2021 Upper Clark Fork River Basin Surface Water Monitoring Report

NRDP Contract 90022-TO 2.1

Prepared by the Clark Fork Coalition

Abstract

The purpose of this report is to present the results of seasonal water temperature and streamflow monitoring on the upper Clark Fork River and tributaries where existing data is lacking. Flow monitoring also occurred on in-stream flow projects, and assist with monitoring related to restoration projects.

These flow studies assist in implementing projects identified in the Natural Resource Damage Program's *Final Upper Clark Fork River Basin Aquatic and Terrestrial Restoration Plans* (Restoration Plans), updated and approved February 2019. Group 1 Projects that may supply instream flows to the area of the Clark Fork River between Galen and Deer Lodge are the highest priority. Second in priority are Group 2 projects that supply flow to Priority 1 tributaries and third in priority are Group 3 projects that supply flow to Priority 2 tributaries. In the 2019 revision to the Restoration Plan it was determined that all projects in Group 1, Group 2, and Group 3 will be investigated at the same time.

The overarching goal of the project is to better understand summer streamflow and water temperature conditions in the Upper Clark Fork River Basin. The stretch of the mainstem of the Clark Fork River between Galen and Deer Lodge and tributaries that feed it face chronic dewatering issues and typically experience the lowest flows during periods of peak demand in late July and early August. The data collected for this task order is integral to the understanding of surface water and groundwater dynamics in the most dewatered portion of the upper Clark Fork Basin.

Introduction

In accordance NRDP Contract 90022-TO 2.1, for the 2021 field season the Clark Fork Coalition (CFC) managed 11 continuous flow and temperature monitoring sites described in Table 1. These target streams have been monitored by the CFC for multiple seasons and provide valuable data on severely dewatered systems. The CFC also performed synoptic flows studies and spot measurements in Mill Creek, Gold Creek and the Clark Fork River mainstem. The purpose of the monitoring is to provide information that quantifies the impacts of low flows and high water temperatures on aquatic ecosystems in the upper Clark Fork Basin.

Upper Clark Fork River Basin Monitoring Sites	
Stream	**Site**
Lost Creek	Below Beckstead Ditch
Cottonwood Creek	Above Applegate Upper Diversion (Sherm's Corral Bridge)
	Cottonwood Creek in Deer Lodge
Dry Cottonwood Creek	Below East Side Road
Clark Fork River	Galen Road
	Below West Side Ditch
	Above Valiton ditch
	Sager Lane
Racetrack Creek	Outflow from Reservoir
	Above all Diversions (USFS)
	Below Cement Ditch

Table 1- Locations of primary monitoring sites managed by the CFC in the upper Clark Fork Basin.

The individual monitoring sites are identified in the map (Figure 11). At each CFC monitoring site, a continuous data logger (HOBO) recorded both stream stage and water temperature data at 30 minute or 60 minute intervals. The primary purpose of these data collection efforts was to quantify the magnitude and timing of water conditions on the upper Clark Fork River and priority tributaries. Water temperature data was also collected to determine if water temperatures exceeded threshold levels considered sustainable for salmonids.

In addition to the continuously monitored sites described above, the CFC also recorded data at other potential project locations in the upper Clark Fork Basin (Table 10).

1. Spot flow measurements of discharge on the Alvi Beck ditch located on Dry Cottonwood Creek Ranch. Measurements were collected at the headgate and past the fish screen to evaluate the performance of the recently install fish screen and diversion during low flow conditions.
2. Spot flow measurements occurred on the Valiton Ditch near the headgate and below the last pump to continue quantifying irrigation use at that site.
3. Spot measurements occurred on Cottonwood Creek at 4 locations in order to monitor the Applegate instream flow project and characterize pre-project ditch flows for potential fish screen/diversion project.
4. A synoptic flow study was completed on Gold Creek on 8/4/2021 to better characterize hydrologic conditions and irrigation withdrawals (Figure 12).
5. A synoptic flow study was completed on Mill Creek on 6/29/2021 to quantify the primary irrigation withdrawals (Figure 13).
6. Synoptic flows studies were completed at multiple locations on the Clark Fork River mainstem, ditches and tributaries between Warm Springs and Deer Lodge on 8/2/2021 and 8/12/2021 to assist Trout Unlimited and the NRDP with assessing the impacts of the Silver Lake release.

This report provides a narrative of streamflow and water temperature conditions observed at each of monitoring sites funded by the NRDP, as well additional pertinent locations funded by the CBWTP. The monitoring sites are summarized in Tables 1 above and are displayed in the map in Figure 11.

Methods

At each of the continuously monitored locations, streamflow and water temperature was manually measured every 2-4 weeks between June and September by CFC staff. These measurements were used to develop a rating curve for the continuous hydrographs. Individual flow measurements were tabulated using a Hach or Ott digital flow meter following standards established by the USGS (http://pubs.usgs.gov/wsp/ wsp2175/). To assure data reliability, the flow meters were calibrated monthly throughout the field season (and more frequently if needed). In accordance with the USGS measurement protocols, no individual velocity measurements in a stream cross section represented more than 10% of the total observed flow.

River stage and water temperature data was collected using data loggers that remotely recorded data at 30 or 60 minute intervals. Hobo data loggers were used at all sites during the 2021 field season.

River stage data from the HOBOs loggers was correlated to flow by developing a stage-discharge rating curve for each site. The rating curves were produced by plotting the flow measurement data against the river stage data and calculating a power function from the plotted data. Using the equation from the rating curves, river stage data was extrapolated to develop a continuous hydrograph for each site. Although the locations of monitoring sites typically remain the same from season to season, small changes to a stream's cross sectional geometry (caused by natural morphological processes) may significantly impact the accuracy of previous years rating curves. Because of this, new rating curves were generated at all of the sites for the 2021 data.

The hydrographs and thermographs contained in appendix A were constructed from the extrapolated flow data and water temperature recordings from the data loggers. Streamflow data represents daily averages; maximum daily water temperature represents the highest individual daily reading. Meteorological data was retrieved from the National Climatic Data Center (https://www.ncdc.noaa.gov/ climate-information) and Montana Climate Office (https://climate.umt.edu/).

Results

Streamflow and water temperature graphs for the 2021 monitoring season are provided in Figures 2-13.

After experiencing above average water supply conditions in 2019 and 2020, the upper Clark Fork Basin saw below average streamflows for most of the summer in 2021. March 28th peak snowpack measured at 99% of average for the Upper Clark Fork according to the NRCS SNOTEL report, however below average precipitation coupled with above average temperatures summer contributed to some of the lowest streamflows the Upper Clark Fork has experienced since 2000 based on the USGS gage at Deer Lodge.

Analysis & Conclusions

Clark Fork River
Figures 2 & 3

The Clark Fork River experienced below normal discharge in 2021, with the lowest flow of 5.0 CFS on August 2nd occurred below Sager Lane. For comparison, in 2016 flows dropped to 3.4 CFS at this location on August 5th. Despite normal snowpack, below average precipitation in June and July and above average temperatures contributed to these unusually low streamflows in 2021. Flow releases from Silver Lake into the Clark Fork River starting on August 2 coupled with multiple precipitation events allowed flows to return to average conditions through most of August and September.

Water temperatures tracked consistently across the monitoring locations although there were significant differences in the magnitude of temperatures recorded (Figure 3). Temperatures at all locations peaked late June/early July and again

in late July when thermal inputs were at a maximum. The maximum water temperature for 2021 was 25.3 degrees Celsius on June 30th below Sager Lane. Water temperatures generally decreased after August 5th following a number of precipitation events, shorter days and cooler nights.

Racetrack Creek
Figures 4 & 5

During the 2021 field season, Racetrack Creek followed a flow pattern that was similar to other area streams. After a typical snowmelt driven runoff, natural flows on Racetrack Creek began a recession toward irrigation influenced baseflow levels in early July. Due to below average precipitation and early runoff, releases from Racetrack Lake Reservoir occurred earlier than usual, starting on July 9th and extending until August 1st. The CFC telemetry station at the outlet of the dam was activated on July 13th to track outflows from the reservoir, which averaged around 12 CFS during the course of the release. CFC also actively managed a second telemetry station at Racetrack Lake that monitored lake levels in order to track the volume remaining in the reservoir during the course of the release. Flows below the Cement Ditch monitoring location persisted at about 5 CFS until August 3rd, around the same time releases from Racetrack Lake ended. Flows below the Cement Ditch generally remained depressed or close to zero through early October when fall precipitation augmented flows on Racetrack Creek. Flows were not monitored at the Edge Lane monitoring site on lower Racetrack Creek in 2021 due to abnormally low flow conditions in May-June that would have presented challenges collecting enough data to develop a rating curve.

Cottonwood Creek
Figures 6, 7 & Table 10

Flows were monitored in Cottonwood Creek at five locations for the purposes of ensuring instream flow from the Applegate flow enhancement project were maintained. An instream flow authorization of 4.76 CFS is in place from May 16th to July 14th and 1.7 CFS from July 15th to September 15th. Flows in Cottonwood Creek remained in compliance with the DNRC Change of Use Authorization; with steady flow at both sites above 4.76 CFS until July 6th and flows averaged 1.7 CFS from July 15th-Sept. 15th, although were below the 1.7 CFS value at times due to senior upstream irrigation uses. Spot measurements were also taken above and below the Applegate upper diversion after July 15th to ensure compliance, however upstream senior water right holders were utilizing all remaining flow.

Lost Creek (below Beckstead Ditch)
Figures 8 & 9

Flow measurements below the Beckstead ditch on lower Lost Creek were conducted to ensure compliance with the Lampert Ranch split-season lease, which requires that 1.93 CFS be left instream from July 1st- August 31st of each year. Flows in excess of instream right were recorded at this location for the entire summer before steadily increasing starting August 15th through the remainder of the summer and fall.

Dry Cottonwood Creek
Table 10

This site was situated on the CFC's former Dry Cottonwood Creek Ranch (DCCR) just below East Side Road in Dry Cottonwood Creek, downstream of the last diversion. Flows in Dry Cottonwood Creek were poor in 2021 and only extended from early May to early June due to little to no snowpack and precipitation. As a result CFC was unable to collect enough flow measurements to obtain a hydrograph in 2021. CFC is currently in the process of trying to convert 4.3 CFS of irrigation rights to instream flow in Dry Cottonwood Creek. For comparison Dry Cottonwood Creek flowed until August 16thin 2020.

Valiton Ditch at Headgate and Below Last Broken Circle Pump
Table 10

This is the fourth year of monitoring by the CFC on Valiton Ditch, which withdraws water from the Clark Fork River above Sager Lane and below Racetrack. Three spot measurements were conducted below the headgate and ranged from 5.5 to 9.9 CFS. In 2018, diverted flow ranged from 6-11 CFS at the headgate. A spot measurement of 4.2 CFS was taken past the last Clark Fork River Ranch pump station on June 15, 2021. The purpose of this effort was to better understand the magnitude of irrigation use at this location and assist with future planning and design for diversion improvements at this location.

Alvi Beck Ditch
Table 10

A new rock riffle diversion, pipeline and corrugated fish screen were incorporated into this ditch system in the fall of 2020. CFC staff assisted with cleaning and maintenance of the fish screen during 2021 under a separate task order. Two spot measurements were collected at the headgate and at the outlet of the fish screen to evaluate fish screen performance under low flow conditions and the quantity of flow required by the fish bypass pipe.

Gold Creek Synoptic Flow Study
Figure 12

On August 4, 2021, a synoptic flow study of Gold Creek was conducted to better assess flow conditions during peak irrigation demand. A flow of 16.9 CFS was measured above all major diversions and diminished due to the Don Beck Rabel Bridge Ditch and Don Beck Patty Fence Ditch to 9 CFS at the Don Beck Driveway Bridge. Four additional diversions downstream (Hogan, Hollenback, Thomas, Beck) resulted in the lowest flow in Gold Creek of 1.0 CFS at Wall City. Gold Creek rebounded to 15.6 CFS at the Thomas Ranch Picnic Area (below Thomas pump) just above the confluence with the Clark Fork River. There are no known tributary inputs between Wall City and the Thomas Ranch, however there is a drain ditch and return flows according to the Don Beck that contributes to the gain in flows.

Mill Creek Synoptic Flow Study
Figure 12

A synoptic flow study of ditches in Mill Creek occurred on June 29, 2020 conducted by CFC, TU and NRDP staff for the purpose of quantifying irrigation withdrawals and identifying priority locations for flow restoration. Mill Creek Irrigation Company operates 4 diversions that were collectively diverting 9.8 CFS. The other major diversions include the 2 Glen Willow ditches that were diverting 19.4 CFS in total. Total diverted flows accounted for on June 29th were 31.09 CFS. The difference in flow between the USGS gages was 48.1 CFS, which indicates there is a losing reach between the USGS gages (30%) in addition to the irrigation withdrawals.

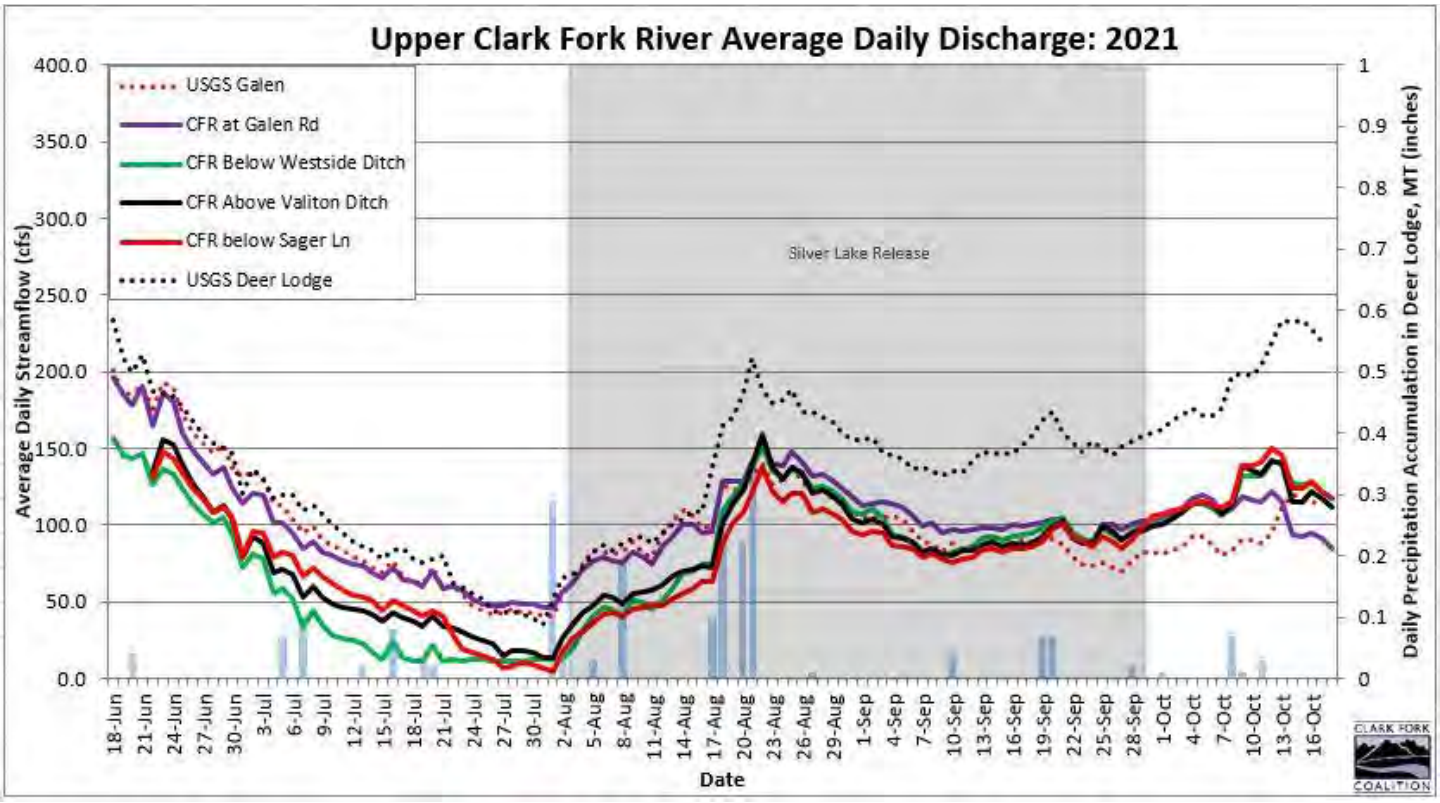

Figure 2- Upper Clark Fork average daily hydrographs for the 2021 irrigation season.

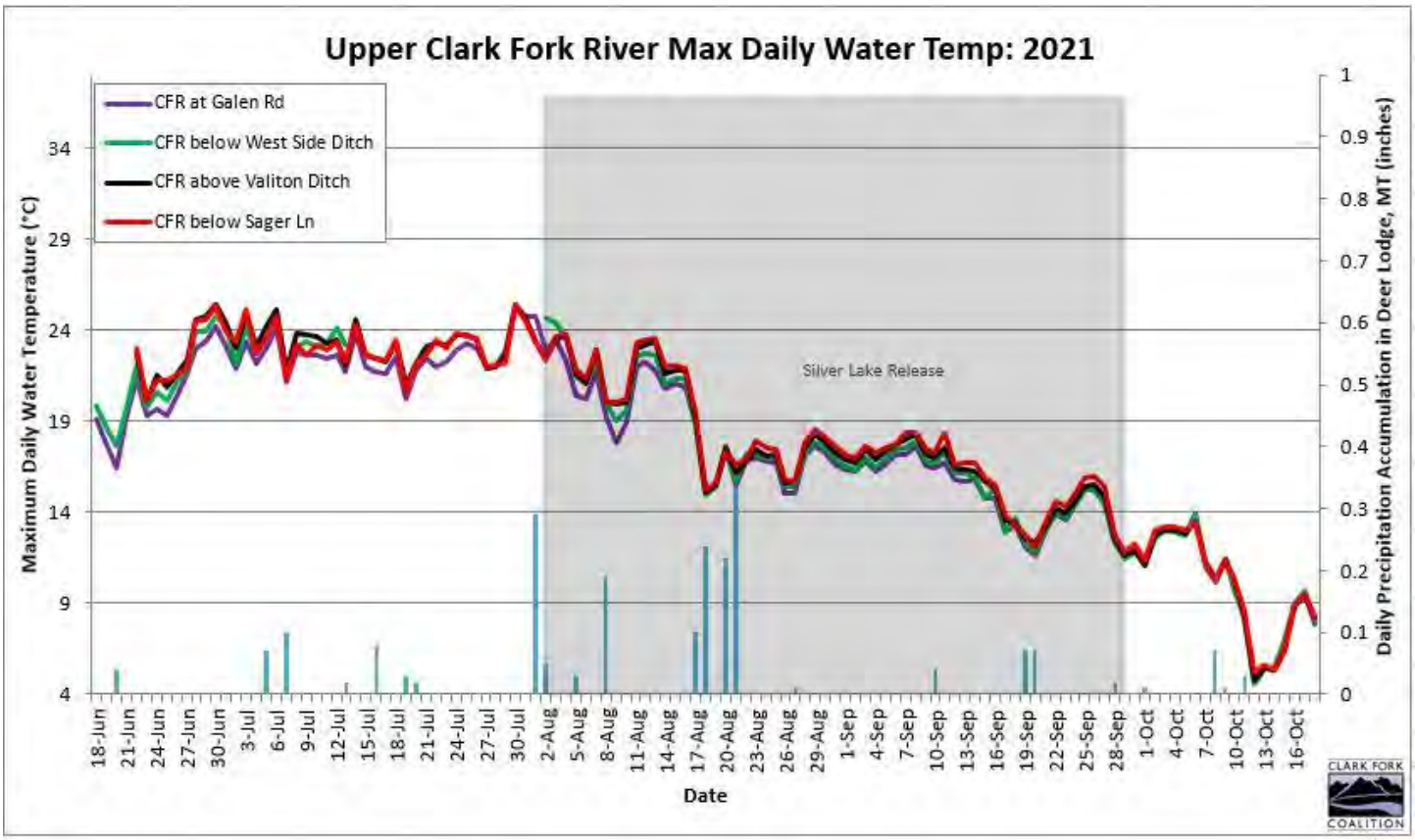

Figure 3- Upper Clark Fork maximum daily thermographs for the 2021 irrigation season.

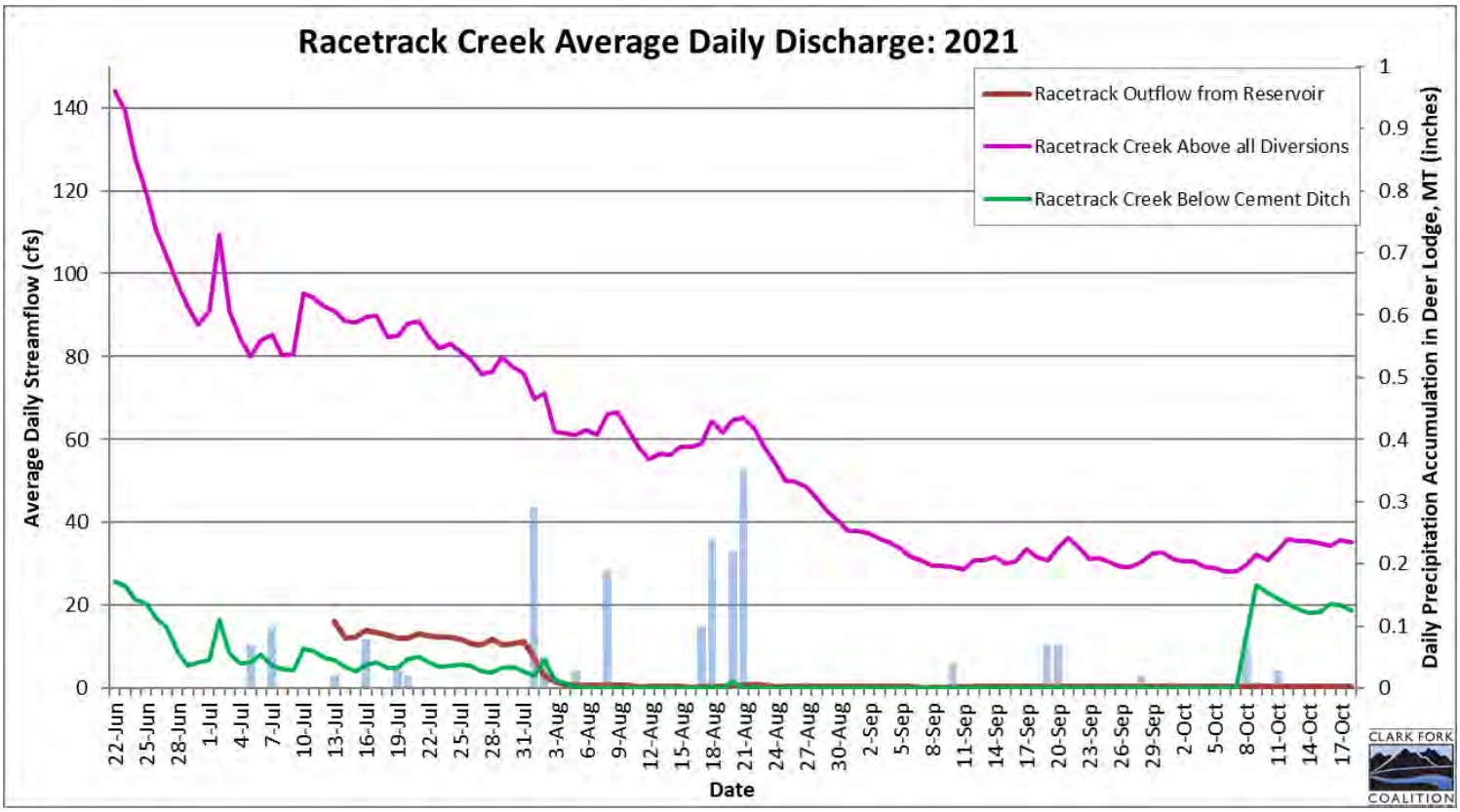

Figure 4- Racetrack Creek average daily hydrographs for the 2021 irrigation season.

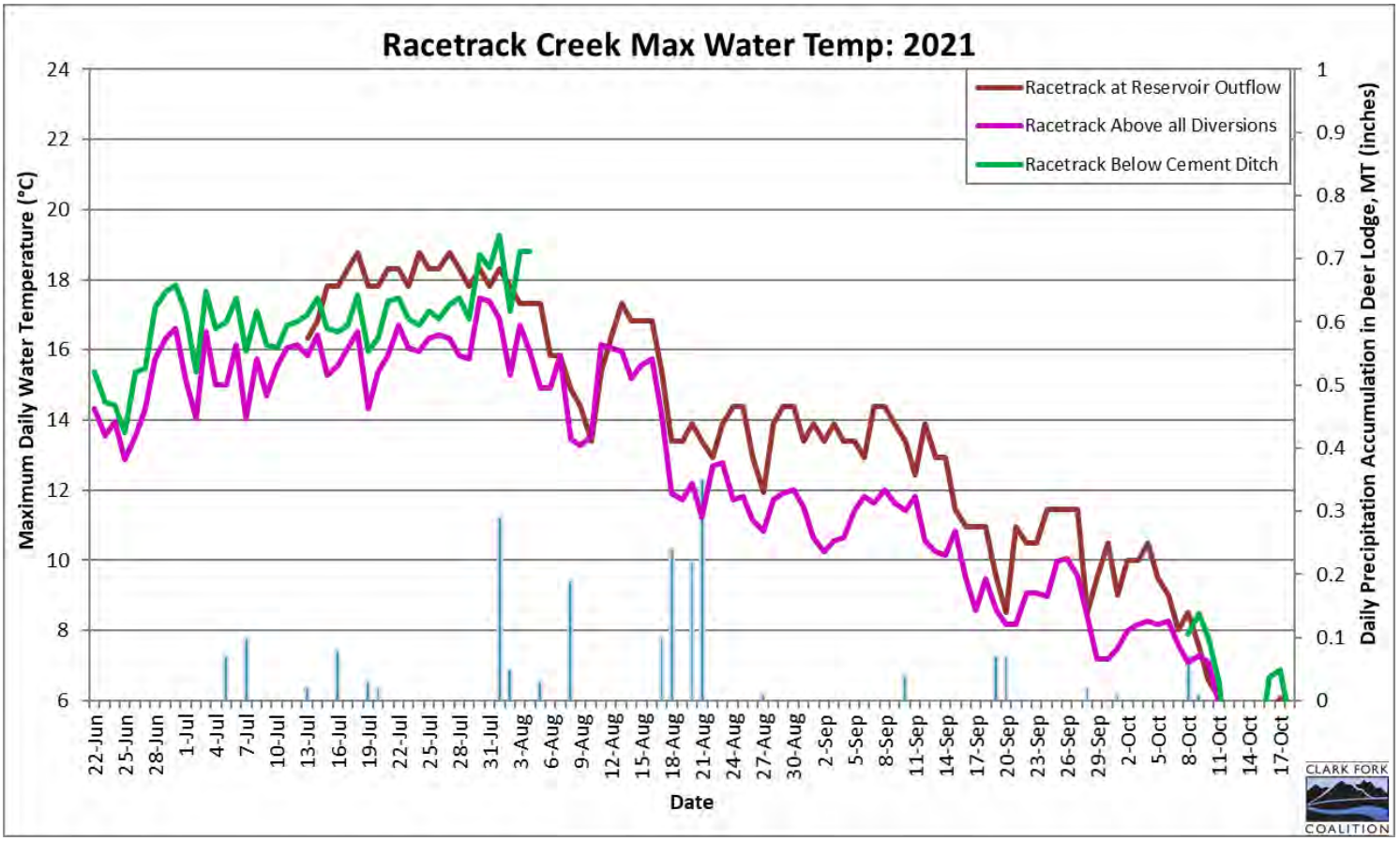

Figure 5- Racetrack Creek average maximum daily thermographs for the 2021 irrigation season.

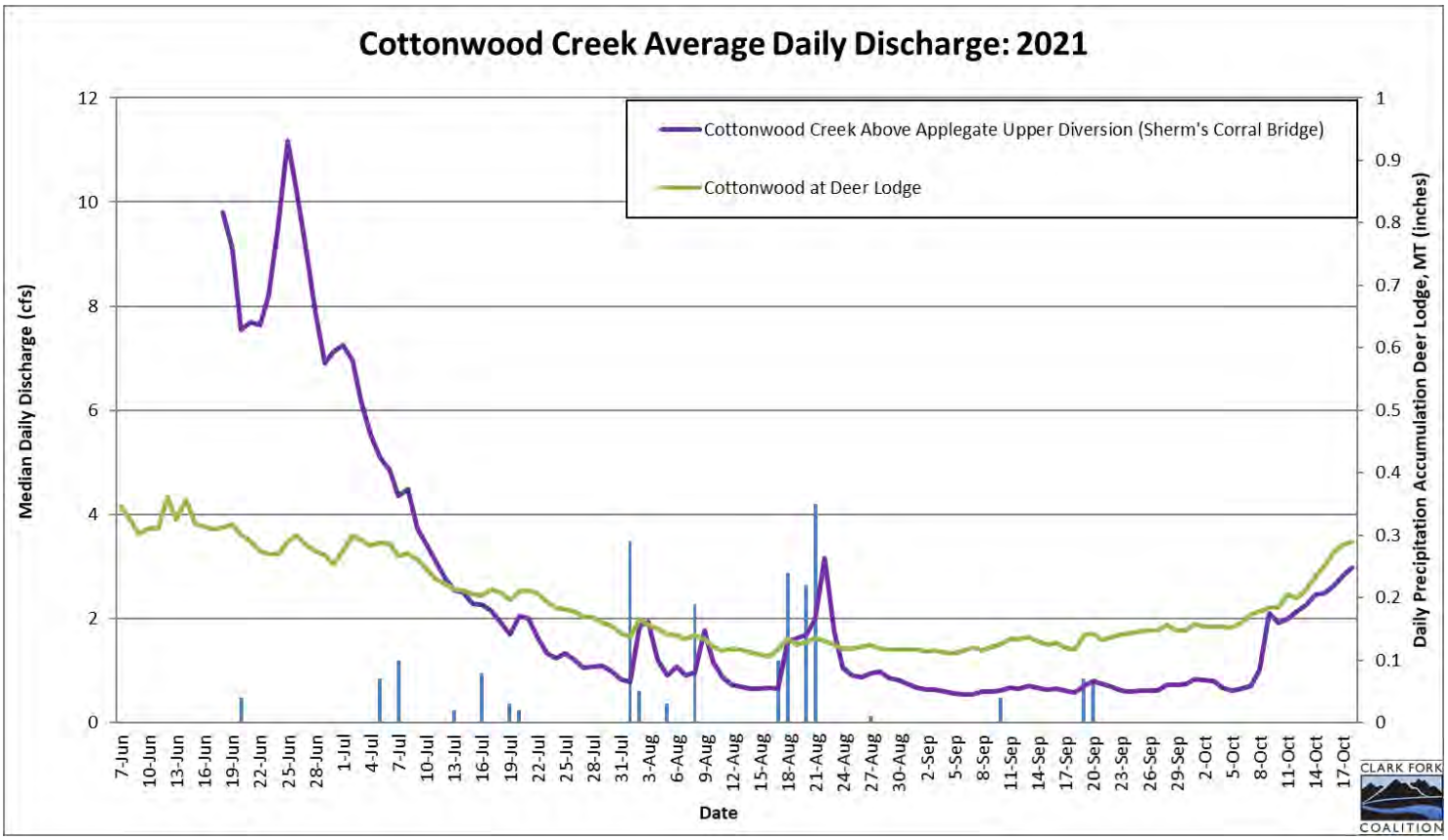

Figure 6- Cottonwood Creek average daily hydrographs for the 2021 irrigation season.

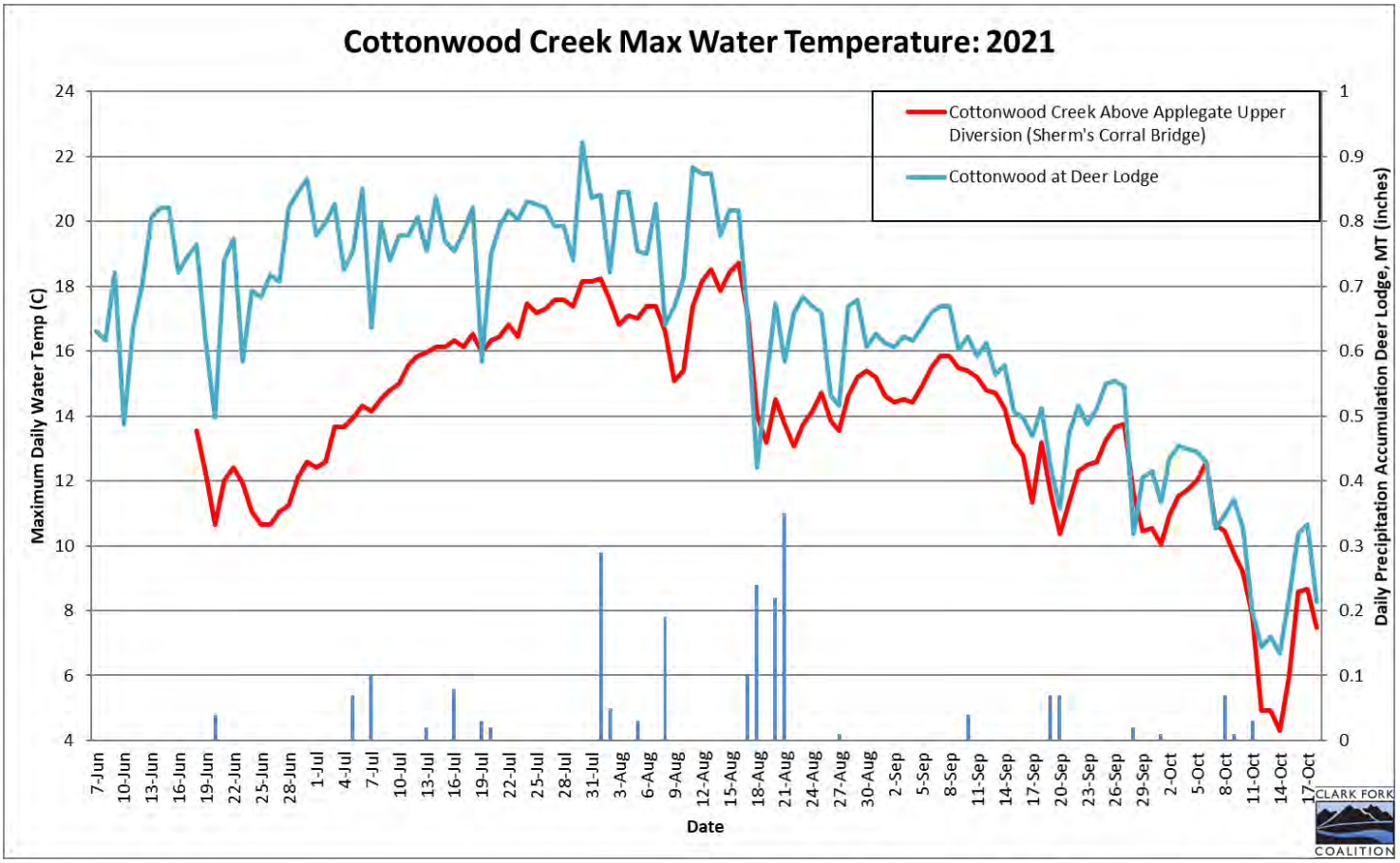

Figure 7- Cottonwood Creek maximum daily thermographs for the 2021 irrigation season.

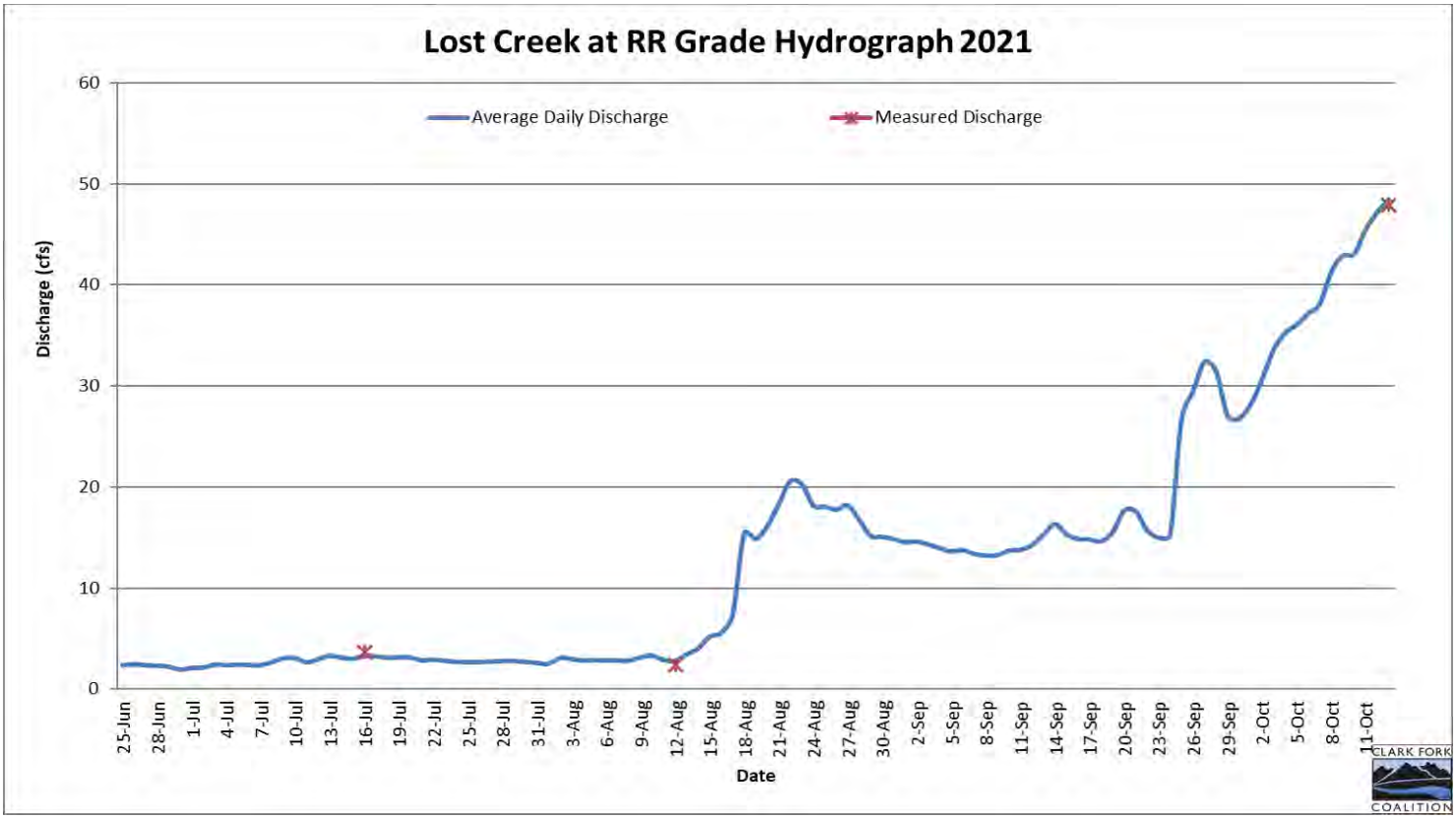

Figure 8- Lost Creek average daily hydrograph for the 2021 irrigation season.

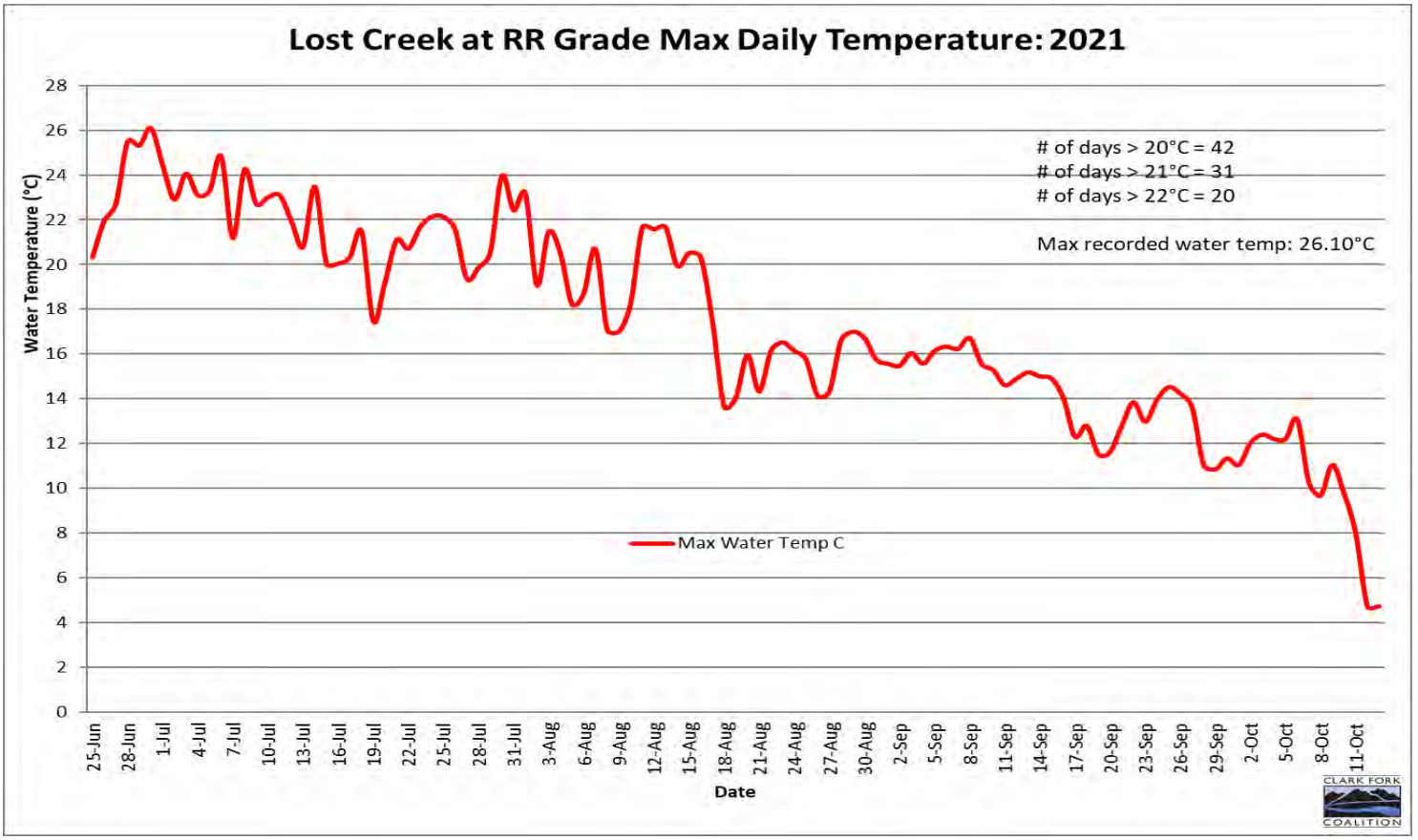

Figure 9- Lost Creek maximum daily thermograph for the 2021 irrigation season.

2021 Manual Discharge Measurements			
Location	Date	Time of Measurement	Discharge (CFS)
Valiton Ditch at Headgate			
	15-Jun	12:30 PM	9.9
	2-Aug	1:05 PM	6.5
	12-Aug	12:30PM	5.5
Valiton Ditch Past Greico Pump (CFRR)			
	15-Jun	11:45 AM	4.2
Alvi Beck at Headgate			
	30-Jul	4:30pm	2.4
	9-Aug	2:45pm	4.0
Alvi Beck Past Fish Screen			
	30-Jul	4:45pm	2.0
	9-Aug	4:40pm	3.2
Kohrs-Manning Ditch			
	2-Aug	3:00pm	6.5
	12-Aug	1:30pm	10.4
West Side Ditch (Racetrack Pond)			
	2-Aug	11:35	29.7
	12-Aug	11:50	35.1
Whalen Ditch (Racetrack Pond)			
	2-Aug	11:55am	4.8
	12-Aug	12:11 PM	7.1
RCC Ditch (Cottonwood Creek)			
	18-Jun	1:25 PM	12.0
	16-Jul	12:40 PM	3.0
Cottonwood Creek Above Burt Diversion			
	16-Jul	1pm	2.0
	7-Sep	3pm	0.4
Cottonwood Creek above Applegate Lower Diversion			
	16-Jul	12:30pm	0.1
	20-Aug	10am	0.3
Cottonwood Creek below Applegate Lower Diversion			
	16-Jul	12:30pm	0.0
	20-Aug	10:20am	0.0
Modesty Creek at Frontage Road			
	12-Aug	11:45 AM	1.3
Dry Cottonwood Creek at East Side Road			
	27-May	2:05 PM	0.8
Mill Creek at HWY 1			
	22-Sep	5:50 PM	2.0

Table 10- Spot measurements for the 2021 irrigation season.

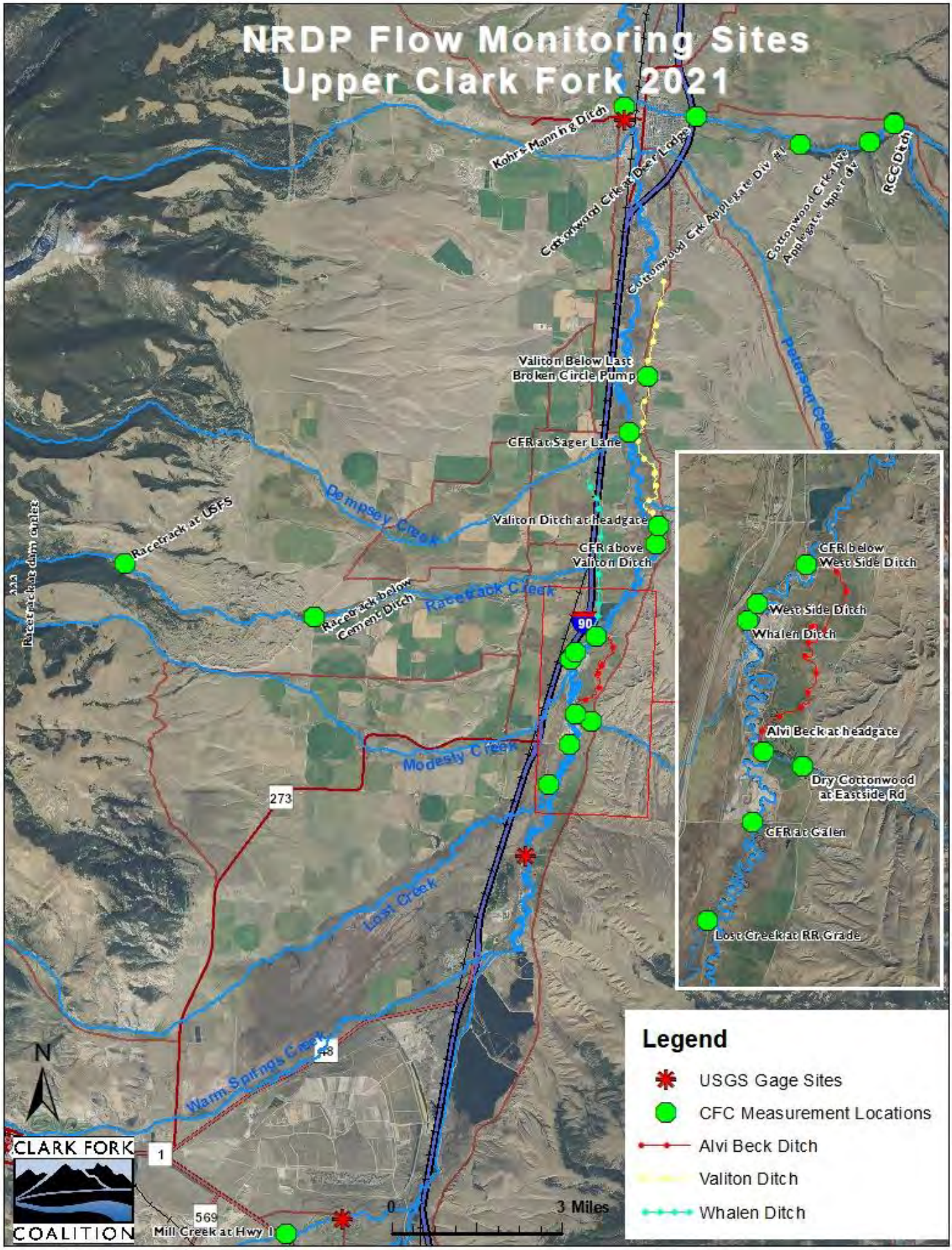

Figure 11- Map of measurement locations for the 2021 irrigation season.

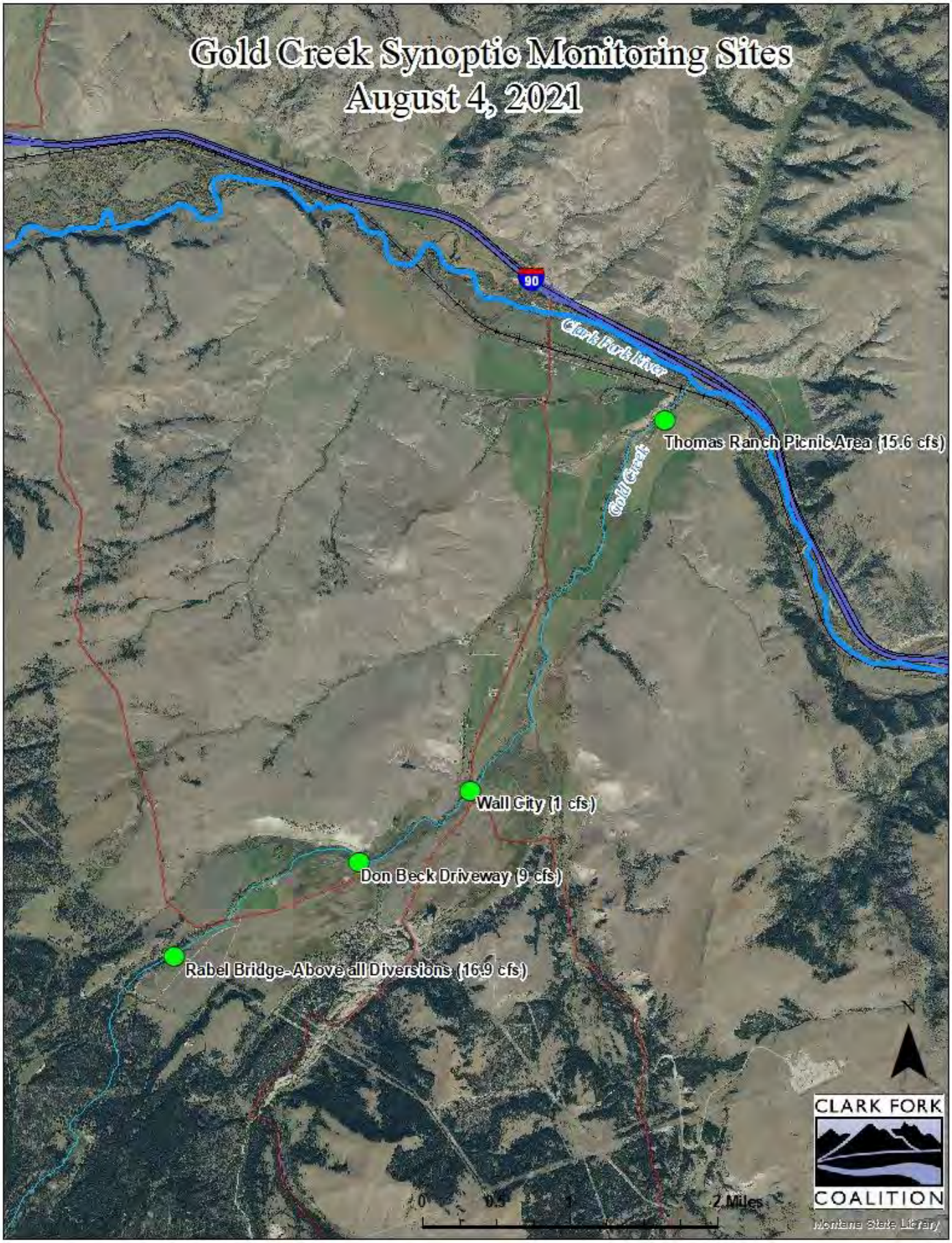

Figure 12- Map of Gold Creek synoptic flows measurements.

Figure 13- Map of Mill Creek synoptic flows measurements.