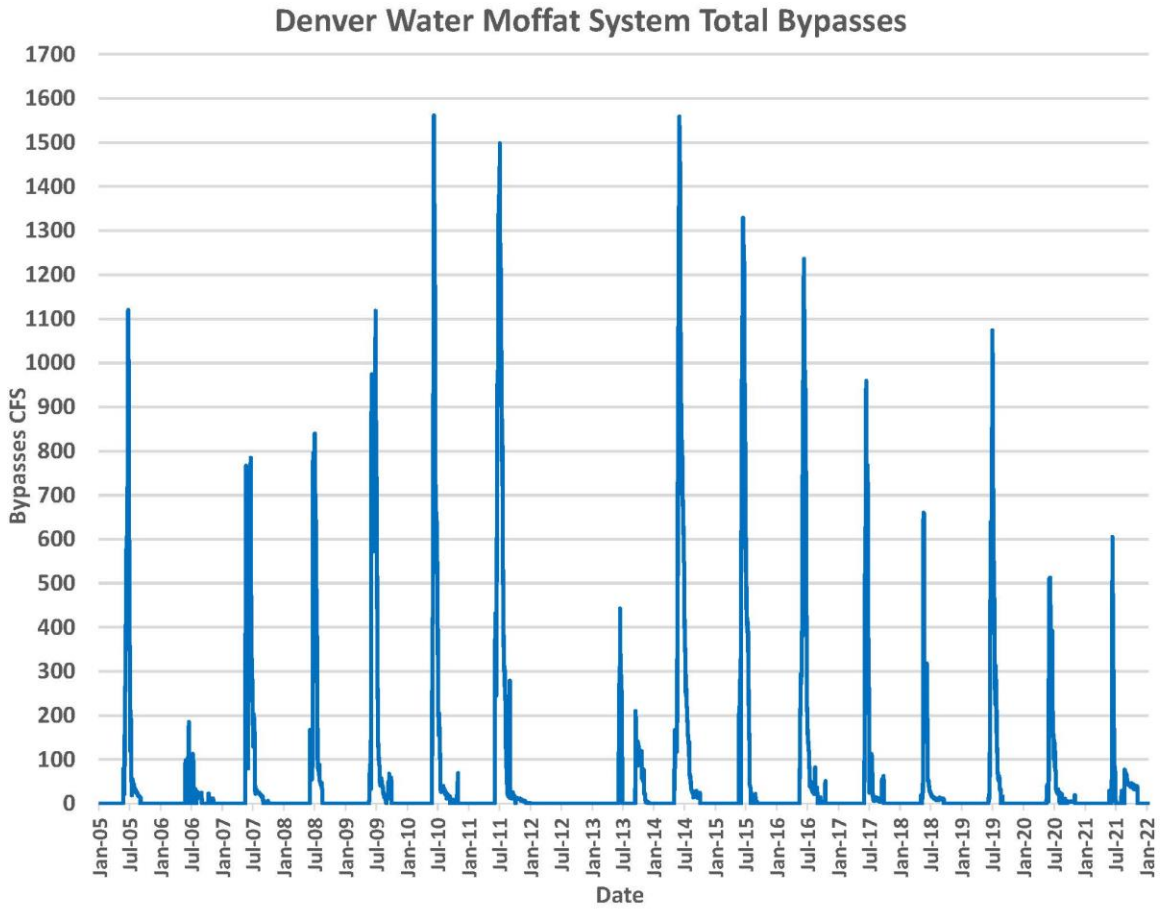


Figure 24: Moffat System Bypasses 2005 to 2021

Coordinated Reservoir Operations (CROS)

As part of the Recovery Program, when the projected Cameo peak flow is above 12,700 cfs and below the flood capacity of about 25,500 cfs, Denver Water, the River District, and the Bureau of Reclamation (Reclamation) participate in Coordinated Reservoir Operations (CROS) to benefit the Endangered Fish in the Grand Valley area by augmenting peak runoff, generally in June. In early May the 2021 peak flow in the Grand Valley was projected to be about 6,350 cfs (see evolving peak forecast plot, **Figure 25**). The peak forecast was well below the level that would trigger CROS, therefore no peak flow augmentation occurred.

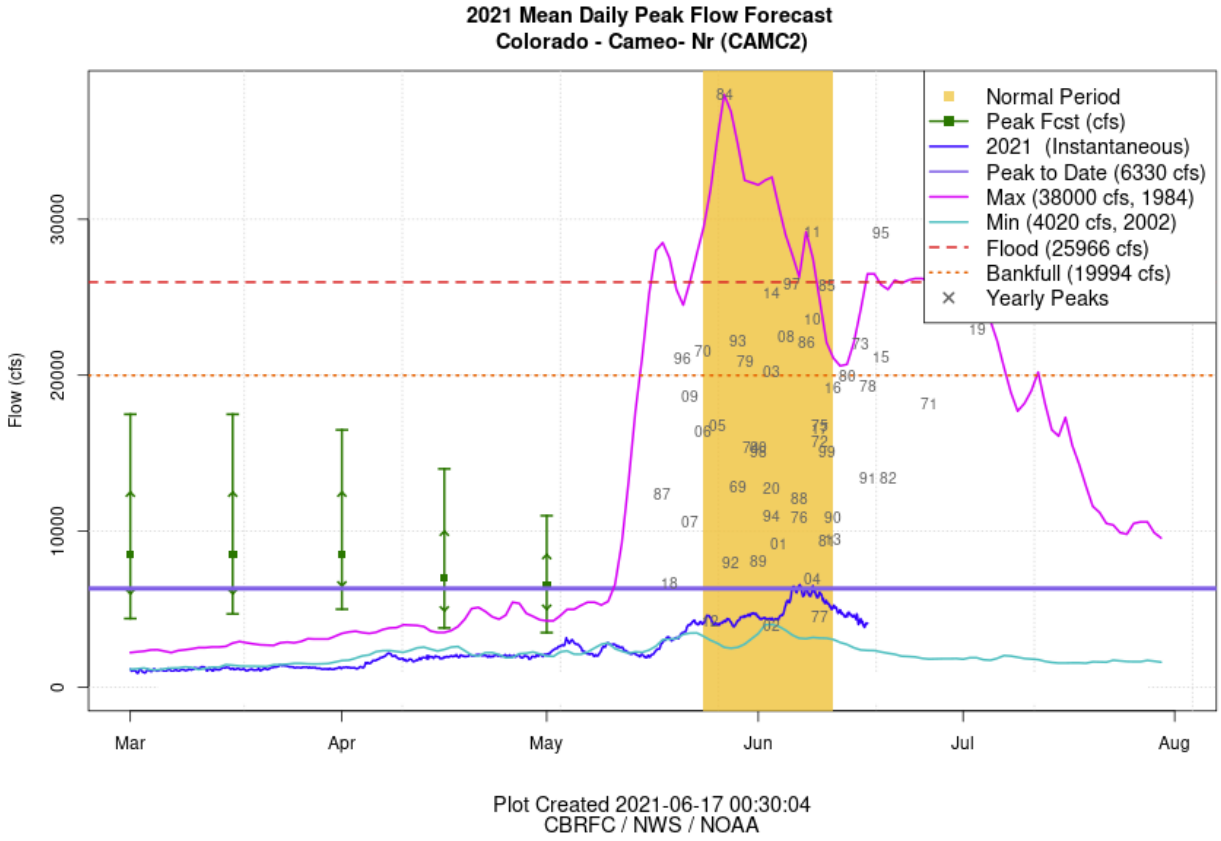


Figure 25: 2021 CBRFC Peak Flow Forecast, Yearly Peaks and Record Year Data for Cameo

Granby Fill and Windy Gap Pumping Operations

The 2021 Colorado Big Thompson Annual Operating Plan (CBT AOP) April 1 Most Probable Forecast model predicted that Granby Reservoir would not fill under any scenario. Historically, Granby Reservoir spilled in 2011, 2014, 2015, 2016, 2017, and again in 2019, but not in 2020 or 2021, see **Figure 26**. Under the April 1 CBT AOP Most Probable scenario, Windy Gap was predicted to pump 30,300 af into Granby Reservoir. Actual 2021 Windy Gap pumping totaled 15,371 af into Granby Reservoir, with approximately 6,200 af bypassed for water temperature and low river flow concerns. Willow Creek Reservoir was kept at a lower elevation than past years to provide room for high storm runoff peaks due to the East Troublesome Fire. Granby Reservoir reached its peak contents of approximately 469,758 af on July 7, which is approximately 69,242 af from full, and the lowest maximum since 2013 (Figure 27).

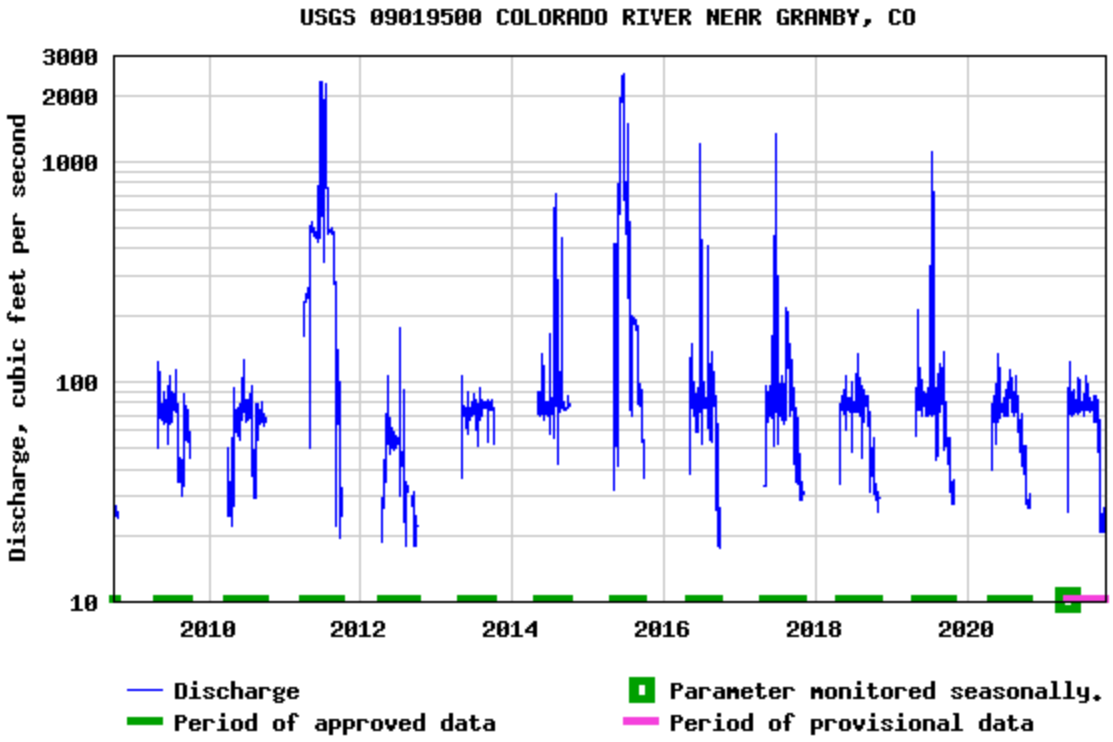


Figure 26: USGS Streamflow Colorado River near Granby 2009 to 2021

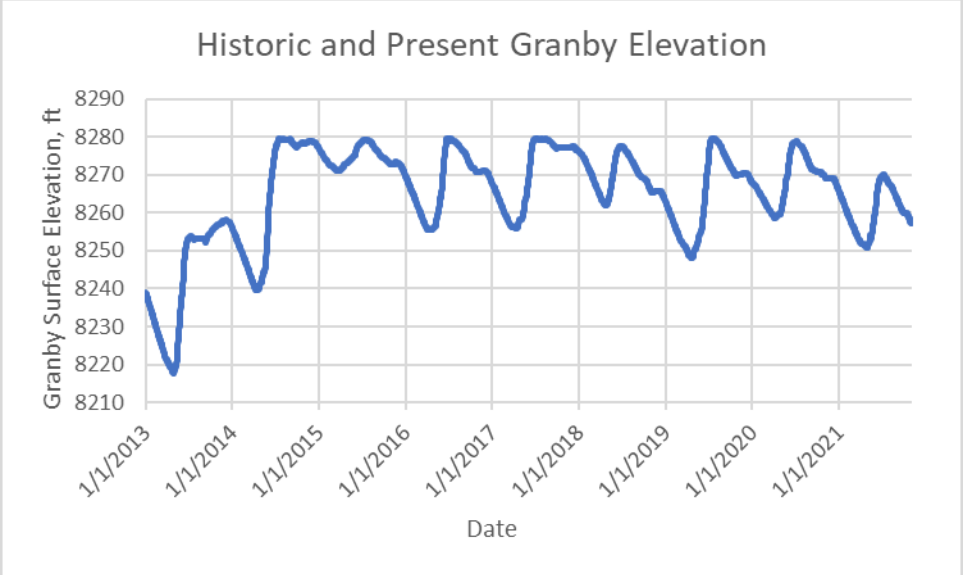


Figure 27: Historic Granby Elevations showing 2021 as the lowest maximum contents since 2013.

In-Season Operations

The Operations Subcommittee continued weekly teleconference calls to discuss in-season operations through early September. Each week prior to the LBD operations call, the River District forwarded river flow forecasts and graphs of discharge flows below Grand County facilities, and Grand County sent Daily Maximum Temperature (DM) and Maximum Weekly Average Temperatures (MWAT) water temperature charts from several locations. Water temperatures are assessed at 65 sites throughout the CEA using time-series data obtained

from several sites monitored by GCWIN, USGS, BLM, and Northern Water. These analyses can be critical to allocating bypass water in locations where real-time data are unavailable. Comprehensive stream temperature assessments for prior years can be obtained from the LBD website at: https://www.grandcountylearningbydoing.org/reports.html.

Real-time water temperature data are available at a few USGS sites and three mainstem Colorado River sites maintained by Northern Water. Data from multiple sites can be plotted together to reflect temperature increases in gaged reaches Northern Water's water temperature data at stream gages below Windy Gap Reservoir, at Hot Sulphur Springs and at Parshall can be compared to chronic and acute water temperature standards for aquatic life (see **Figure 21**).

Denver Water Operations

Pursuant to the 2012 Colorado River Cooperative Agreement (CRCA), each year beginning with the year Denver Water's Moffat Collection System Project (aka Gross Reservoir Expansion Project or Moffat Project) becomes operational, Denver Water will commit to releasing 1,000 af of water from its Moffat Collection System to streams in Grand County for the purposes of benefiting the aquatic environment.

Although the Moffat Project is not yet operational, in 2015, 2016 and 2017 Denver Water worked with Grand County and LBD to coordinate voluntary bypasses ("Voluntary Water") from its Moffat Collection System to benefit the aquatic environment, targeting Ranch Creek and tributaries. No voluntary water was made available to LBD in 2018, 2019 or 2020 due to planned maintenance bypass operations, which increased bypasses without the need to trigger voluntary water releases. Denver Water's 2021 LBD in-season operations are summarized in **Attachment D**.

Mainstem Colorado Calls

As previously stated, the Shoshone Power Plant experienced a season-long outage from April 5th through October 19th 2021. Causes included bearing failure in April, debris flows brought about by locally intense rain events on the Grizzly Creek fire scar in July and August, and removal of rockfall in the diversion tunnel in October. The Shoshone Outage Protocol (ShOP) was in effect in early April and for most of the summer. The Cameo administrative Call came on July 11th, and remained on until Xcel brought Shoshone back online on October 20th.

Granby Operations

Releases below Granby Reservoir are dictated by the 1961 Operating Principles. Late season water supply flexibility is provided below Granby through the availability of 5,412.5 af (5412 water) to the Recovery Program. During wet years, 5412 water can be released from Granby Reservoir and exchanged after August 1st into Green Mountain, Williams Fork and/or Wolford Mountain Reservoirs for later release to the 15-mile reach in the Grand Valley to benefit the Endangered Fish. The 5412 releases aid in maintaining a 75 cfs flow at the USGS Granby gage in August and September for the benefit of the cold-water fishery. The release schedule is determined by the US Fish and Wildlife Service, with input from other entities, including Grand County, Northern Water, and LBD.

In 2021, dry conditions dictated a mid-July release of the 5412 water from Granby Reservoir to benefit the 15-mile reach (see **Figure 25**). 5412 releases maintained 75 cfs in August and 60 cfs through mid-September below Granby Reservoir. Williams Fork, Wolford Mountain, and Green Mountain Reservoir operations are shown in **Figures 20 through 22**.

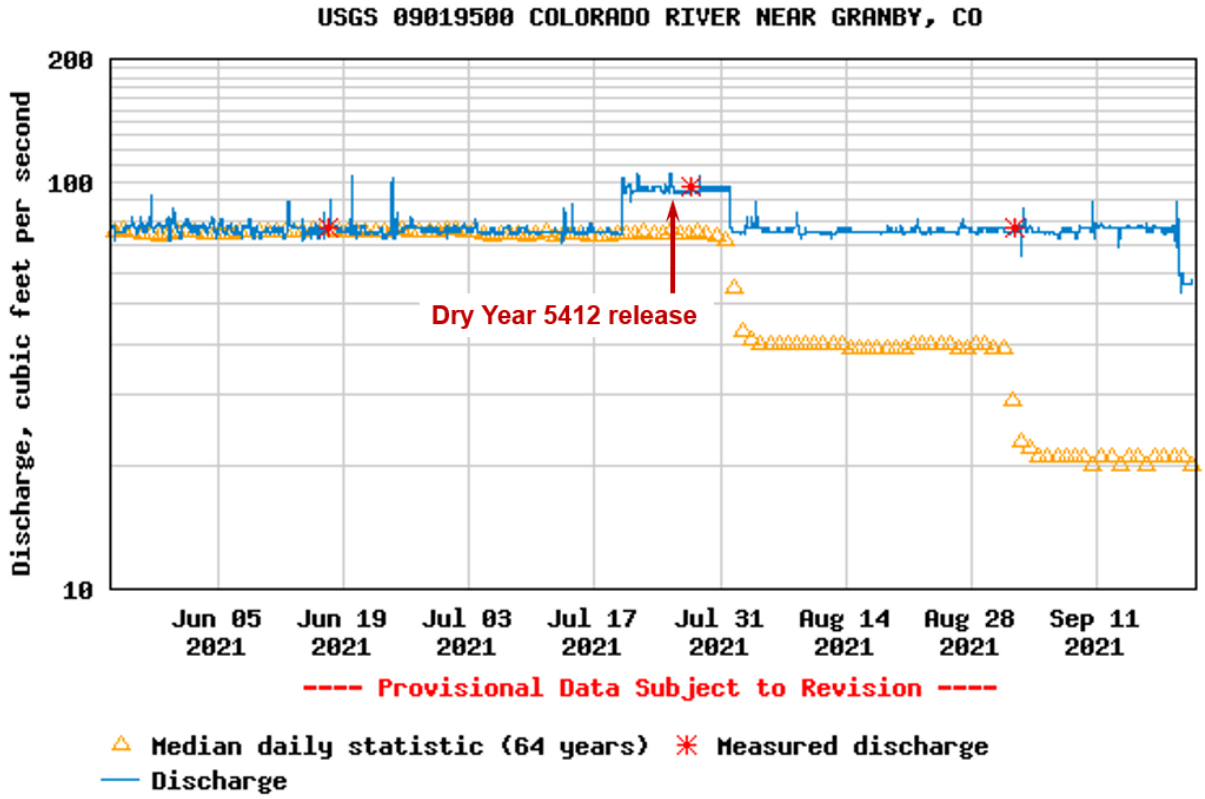


Figure 28: USGS Streamflow Colorado River near Granby (Y-gage)

Grand Lake Clarity and Operations in the Three Lakes

The Grand Lake Clarity season extends from July 1 to September 11. At the start of the clarity season, Adams Tunnel diversions were kept low to maintain a positive hydraulic gradient from Grand Lake to Shadow Mountain Reservoir. However, water temperatures in Shadow Mountain Reservoir began to climb, indicating favorable conditions for an algae bloom. At this point, a collective decision was made to resume pumping at the Farr Pump Plant and the associated increase in Adams Tunnel diversions to cool Shadow Mountain Reservoir. Throughout the clarity season, pumping was decreased on weekends and increased during the weekday, as this pattern has shown to maintain clarity in Grand Lake (**Figure 29**).

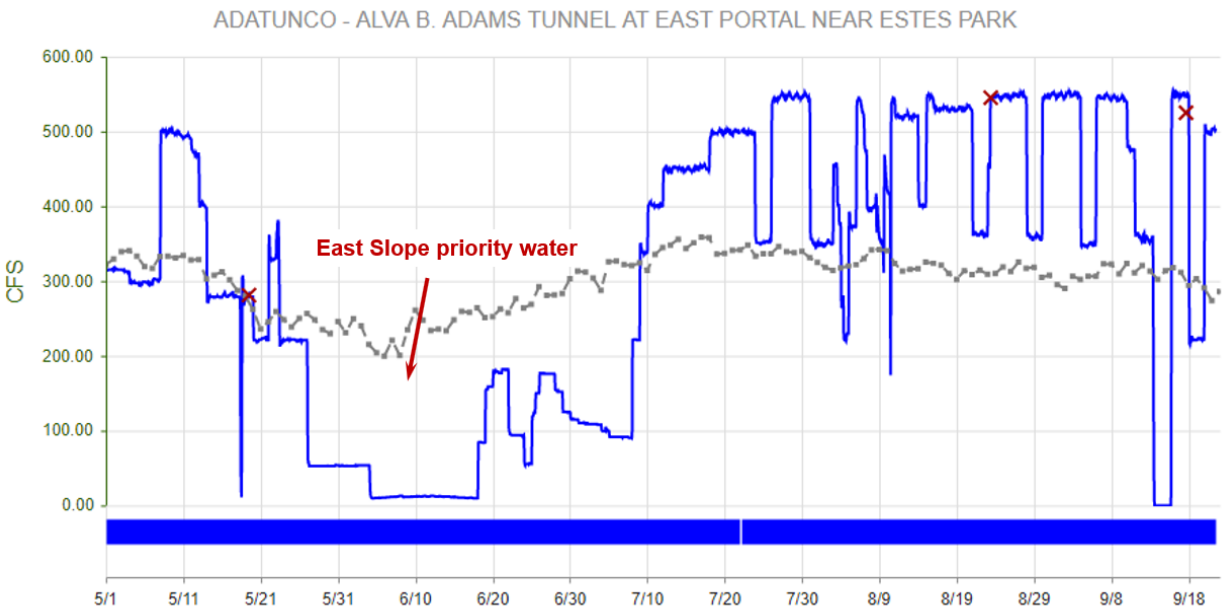


Figure 29: 2021 Adams Tunnel Diversions

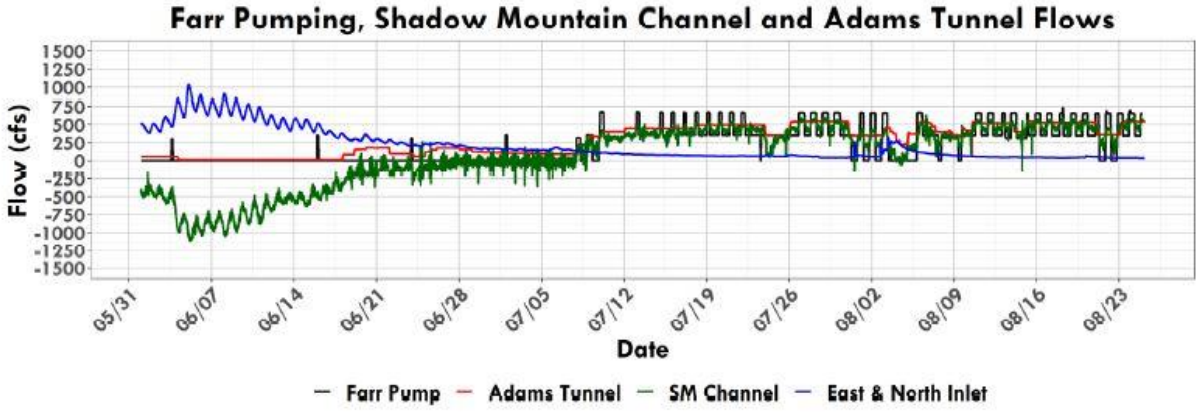
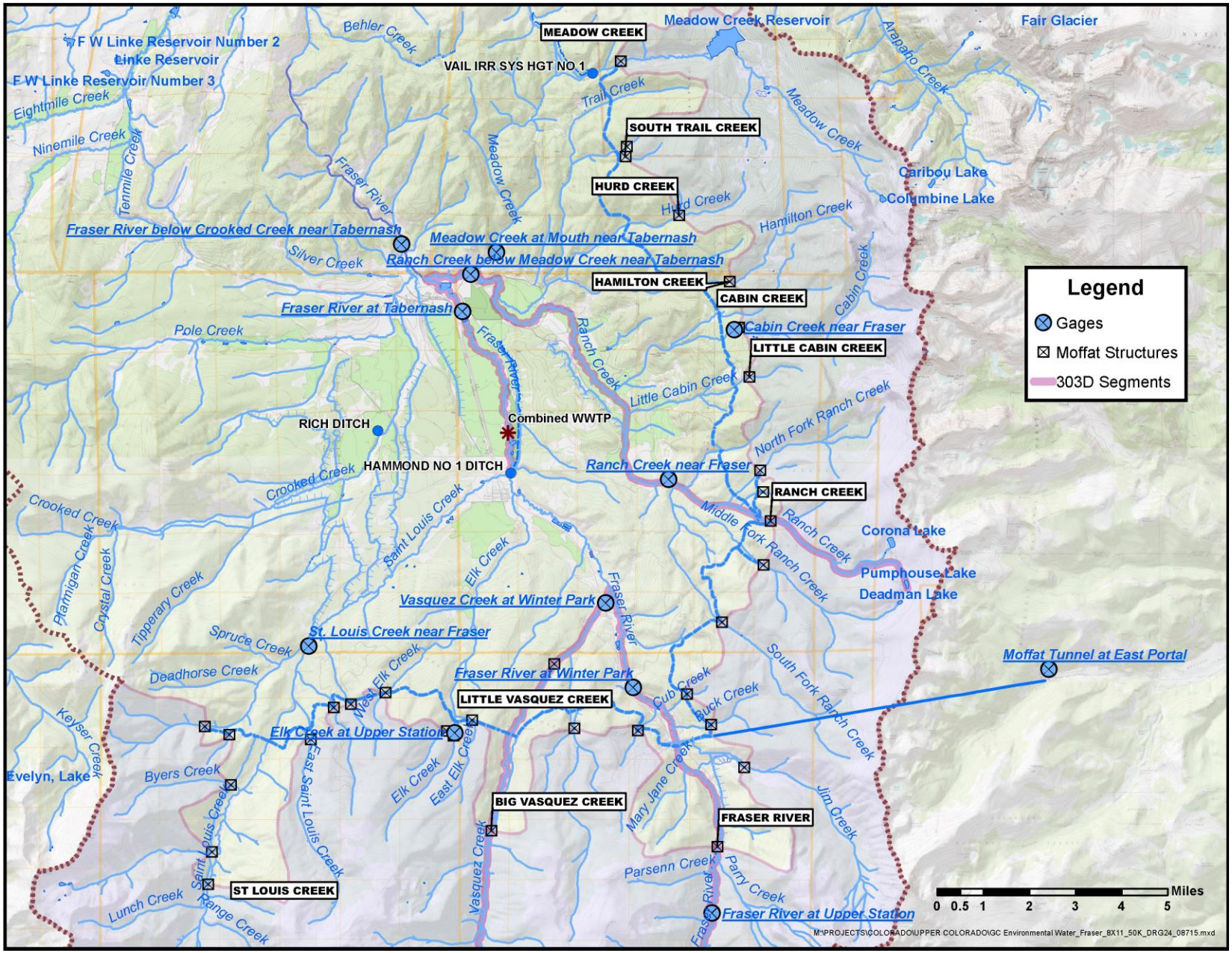
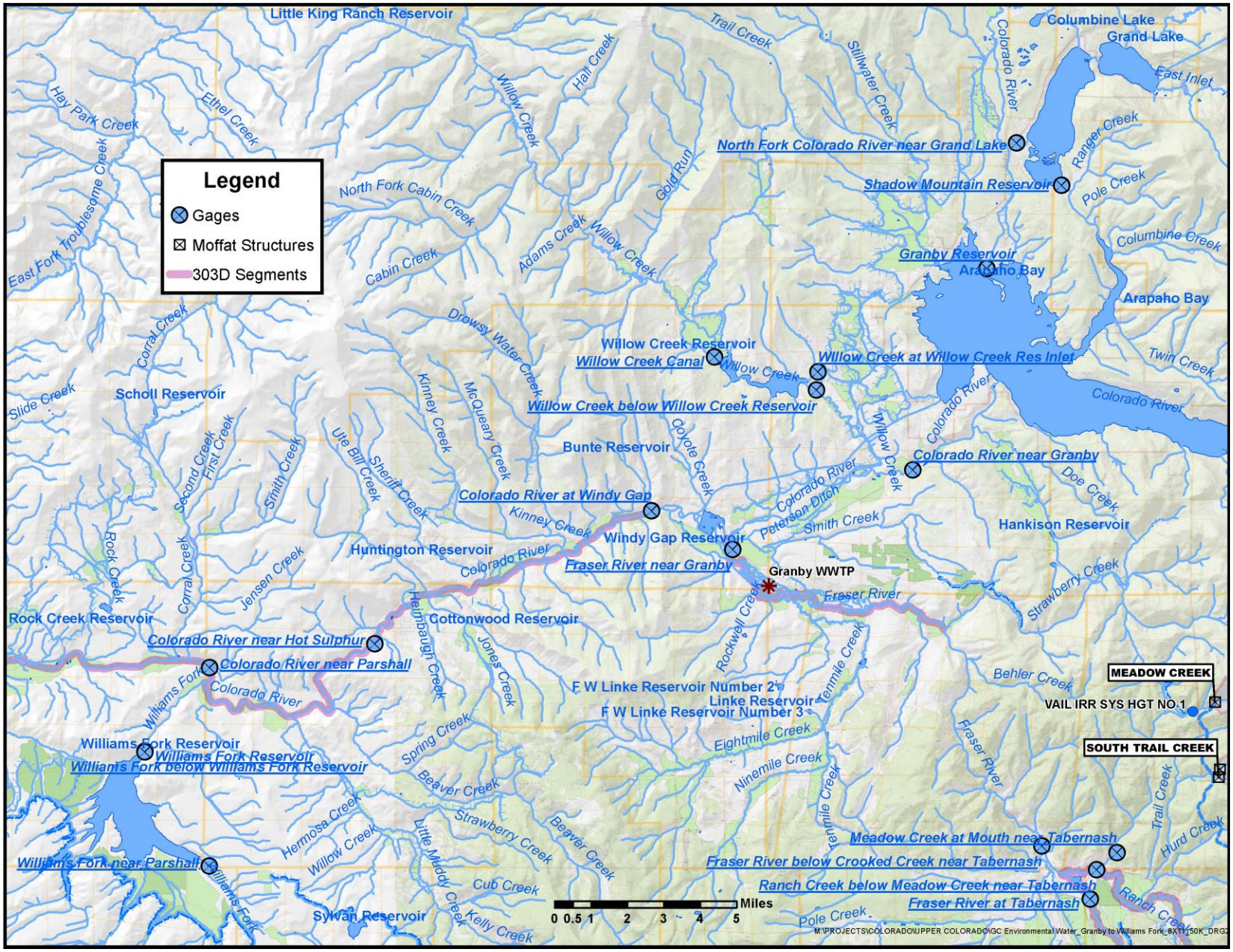


Figure 30: Farr Pumping, Adams Tunnel Diversions, Shadow Mountain Flows and East & North Inlet Combined Inflow for the 2021 Grand Lake Adaptive Management Season

Attachment A: Map of Fraser River Collection System



Attachment B: Map of Colorado River from Granby Reservoir to Williams Fork



Attachment C

LBD Water Sources and Quantities Offering Flexibility

1. Moffat Collection System Voluntary/Enhancement Water

- 1,000 af environmental bypass
- Surplus water not needed in a given year by Denver Water

2. Northern/Subdistrict Water

- Grand County's Water Supply
    - Variable Supply - 3.8% of Windy Gap Pumping in excess of 15,000 af, up to 1,500 af
    - MPWCD transfer water – Potential August 1 transfer equal to unused portion of Middle Park's Annual Water Supply (up to 2,300 af) from prior Windy Gap accounting year (only half of the unused water available for transfer prior to completion of Chimney Hollow Reservoir)
    - End of year pumping if Subdistrict pumping complete, must pay power costs for pumping (DW allocated $1M pumping fund)
    - Storage capacity:
        - Before Chimney Hollow completion – 7,500 af, if unused capacity available
        - After Chimney Hollow completion - 4,500 af in Granby Reservoir, if unused capacity available, with ability to share MPWCD's storage if both agree
- MPWCD's Water Supply
    - Variable Supply - 3.8% of Windy Gap Pumping in excess of 15,000 af, up to 1,500 af (estimated long-term average yield of 700 af)
    - Storage capacity of 3,000 af in Granby Reservoir, if unused capacity available

3. Endangered Fish Water

- 5,412.5 af for endangered fish. US Fish and Wildlife Service (FWS) can call for this water. The water may be released from Granby after August 1st during wet years, and exchanged into Green Mountain, Williams Fork and/or Wolford Reservoir, until FWS asks for the release to the 15-mile reach. Releases depend on the type of hydrologic year and the targeted streamflow in the Colorado River in the 15-mile

reach. These releases are coordinated with Grand County and other interested parties during the HUP calls, benefiting the stream segment below Granby Reservoir. The typical release schedule aids in maintaining a 75 cfs flow at USGS Granby gage from Aug 1 through mid-September

4. Williams Fork Reservoir Storage

- 1,000 af environmental water (CRCA) stored when 1,000 af environmental water is bypassed during a mainstem Colorado River Call. 2,500 af maximum carryover, first to spill, notification of anticipated spill

Attachment D

Denver Water Learning By Doing Operations
2021 Summary of Denver Water's Water Releases to Benefit the Fraser River Basin

Learning By Doing Operations

2021 Summary of Denver Water's Water Releases to Benefit the Fraser River Basin

Learning By Doing (LBD) Operations Subcommittee calls began early in 2021 due to observed low flows and high-water temperatures in the Colorado River. April 1st runoff projections were less than optimistic for the Colorado and South Platte River Basins. Snowpack conditions were below normal throughout Denver Water's collection system. South Platte River snowpack was 92% of normal and Colorado River snowpack was 89% of normal. The most probable streamflow forecasts ranged from 66% to 92% of average; by April, forecasts on the west slope did not change from March predictions while east slope forecasts increased 10-15%. Reservoir storage was 77% full, average for April is 79% full. Forecasted peak reservoir storage ranged from 83% full in dry conditions to 100% full in wetter conditions with 92% full being most probable. As a result, Denver Water predicted that many of its reservoirs would have limited extra water for spills[1] (un-diverted flows) if they filled at all. Therefore, in April Denver Water projected very limited opportunities for spills on the Moffat Collection System.

May 2021 did not bring relief to the water users. The weather was cool and wet but did not increase snowpack much and the May forecasted runoff for Denver Water's collection system decreased by 10% on the west slope and only increased by 2 to 5% on the east slope as compared to the April forecast. Williams Fork Reservoir and Dillon Reservoir were not projected to fill and a 45,000 AF Substitution was anticipated. The last time a Substitution occurred was 2013 (see Table 5 below). Denver Water was able to start storing runoff water native to South Boulder and Ralston creeks on the east slope in Gross and Ralston reservoirs. Additionally, Denver Water started planning for two maintenance projects that would impact Moffat Collection System operations. The first – Moffat Tunnel East Portal outlet structure improvements – was scheduled to take place from late August through the beginning of November 2021 and required the Moffat Tunnel to halt diversions. The second – Ralston Reservoir outlet works replacement project – was scheduled for the winter of 2021/2022. This project began in October 2021 and will continue until March 2022 and requires the draining of Ralston Reservoir.

By early June, stream temperatures in the Colorado River at and below Kremmling were observed to be near or above the state's stream temperature standards for aquatic life, stream flows were at historic lows, and ambient temperatures were at all-time highs. The LBD partners reacted quickly and cooperatively to address these dire early season conditions to protect aquatic life. In response, a swift mitigation effort transpired. On June 5, the Colorado River District alerted the LBD partners of the concerning Colorado River conditions and made a call to action for the water management entities to forego diversions and allow for additional bypass flows that would permit excess water to continue naturally downstream, increasing river flow to the distressed section of the Colorado River at and below Kremmling. Within 24 hours, additional water was bypassed by Denver Water, Northern Water, and the Colorado River District to increase stream flows despite reservoirs not being full. These additional water releases were made by Northern Water at Windy Gap Reservoir, Denver Water at the Moffat Collection System, and the River District at Wolford Mountain Reservoir. Beginning on Monday, June 14, Denver Water increased flows from Williams Fork Reservoir to provide additional water for the Colorado River. Denver Water timed the releases to maximize higher volumes of the cooler reservoir water to reach the

[1] Denver Water classifies "un-diverted" water as a "spill". This water is not diverted and allowed to pass downstream of the diversion point. Table 1 of this report list the different types of spills Denver Water experiences during operation of the water collection system.

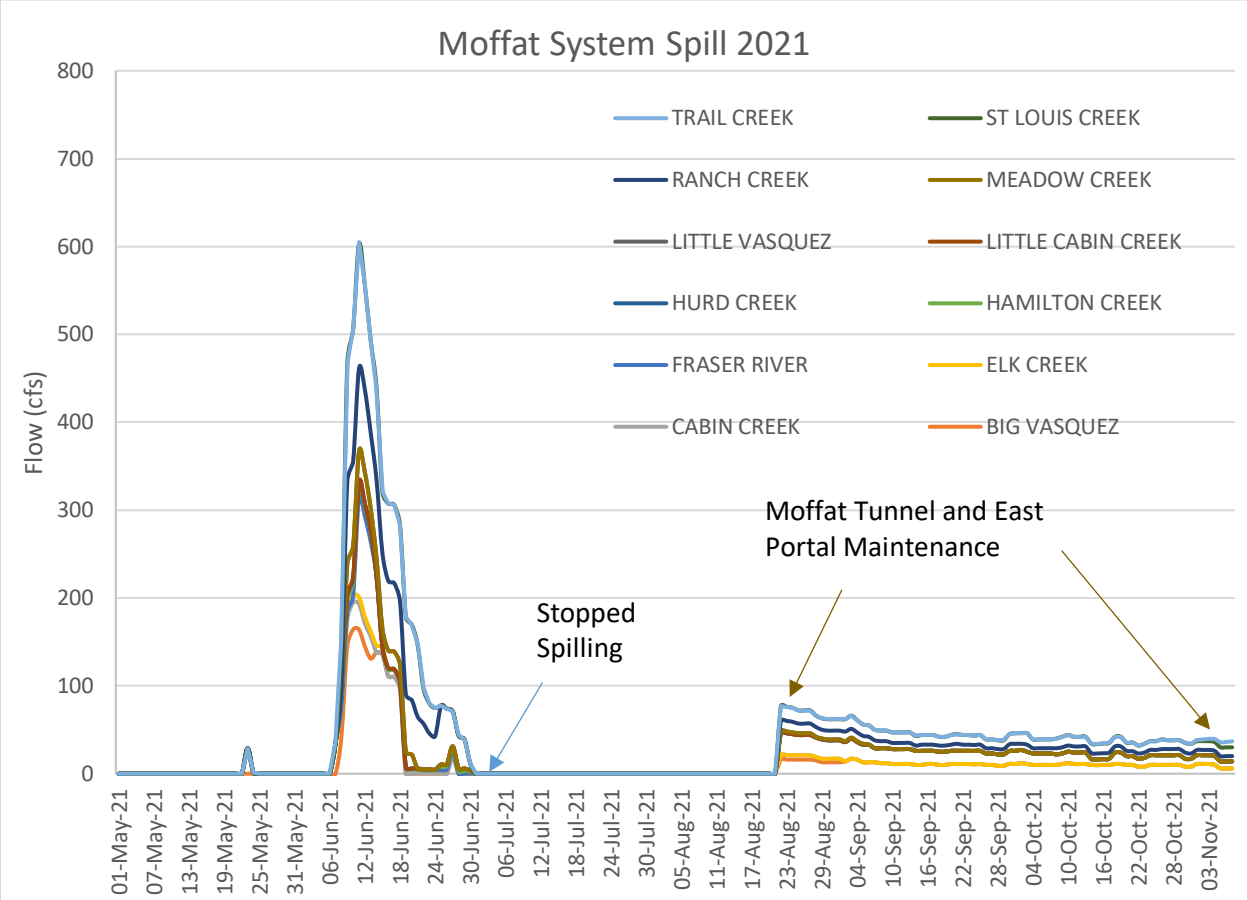
downstream Colorado River reach during the warm ambient daily temperatures and to minimize smaller releases at night, which continued to provide benefit by adding additional flows downstream. This additional bypass water increased stream flows and helped decrease the stream temperature[2] (Table 1). As a result of these additional bypass flows, Denver Water missed filling Williams Fork Reservoir by an additional volume.

The lower-than-average runoff and subsequent lower than average stream flows also resulted in 2021 being a substitution year. While summer rains brought some relief, Denver Water owed approximately 33,500 AF and Colorado Springs Utilities owed approximately 4,000 AF to Green Mountain Reservoir first fill. The substitution amount was finalized in early September 2021, although water releases from Wolford Mountain and Williams Fork reservoirs began on August 21, 2021. Subsequent releases were made from Ruedi, Homestake, and Upper Blue reservoirs. Appendix 4 shows the releases and dates from each of the reservoirs.

Following LBD calls in the spring, the first official LBD Operations Subcommittee call of 2021 was held on May 12, 2021 and discussion included expected spring operations and forecasted spills. In addition to the releases made prior to filling Gross and Ralston reservoirs, Denver Water began spilling the Moffat Collection System on June 7 starting with Cabin Creek, Hurd Creek, and Hamilton Creek diversions. Ranch Creek, St. Louis Creek, Vasquez Creek, and the Fraser River soon followed. Gross and Ralston[3] reservoirs filled in early July and Denver Water matched water diversions to water demands in its Moffat Collection System. Approximately 11,000 AF was spilled from the Moffat Collection System between June 7 and June 30. As the year transitioned from Spring runoff to Summer flows, precipitation decreased and air temperature increased, and drought conditions began settling in across Colorado. This led to decreased flows throughout the collection system during the summer.

Operations at Williams Fork Reservoir were also impacted by the dry warm weather in the spring. Despite not being projected to fill, Denver Water bypassed inflow to boost streamflow and lower stream temperature in the Colorado River near Kremmling. Outflows at Williams Fork Reservoir were increased in the morning to 115 to 120 cfs and then lowered at night to 17 cfs (348 AF). The intent was to release more cold water from the bottom of Williams Fork Reservoir during the daytime when air temperature and water temperature were the highest, and less at night when cooler temperatures were present. Denver Water made these changes for 8 days.

[2] A complete summary of these efforts can be found in the 2021 LBD Operations Summary.
[3] The capacity of Ralston Reservoir was limited in 2021 due to a maintenance project on the primary spillway.



For a second time during the summer of 2021, water management entities involved in the LBD Operations Subcommittee were engaged in actions to address stream flows and water temperatures in Grand County. LBD partners tracked a rise in water temperature on Ranch Creek, a tributary of the Fraser River near Tabernash. In response, beginning August 2, Denver Water voluntarily bypassed 420 AF of water through August 18, 2021 at the request of LBD. Denver Water began to bypass all diversions in the Moffat Collection System to accommodate work on the Moffat Tunnel from August 22 to November 7, 2021. 7,104 AF of additional water was spilled due to the work on the Moffat Tunnel.

While not impacting streamflows, the Cabin Creek Aquatic Organism Passage (AOP) project began in mid-August and completed at the end of September 2021 and required the closing of FS 128 (aka "Water Board Road"). The installation of the AOP culvert will allow native Colorado River Cutthroat Trout to migrate upstream under FS 128. This project was undertaken by LBD with Denver Water crews installing the culvert, USFS completing the design and permitting, and LBD purchasing the culvert and other materials using grant funding.

When planning for the 2021 runoff and summer operations in early spring, Denver Water anticipated a below average runoff and limits on diversions due to the construction project on the Moffat Tunnel. Therefore, DW made the decision that no voluntary water releases would be made in 2021.[4]

Table 1. 2021 Summary of Denver Water's additional bypass flows for spills, voluntary, and maintenance.

Dates	Duration	DW Diversion Location	Total Amount of Water Bypassed (AF)[1]
6/7/2021 to 6/30/2021[2]	24 days	Moffat Collection System (i.e Cabin Creek, Hurd Creek, Hamilton Creek, Ranch Creek, St. Louis Creek, Vasquez Creek, and the Fraser River)	11,000
6/15/2021 to6/22/21 [2]	8 days	Williams Fork Reservoir	348
8/2/2021-8/19/2021[2]	17 days	Ranch Creek	420
8/22/2021 to 11/7/2021[3]	78 days	Moffat Collection System (all)	7,104
TOTAL			**18,872**

1 - Does not include USFS-required bypass flows at Denver Water's diversions
2 – In cooperation with LBD
3 – For Denver Water scheduled maintenance

Table 2 shows Voluntary/Environmental bypasses, Construction bypasses, and Spill bypasses from 2015 to 2021. Compared to other years, 2021 voluntary/environmental and construction bypass flows were the highest while total spills were the lowest since 2015.

[4] Denver Water bypasses or spills water for the following reasons: 1. Lack of storage and water demand on the East Slope; 2. The Moffat Collection System (piping) is at capacity; 3. Maintenance projects; 4. Voluntary releases for environmental benefit; and 5. Downstream water rights, fish flows, or delivery obligations (CRCA).

Table 2. Summary of additional bypass flows from 2015 through 2021.

Year	Voluntary/Environmental	Construction	Spill
2015	500	---	41,000
2016	119	1,279	64,000
2017	613	1,050	39,000
2018	---	950	17,000
2019	---	100	42,000
2020	---	1,939	21,000
2021	768	7,104	11,000

FLUSHING FLOWS

The Grand County Mitigation and Enhancement Coordination Plan (MECP), U.S. Forest Service (USFS) Off-license Agreement, and Section 404 Permit for the Moffat Project (a.k.a., Gross Reservoir Expansion Project) all have flushing flow requirements. In 2021, these flows were met or exceeded at Fraser River, Vasquez Creek, St. Louis Creek, Ranch Creek, Steelman Creek, Bobtail Creek and McQueary Creek (see table "Attachment 1 – 2021 Flushing Flow Monitoring Report"). In 2021, flushing flows were not achieved at Cabin Creek although priority was given for it. A comparison to past years' data collected since 2018 is shown in the table "Cumulative Flushing Flow Monitoring Report" in Attachment 2.

In 2022, Denver Water will use system flexibility to target a flushing flow on Cabin Creek. Secondarily, the upper Williams Fork will be targeted.

FRASER SEDIMENT POND

Denver Water, Colorado Department of Transportation (CDOT), and Grand County entered into a participation agreement to remove accumulated sediment from the Fraser River Diversion structure in 2011 (DW Contract 500441). Table 3 shows sediment removal at this location for each year since 2013, which was the first year of sediment removal activities. Reduced sediment removal was expected in subsequent years following 2013 as a large amount of sediment had built up at the inlet to the diversion pond prior to sediment removal. Additionally, the year-to-year amount of sediment removed will vary based on hydrology conditions and the amount of traction sand applied each winter.

Table 3. Truck Loads and Amount of Sediment (Tons) removed each year from the Fraser River Diversion

Year	Truck Loads	Sediment Removed (Tons)
2013	68	680
2014	69	690
2015	55	550
2016	37	370
2017	32	320
2018	29	290
2019	33	330
2020	18	180
2021	18	180
Total	**323**	**3,410**

2020 DENVER WATER DIVERSIONS

In the future, bypass (un-diverted) water will be available every year for LBD to use. The graph and table shown in Attachments 3(a) and (b) depict Denver Water diversions based on gaged flows in the Moffat Collection System for 2020. Flows in 2021 will be provided in next year's summary. However, this historic information can be useful to LBD in order to plan where additional bypass water may be available as it shows where in the Moffat Collection System that Denver Water diverted water for a given year. A summary of 2020 Denver Water diversions is shown in Table 4. For detailed information, refer to Attachments 3(a) and (b).

Table 4. Moffat Collection System 2020 Diversions (based on canal gages)

Location	Total Volume Diverted 7/1/2020-9/30/2020 (AF)	July Average Daily Diversion Rate (cfs)	August Average Daily Diversion Rate (cfs)	September Average Daily Diversion Rate (cfs)
Jones Pass to Vasquez Creek	3,130	34	11	6
Vasquez Diversion	3,176	33	10	8
St. Louis Creek to Elk Creek Diversion	3,021	35	12	3
Little Vasquez and Cooper Creek Diversions	1,158	11	5	3
Meadow Creek Direct Diversion	0	0	0	0
Meadow Creek Storage Release	0	0	0	0
Trail Creek to Little Cabin Creek Diversion	0	0	0	0
North Ranch to Buck Creek Diversion	0	0	0	0
Fraser River and Jim Creek Diversions	2,712	31	7	6

2021 GREEN MOUNTAIN SUBSTITUION

Prior to 2021, there were four substitution years (2002, 2003, 2012, and 2013) with 2021 being the second largest amount of water at almost 40,000 AF (Table 5). The timing and location of water releases made for the substitution can benefit streams in Grand County. In 2021 10,000 AF was released from Williams Fork Reservoir (August 21 and September 24, 2021), and 22,963 AF from Wolford Mountain Reservoir (August 21, 2021 and October 21, 2021). Attachment 4 shows the release dates and amount of water each reservoir contributed to the 2021 substitution.

Table 5. Total Substitution (Denver Water and Colorado Springs Utilities) amounts by Year.

Year	Amount (AF)
2002	31,747
2003	30,320
2012	39,786
2013	8,487
2021	37,818

Attachment 1 – 2021Flushing Flow Monitoring Report

Fraser and Upper Williams Fork River Basins

ANNUAL FLUSHING FLOW MONITORING - 2021

Report Date: November 1, 2021

Year Type: **DRY**

Waterbody	Measuring Location	Flushing Flow Mean Daily Discharge (cfs)	Dates Flow was at or above Flushing Flow Target	Flushing Flow (mean daily flow) Achieved for a Minimum of 72 Hours?
Fraser River Basin				
Fraser River at Winter Park	USGS 0902400	80	6/11-6/13[1]	YES
Vasquez Creek at DW Diversion	broad-crested weir on diversion	50	6/9-6/18	YES
Ranch Creek near Fraser	USGS 09032000	40	6/4-6/6, 6/9-6/27	YES
Cabin Creek near Fraser	USGS 09032100	40	None[2]	NO
St. Louis Creek near Fraser	USGS 09026500	70	6/8-6/14, 6/16-6/20	YES
Williams Fork River Basin				
Steelman Creek	Williams Fork below Steelman Creek - USGS 09035500	At least 35 cfs	6/6-6/11 (above 140 cfs all diversion spilling)	YES
Bobtail Creek		At least 80 cfs	6/6-6/11 (above 140 cfs all diversion spilling)	YES
McQueary Creek		At least 25 cfs	6/6-6/11 (above 140 cfs all diversion spilling)	YES

1 - Spill limited to accommodate WPRA construction project for Fraser River Pump and Pipeline facilities.
2 - Cabin Creek was prioritized for a flushing flow in 2021 but natural inflows were insufficient and so the target flow was not met.

Attachment 2 – Cumulative Flushing Flow Monitoring Report

Fraser and Upper Williams Fork River Basins

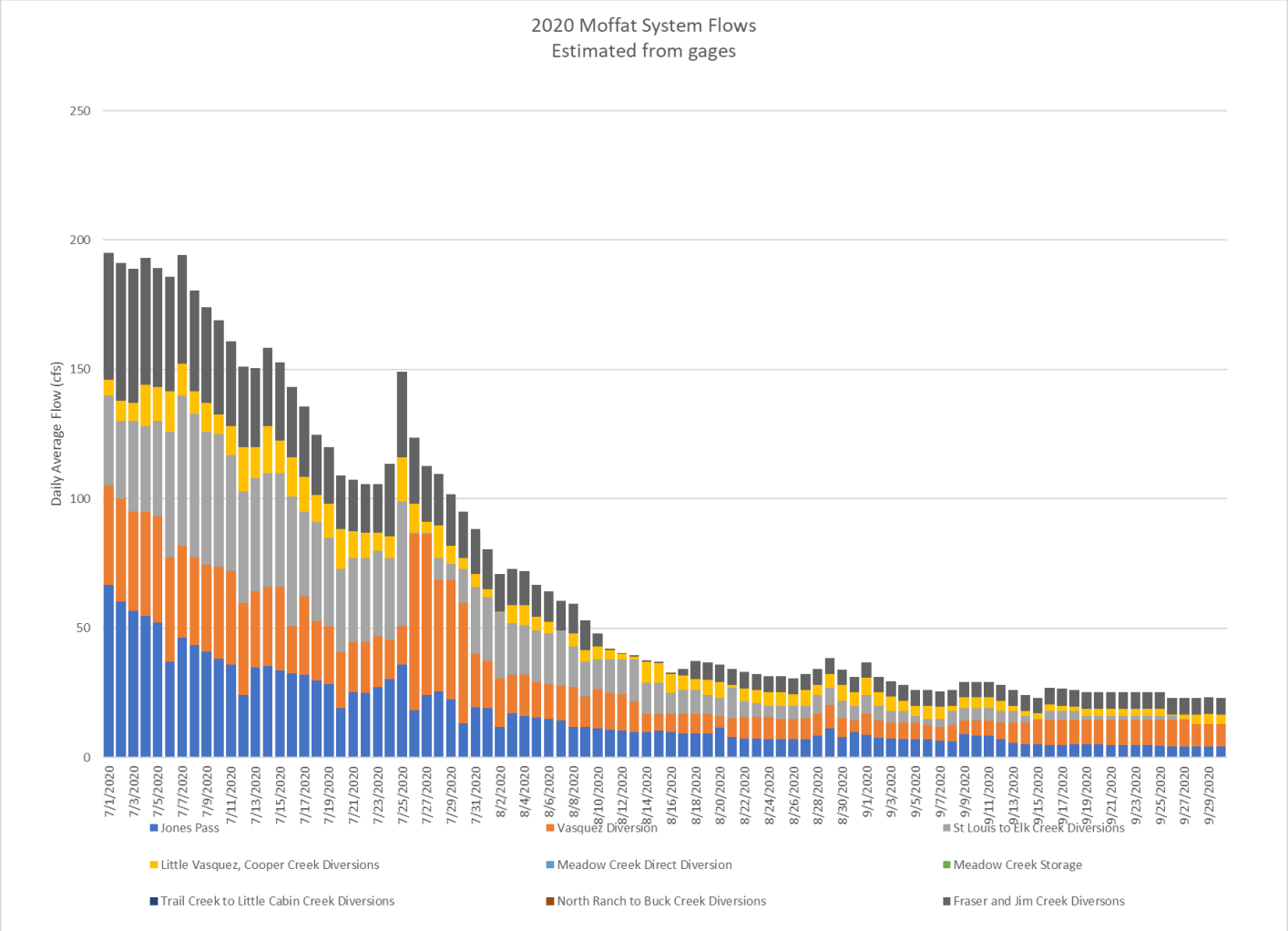
FLUSHING FLOW MONITORING (2018-2021)

Cumulative Reporting (Target: 4 out of 10 years)

Waterbody	Flushing Flow Mean Daily Discharge (cfs)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Summary
		Flushing Flow Achieved?											
Year Type		Dry	Wet	Norm	Dry								
		Fraser River Basin											
Fraser River at Winter Park	80	YES	YES	YES	YES								4 of 4 years
Vasquez Creek at DW Diversion	50	YES	YES	YES	YES								4 of 4 years
Ranch Creek near Fraser	40	YES	YES	YES	YES								4 of 4 years
Cabin Creek near Fraser	40	NO	YES	NO	NO								1 of 4 years
St. Louis Creek near Fraser	70	YES	YES	YES	YES								4 of 4 years
		Williams Fork River Basin											
Steelman Creek	At least 35	YES	YES	NO	YES								3 of 4 years
Bobtail Creek	At least 80	YES	YES	NO	YES								3 of 4 years
McQueary Creek	At least 25	YES	YES	NO	YES								3 of 4 years

Attachment 3(a) – Daily Denver Water Diversions from several locations in the Moffat Collection System (July 1, 2020 to September 30, 2020)

2020 Moffat Collection System Estimated Diverted Flows



Attachment 3(b) – Daily Denver Water Diversions from several locations in the Moffat Collection System (July 1, 2020 to September 30, 2020) Note – some of these values are calculated based upon diversion at other locations.

Date	Jones Pass	Vasquez Creek	St. Louis Creek to Elk Creek	Little Vasquez, Cooper Creeks	Meadow Creek Direct	Meadow Creek Storage Release	Trail Creek to Little Cabin Creek	North Ranch to Buck Creek	Fraser River and Jim Creek	East Portal Moffat Tunnel
7/1/2020	67	38	35	6	0	0	0	0	49	195
7/2/2020	60	40	30	8	0	0	0	0	53	191
7/3/2020	57	38	35	7	0	0	0	0	52	189
7/4/2020	55	40	33	16	0	0	0	0	49	193
7/5/2020	52	41	37	13	0	0	0	0	46	189
7/6/2020	37	41	49	16	0	0	0	0	44	186
7/7/2020	46	35	58	12	0	0	0	0	42	194
7/8/2020	43	34	56	9	0	0	0	0	39	181
7/9/2020	41	34	51	11	0	0	0	0	37	174
7/10/2020	38	36	51	8	0	0	0	0	37	169
7/11/2020	36	36	45	11	0	0	0	0	33	161
7/12/2020	24	35	43	17	0	0	0	0	31	151
7/13/2020	35	29	44	12	0	0	0	0	31	151
7/14/2020	35	30	44	18	0	0	0	0	31	159
7/15/2020	34	32	44	12	0	0	0	0	31	153
7/16/2020	32	18	50	15	0	0	0	0	27	143
7/17/2020	32	30	33	14	0	0	0	0	27	136
7/18/2020	30	23	38	11	0	0	0	0	23	125
7/19/2020	28	23	34	13	0	0	0	0	22	120
7/20/2020	19	21	32	15	0	0	0	0	21	109
7/21/2020	25	20	32	11	0	0	0	0	20	108
7/22/2020	25	20	32	10	0	0	0	0	19	106
7/23/2020	27	20	33	7	0	0	0	0	19	106
7/24/2020	30	15	32	8	0	0	0	0	28	113
7/25/2020	36	15	48	17	0	0	0	0	33	149
7/26/2020	18	68	1	11	0	0	0	0	26	124
7/27/2020	24	62	1	4	0	0	0	0	22	113
7/28/2020	25	43	8	13	0	0	0	0	20	110
7/29/2020	22	46	6	7	0	0	0	0	20	102
7/30/2020	13	47	13	4	0	0	0	0	18	95
7/31/2020	19	21	26	5	0	0	0	0	17	88
8/1/2020	19	18	25	3	0	0	0	0	15	80
8/2/2020	12	19	26	1	0	0	0	0	15	71

Attachment 3(b) – Daily Denver Water Diversions from several locations in the Moffat Collection System (July 1, 2020 to September 30, 2020) Note – some of these values are calculated based upon diversion at other locations.

Date	Jones Pass	Vasquez Creek	St. Louis Creek to Elk Creek	Little Vasquez, Cooper Creeks	Meadow Creek Direct	Meadow Creek Storage Release	Trail Creek to Little Cabin Creek	North Ranch to Buck Creek	Fraser River and Jim Creek	East Portal Moffat Tunnel
8/3/2020	17	15	20	7	0	0	0	0	14	73
8/4/2020	16	16	19	8	0	0	0	0	13	72
8/5/2020	15	14	20	6	0	0	0	0	12	67
8/6/2020	15	14	20	5	0	0	0	0	12	64
8/7/2020	14	13	21	0	0	0	0	0	12	61
8/8/2020	12	15	16	5	0	0	0	0	12	60
8/9/2020	12	12	13	5	0	0	0	0	12	53
8/10/2020	11	15	12	5	0	0	0	0	5	48
8/11/2020	11	14	13	4	0	0	0	0	1	42
8/12/2020	10	14	14	2	0	0	0	0	1	41
8/13/2020	10	12	16	1	0	0	0	0	1	40
8/14/2020	10	7	12	8	0	0	0	0	1	38
8/15/2020	10	7	12	8	0	0	0	0	1	37
8/16/2020	10	7	8	7	0	0	0	0	1	33
8/17/2020	9	8	9	6	0	0	0	0	3	34
8/18/2020	9	8	9	4	0	0	0	0	7	37
8/19/2020	9	8	7	6	0	0	0	0	7	37
8/20/2020	12	4	7	6	0	0	0	0	7	36
8/21/2020	8	7	12	1	0	0	0	0	6	34
8/22/2020	7	8	6	5	0	0	0	0	6	33
8/23/2020	7	8	5	5	0	0	0	0	6	32
8/24/2020	7	9	4	5	0	0	0	0	6	31
8/25/2020	7	8	5	5	0	0	0	0	6	31
8/26/2020	7	8	5	4	0	0	0	0	6	31
8/27/2020	7	8	5	6	0	0	0	0	6	32
8/28/2020	8	8	7	4	0	0	0	0	6	34
8/29/2020	11	9	7	5	0	0	0	0	6	38
8/30/2020	8	7	7	6	0	0	0	0	6	34
8/31/2020	10	4	6	5	0	0	0	0	6	31
9/1/2020	9	8	7	7	0	0	0	0	6	37
9/2/2020	8	7	6	5	0	0	0	0	6	31
9/3/2020	7	6	4	6	0	0	0	0	6	30
9/4/2020	7	7	4	4	0	0	0	0	6	28
9/5/2020	7	7	2	4	0	0	0	0	6	26
9/6/2020	7	6	2	5	0	0	0	0	6	26
9/7/2020	7	5	3	5	0	0	0	0	6	26
9/8/2020	6	6	5	2	0	0	0	0	6	26
9/9/2020	9	5	5	4	0	0	0	0	6	29
9/10/2020	8	6	5	4	0	0	0	0	6	29

Attachment 3(b) – Daily Denver Water Diversions from several locations in the Moffat Collection System (July 1, 2020 to September 30, 2020) Note – some of these values are calculated based upon diversion at other locations.

Date	Jones Pass	Vasquez Creek	St. Louis Creek to Elk Creek	Little Vasquez, Cooper Creeks	Meadow Creek Direct	Meadow Creek Storage Release	Trail Creek to Little Cabin Creek	North Ranch to Buck Creek	Fraser River and Jim Creek	East Portal Moffat Tunnel
9/11/2020	8	6	5	4	0	0	0	0	6	29
9/12/2020	7	7	4	4	0	0	0	0	6	28
9/13/2020	6	8	4	2	0	0	0	0	6	26
9/14/2020	5	8	2	2	0	0	0	0	6	24
9/15/2020	5	9	0	2	0	0	0	0	6	23
9/16/2020	5	10	3	2	0	0	0	0	7	27
9/17/2020	5	10	3	2	0	0	0	0	7	27
9/18/2020	5	9	3	2	0	0	0	0	7	26
9/19/2020	5	9	1	3	0	0	0	0	7	25
9/20/2020	5	9	1	3	0	0	0	0	7	25
9/21/2020	5	10	1	3	0	0	0	0	7	25
9/22/2020	5	10	1	3	0	0	0	0	7	25
9/23/2020	5	10	1	3	0	0	0	0	7	25
9/24/2020	5	10	1	3	0	0	0	0	7	25
9/25/2020	5	10	1	3	0	0	0	0	7	25
9/26/2020	4	10	1	1	0	0	0	0	7	23
9/27/2020	4	11	0	2	0	0	0	0	7	23
9/28/2020	4	9	0	4	0	0	0	0	7	23
9/29/2020	4	9	0	4	0	0	0	0	7	23
9/30/2020	4	9	0	4	0	0	0	0	7	23

Attachment 4 – Summary of 2021 Substitution Releases.

Water Source	Release Dates	Total Amount (AF)
Wolford Mountain Reservoir	8/21 to 10/21	22,963[1]
Williams Fork Reservoir	8/21 to 9/24	10,000
Homestake Reservoir	9/2 to 10/13	2,089
Upper Blue Reservoir	10/16 to 11/25	2,025
Dillon Reservoir	TBD	1,000[2]
Total		**38,077[3]**
Ruedi Reservoir	9/13 to 10/6	1,775[4]

1 – Denver Water 22,663 AF Colorado Springs Utilities 300 AF.

2 – held for winter releases to meet minimum stream flows below Dillon Reservoir.

3 – Denver Water 35,438 AF Colorado Springs Utilities 4,414 AF. The amount owed was 37,818, but 38,077 was released to cover transit losses.

4 – The 2,000 AF insurance pool at Ruedi was used to payback various amounts to several reservoirs and reduced the amount of water physical released from those reservoirs.