

# 2019 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 task order is to seasonally monitor water temperature and streamflow conditions on the upper Clark Fork River and tributaries where existing data is lacking. Flow measurement also occurred to monitor in-stream flow projects, and assist with monitoring related to the 2019 Silver Lake Flow Release.

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 sees 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 2019 field season the Clark Fork Coalition (CFC) managed 14 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 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.

<b>Upper Clark Fork River Basin Monitoring Sites</b>	
<b>Stream</b>	<b>Site</b>
Warm Springs Creek	Below Gardiner Ditch
Lost Creek	Below Beckstead Ditch
Cottonwood Creek	Above Applegate Diversion #1 (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
	Valiton Ditch (Upper and Lower)

	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 17). At each CFC monitoring site, a continuous data logger (Trutrack, Solonist or 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 16).

1. Spot flow measurements of discharge on the Alvi Beck ditch located on Dry Cottonwood Creek Ranch. A stage height recorder was deployed at this location, although we were unable to develop a reliable rating curve for a continuous hydrograph for the second year in a row due to backwatering from beaver dam activities and excessive aquatic vegetation.
2. Spot measurements occurred on Cottonwood Creek at 3 locations in order to monitor the Applegate and McQueary instream flow projects.
3. Spot flow measurements on Modesty Creek during the Silver Lake synoptic flow study

<b>Upper Clark Fork River Basin Monitoring Sites (Supplemental)</b>		
<b>Stream/Ditch</b>	<b>Site</b>	<b>Number of Measurements</b>
Alvi Beck Ditch	at DCCR Below pump	3
Baggs Creek	at Pigs Palace Site	4
Cottonwood Creek	Below Applegate Diversion #1	4
Cottonwood Creek	Above Applegate Upper Diversion #2	4
Cottonwood Creek	Below Applegate Diversion #2	4
Modesty Creek	Near the railroad grade	2

Table 2- Supplemental monitoring sites managed by the CFC in the upper Clark Fork Basin.

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 & 2 above and are displayed in the map in Figure 17.

### 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 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. Three separate types of data loggers were used during the 2019 field season as the CFC is in the process of upgrading equipment (TruTrack, Solonist and Hobo).

River stage data from the HOBOS, Solonist and TruTrack 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 2019 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 2019 monitoring season are provided in Figures 2-15.

After 2018's abundant (and near record) water supply conditions, the upper Clark Fork Basin experienced normal snowpack during the 2019 water year that was followed by anomalous high flows throughout most of the spring, summer and fall. With an April 1 peak snowpack measured at 98% of average, and high baseflow conditions that carried over from 2018's plentiful water year, the upper Clark Fork River maintained above average flows throughout the 2019 runoff season. The upper Clark Fork Basin (and all of southwest Montana) also experienced abundant precipitation during August and September, which is typically the driest time of year in the region.

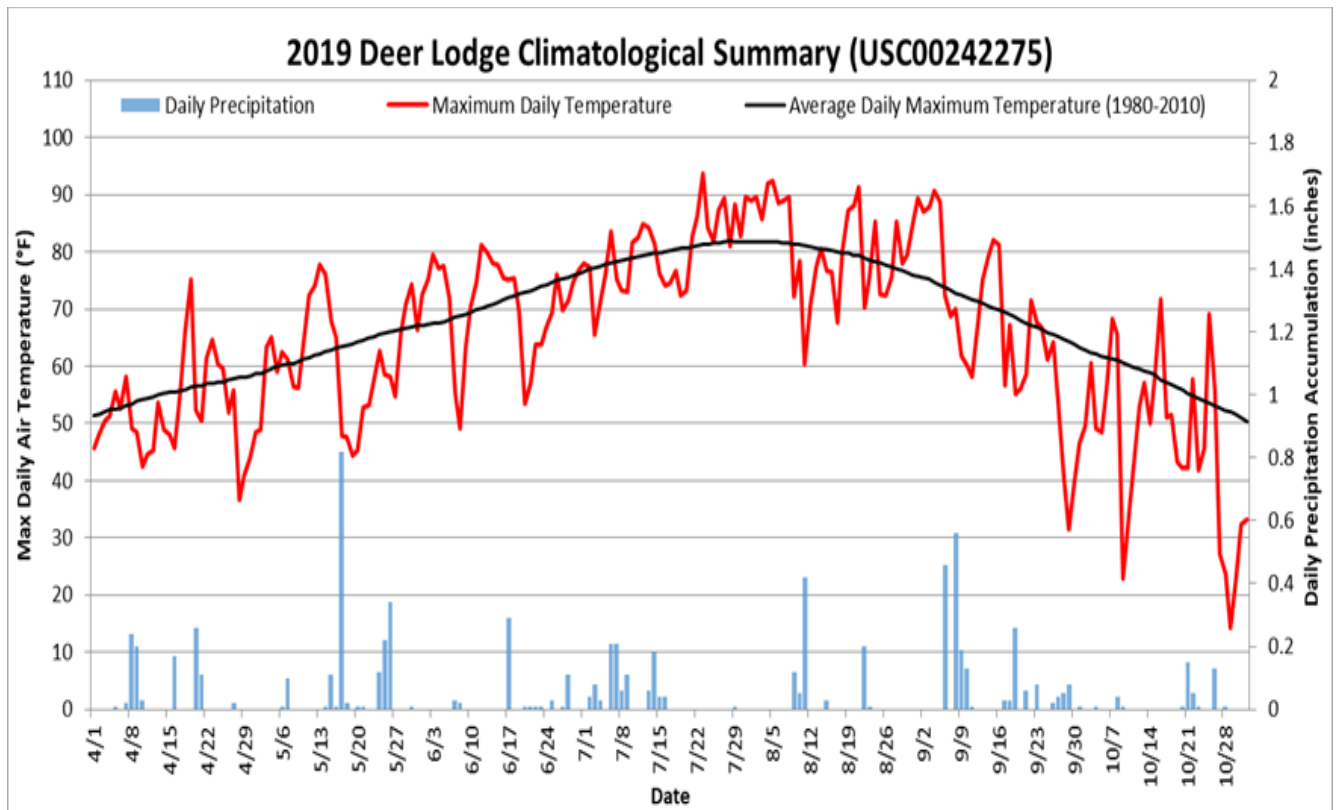


Figure 1- Summer 2019 climatological summary for the Deer Lodge, MT weather station (USC00242275).

### Analysis & Conclusions

#### *Clark Fork River Figures 2 & 3*

The Clark Fork River experienced above normal discharge in 2019, with the lowest flow occurring at the Racetrack Bridge site below West Side Ditch of 68.5 cfs on August 6<sup>th</sup> (during the Silver Lake storage release) and 68.3 cfs at the USGS Perkins Lane Gage on September 5<sup>th</sup>. For comparison, in 2017 flows dropped to 7.5 cfs at the location below West Side Ditch on August 31<sup>st</sup>. Above normal snowpack contributed to these unusually high streamflows in 2019, in addition to frequent rain events through July and August and a flow release from Silver Lake between July 29<sup>th</sup> and August 27<sup>th</sup>. Due to high streamflows and dangerous wading/monitoring conditions, we were not able to safely deploy most of our monitoring equipment until July 2, 2019 in the mainstem Clark Fork River. Irrigation influence on the hydrograph of the mainstem sites became apparent by July 20<sup>th</sup> and persisted until September 9<sup>th</sup>.

Water temperatures tracked fairly consistently across the monitoring locations although there were significant differences in the magnitude of temperatures recorded (Figure 2). Temperatures at all locations peaked in early to mid-August when thermal inputs were at a maximum. The maximum water temperature for 2019 was 23.5 degrees Celsius on August 7<sup>th</sup> below Sager Lane. Water temperatures generally decreased after August 10<sup>th</sup> following a number of precipitation events, shorter days and cooler nights along with inputs of cold water from the Silver Lake Release.

### *Racetrack Creek*

#### *Figure 4 & 5*

During the 2019 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 mid to late July. Unlike the mainstem Clark Fork River that maintained relatively stable flows throughout the summer, Racetrack Creek was completely dewatered below the Cement Ditch by August 23<sup>rd</sup> (much later than usual), while flows at the USFS gage (above all diversions) remained above 55 cfs. With the addition of our gaging site at the outflow of Racetrack Lake, we were able to more accurately track flow releases and downstream impacts. A noticeable 1-4 cfs increase in flow occurred starting July 25 below the Cement Ditch site, the same day the release from Racetrack Lake was initiated. Flows persisted below the Cement Ditch until August 21, which coincides when storage water from Racetrack Lake was exhausted. Flows below the Cement Ditch generally remained depressed or at baseflow levels through late September when fall precipitation augmented flows on Racetrack Creek.

### *Cottonwood Creek*

#### *Figures 6, 7 & 16*

Flows were monitored in Cottonwood Creek at three locations for the purposes of ensuring instream flow from the Applegate flow enhancement project were maintained. An instream flow rate of 4.76 cfs was maintained from May 16<sup>th</sup> to July 14<sup>th</sup> and 1.7 cfs from July 15<sup>th</sup> to September 15<sup>th</sup>. 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 14<sup>th</sup> and flows greater than 1.7 cfs from July 15<sup>th</sup>-Sept. 15<sup>th</sup>. Spot measurements were also taken above and below the Applegate diversion #2 after July 15<sup>th</sup> to ensure compliance. Flows remained elevated through June up until mid-July in lower Cottonwood Creek and remained low but stable through the summer until a major rain event on September 5<sup>th</sup> caused a major spike in streamflows. Aside from the early September rain event, high flows or runoff conditions in lower Cottonwood Creek ended prior to deploying our gaging equipment on June 13<sup>th</sup>.

### *Dry Cottonwood Creek*

#### *Figures 8 & 9*

This site is situated on the CFC's 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 strong in 2019 and extended much longer than usual (until July 22<sup>nd</sup>). This was partially due to the DCCR's careful use of Dry Cottonwood Creek irrigation water for flood irrigation, which ceased on June 24<sup>th</sup>. CFC is currently in the process of trying to convert 4.3 cfs of irrigation rights to instream flow in Dry Cottonwood Creek. On July 23<sup>rd</sup>, the day after the creek stopped flowing, CFC staff observed 30 dead brown trout, one cutthroat trout and 2 sculpin in the pool below East Side road where the flow gage was located.

### *Lost Creek (below Beckstead Ditch)*

#### *Figures 10 & 11*

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 1<sup>st</sup>- August 31<sup>st</sup> of each year. Flows in excess of 10 cfs were recorded at this location for most of the year, with one small dip around August 9<sup>th</sup>, before steadily increasing through the remainder of the summer and fall. A noticeable increase in flows appears to occur during the Silver Lake release from 7/29-8/27.

*Valiton Ditch at Headgate and Below Last Broken Circle Pump  
Figures 12 & 13*

This is the second season of continuous monitoring efforts by the CFC on Valiton Ditch, which withdraws water from the Clark Fork River above Sager Lane and below Racetrack. Flows were measured below the headgate and ranged from 3.3-6.4 cfs for most of the summer, with withdrawals decreasing sharply after the first week of September. In 2018, diverted flow ranged from 6-11 cfs at the headgate. Flows were also monitored down the ditch past the last Broken Circle Pump station in order to measure flows that were being conveyed to the Clark Fork River Ranch now owned by the NRDP. Flows at this location appear to be between 2.5 and 3 cfs from May 29<sup>th</sup>-September 17<sup>th</sup>. We experienced difficulties obtaining flows in the canal at both locations later in the summer due to excessive aquatic vegetation and mud. 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.

*Warm Springs Creek below Gardiner Ditch  
Figures 14 & 15*

As part of the joint Silver Lake test release study between CFC, TU, NRDP and Watercourse Engineering, we deployed a continuous flow and temperature monitoring station (Trutrack) below the Gardiner Ditch on Warm Springs Creek. This data helped fill in some gaps between the USGS stations and help track flow increases and thermal benefits from the Silver Lake release. A noticeable increase in flows occurred during the course of the Silver Lake release, which is more fully described in the Trout Unlimited Report.

*Alvi Beck Ditch  
Figure 16*

This ditch is operated by the Dry Cottonwood Ranch and the monitoring location was just down the ditch from the pump site, which withdraws a maximum of 1.8 cfs. The majority of the remaining ditch water is used for flood irrigation, although there is one pivot further down the ditch on a neighboring property (Jacobson) that is an active user. Diverted flows ranged from 3-7.5 cfs after the pump site based on information from the spot measurements in Figure 14. A Trutrack was deployed at this location, although we were unable to develop a reliable rating curve from the data due to backwatering issues from beaver activity. 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.

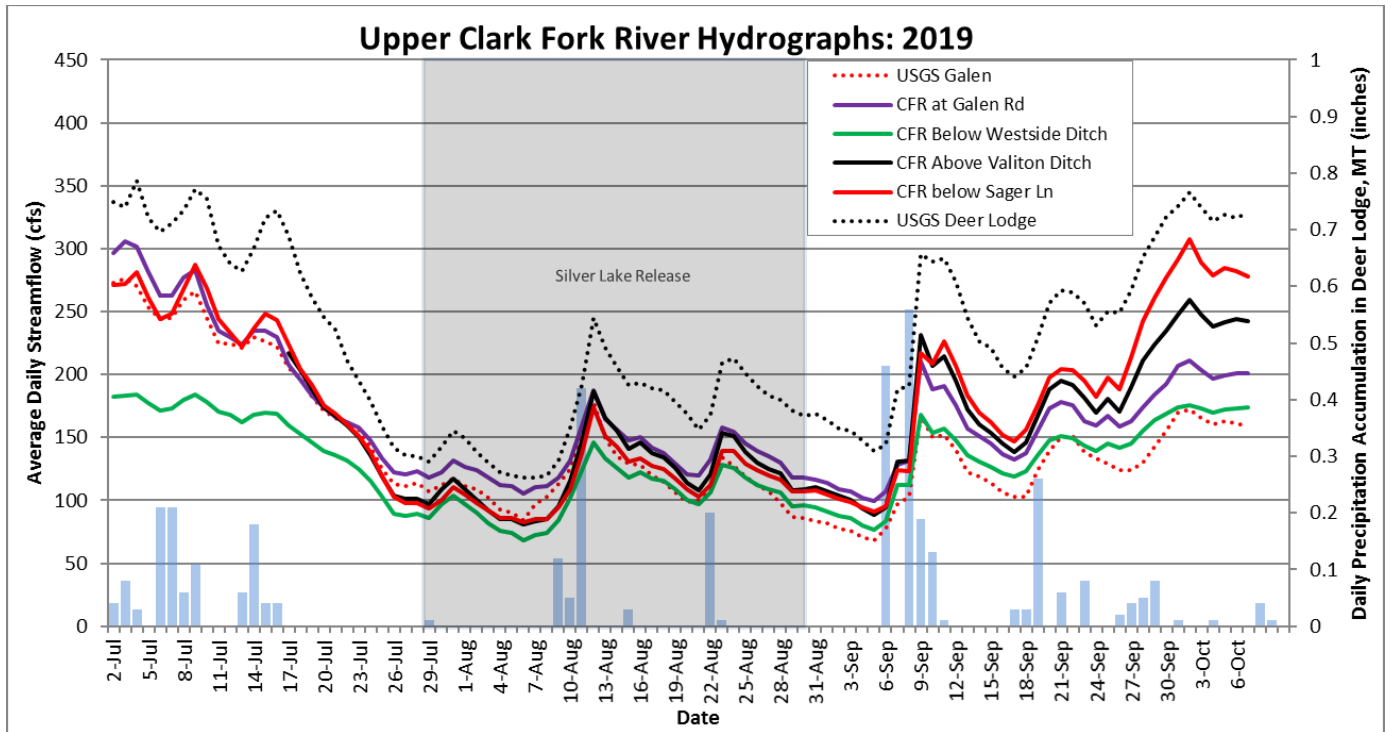


Figure 2- Upper Clark Fork average daily hydrographs for the 2019 irrigation season.

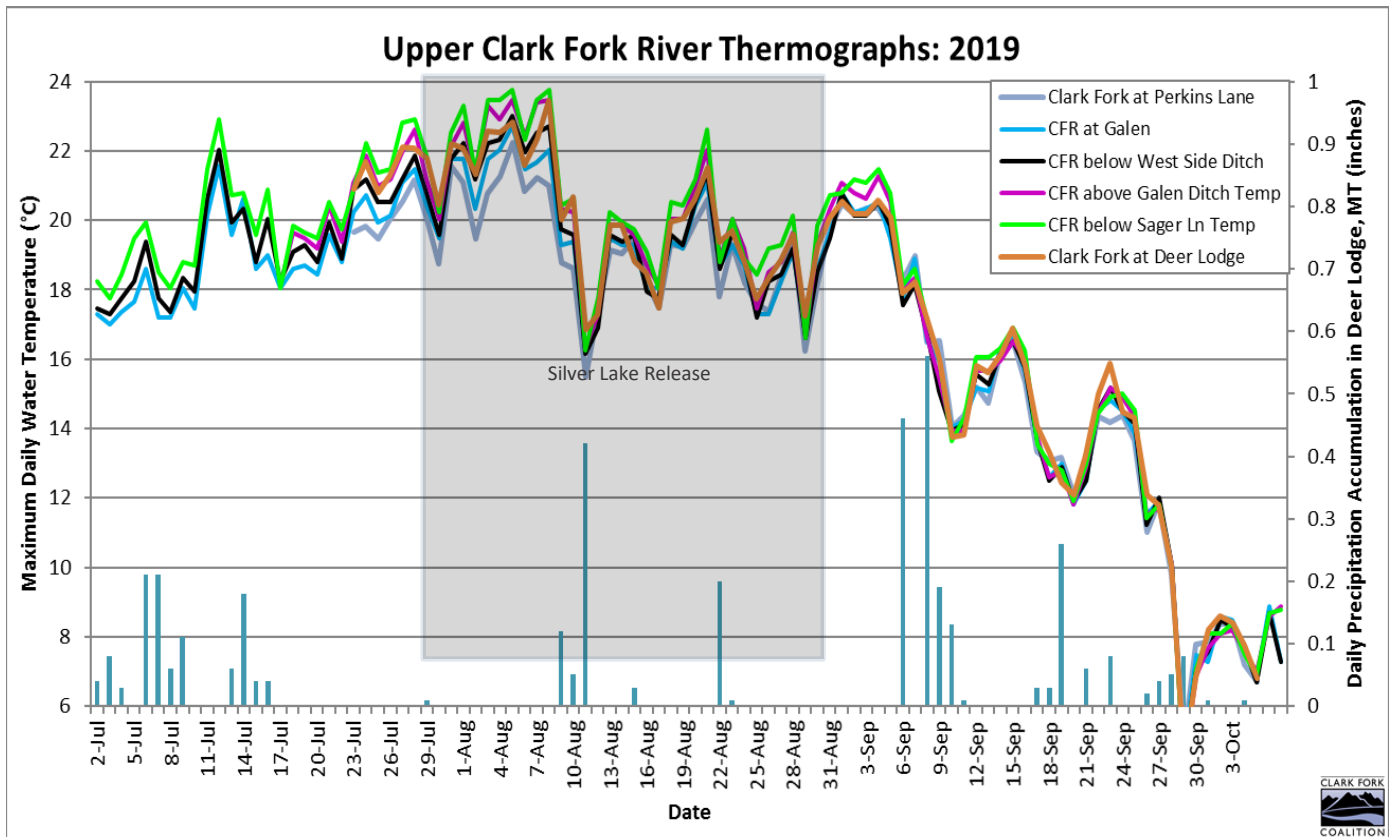


Figure 3- Upper Clark Fork average daily thermographs for the 2019 irrigation season.



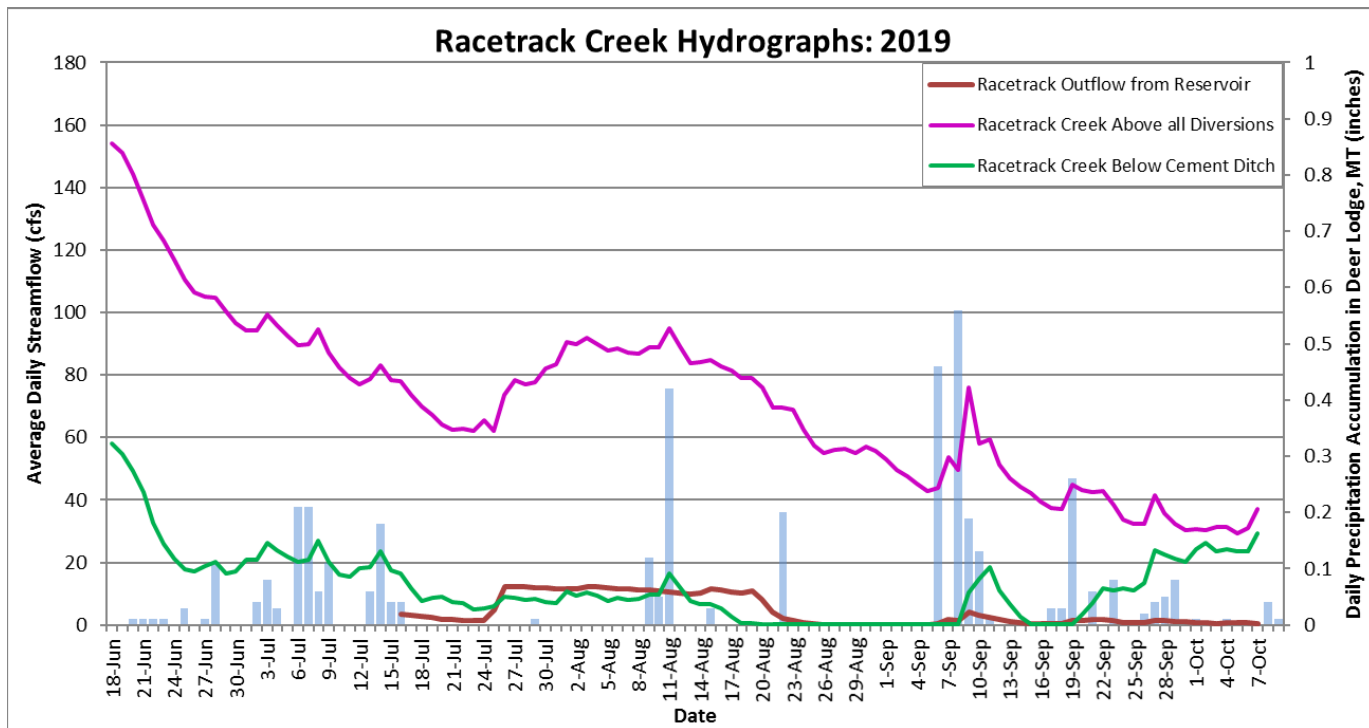


Figure 4- Racetrack Creek average daily hydrographs for the 2019 irrigation season.

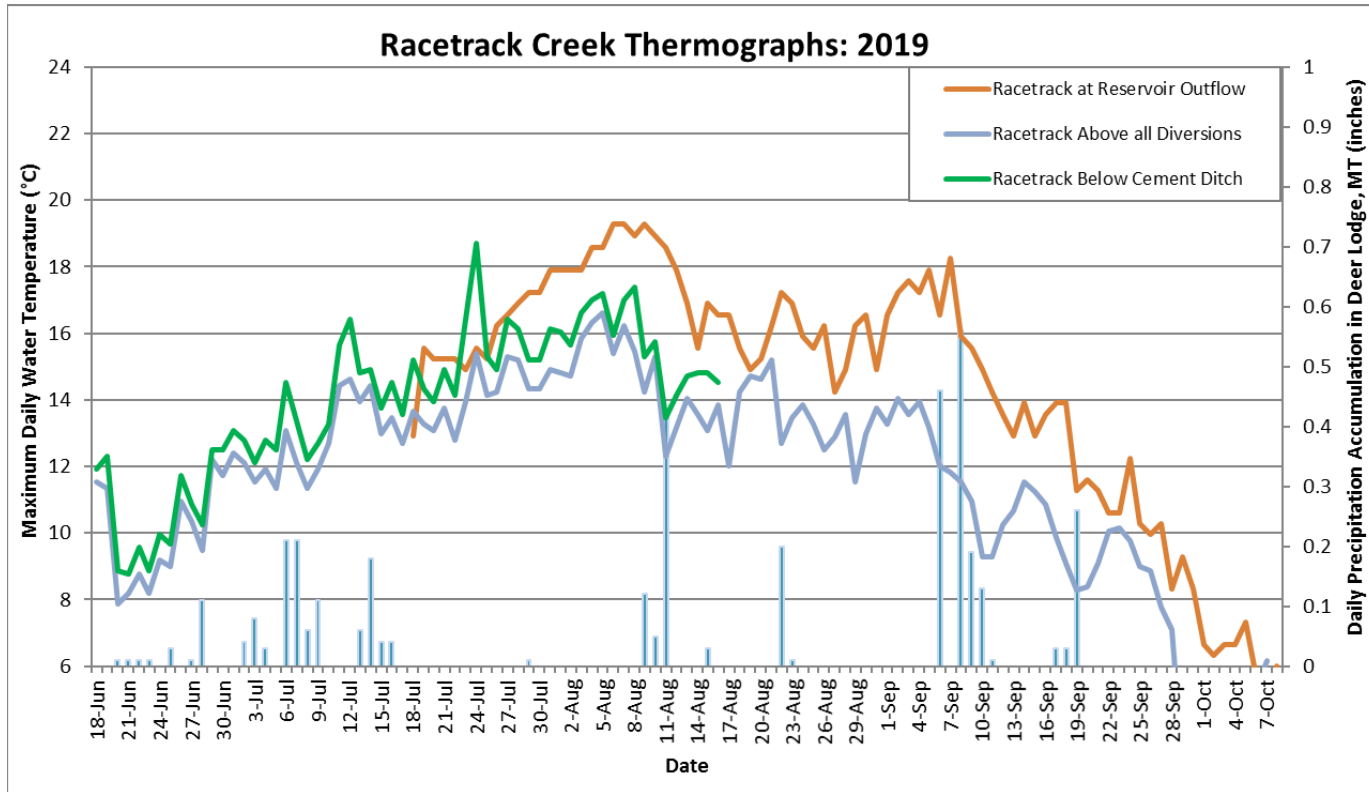


Figure 5- Racetrack Creek average daily thermographs for the 2019 irrigation season.



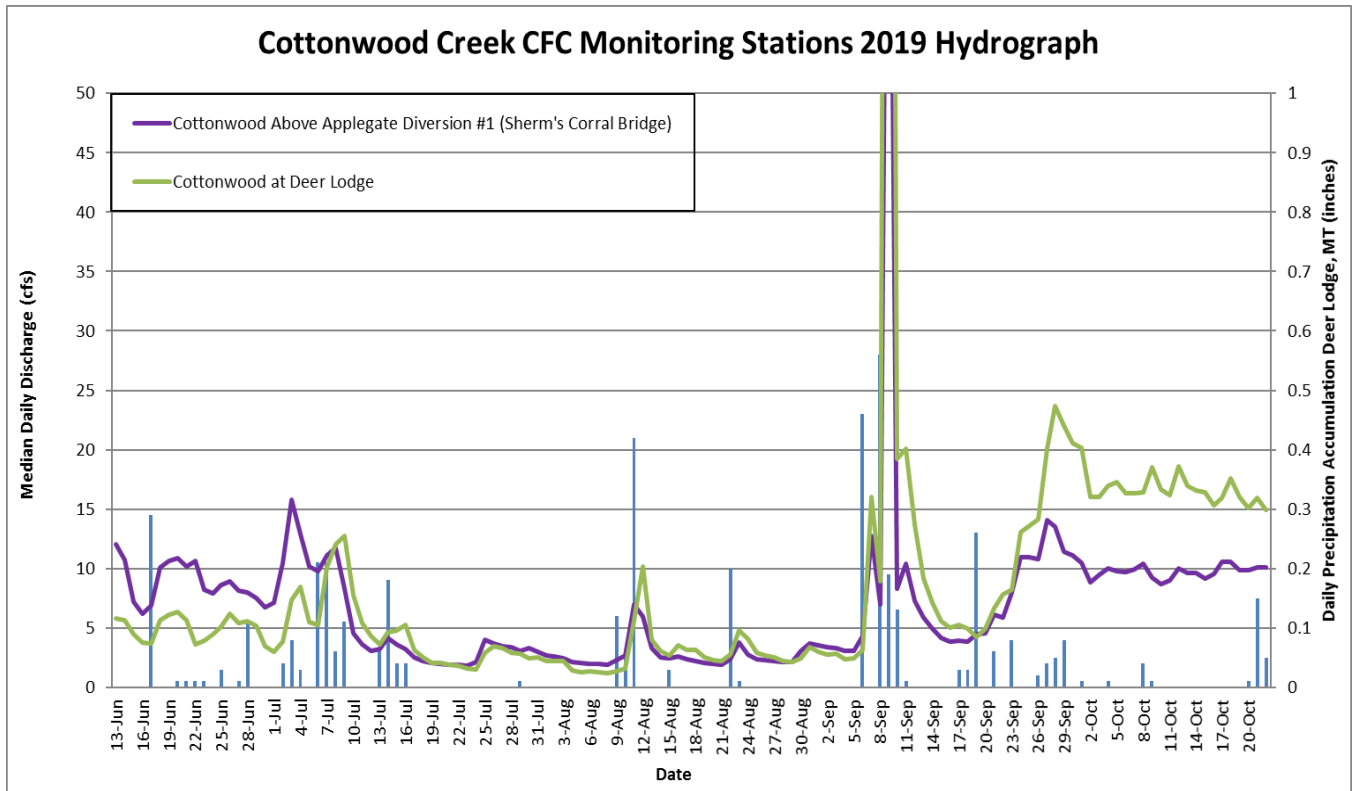


Figure 6- Cottonwood Creek average daily hydrographs for the 2019 irrigation season.

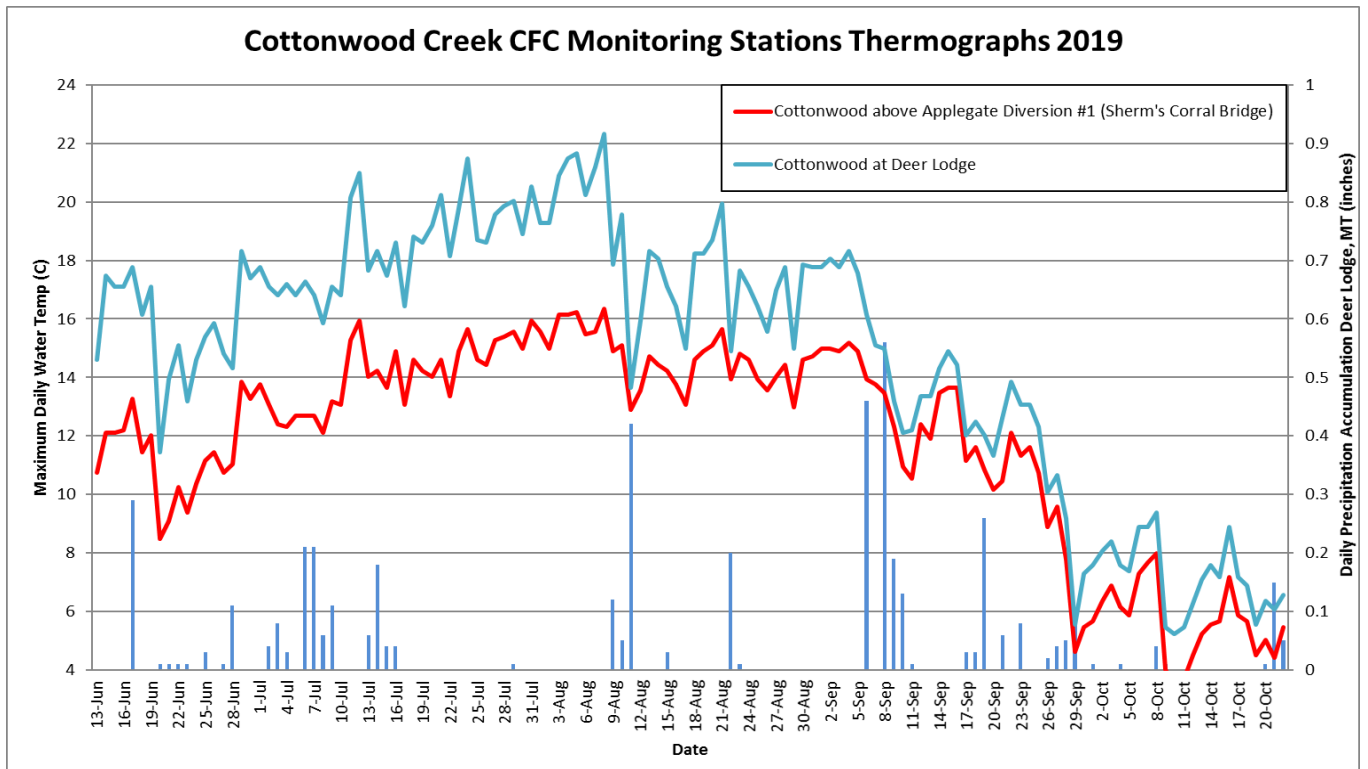


Figure 7- Cottonwood Creek average daily thermographs for the 2019 irrigation season.

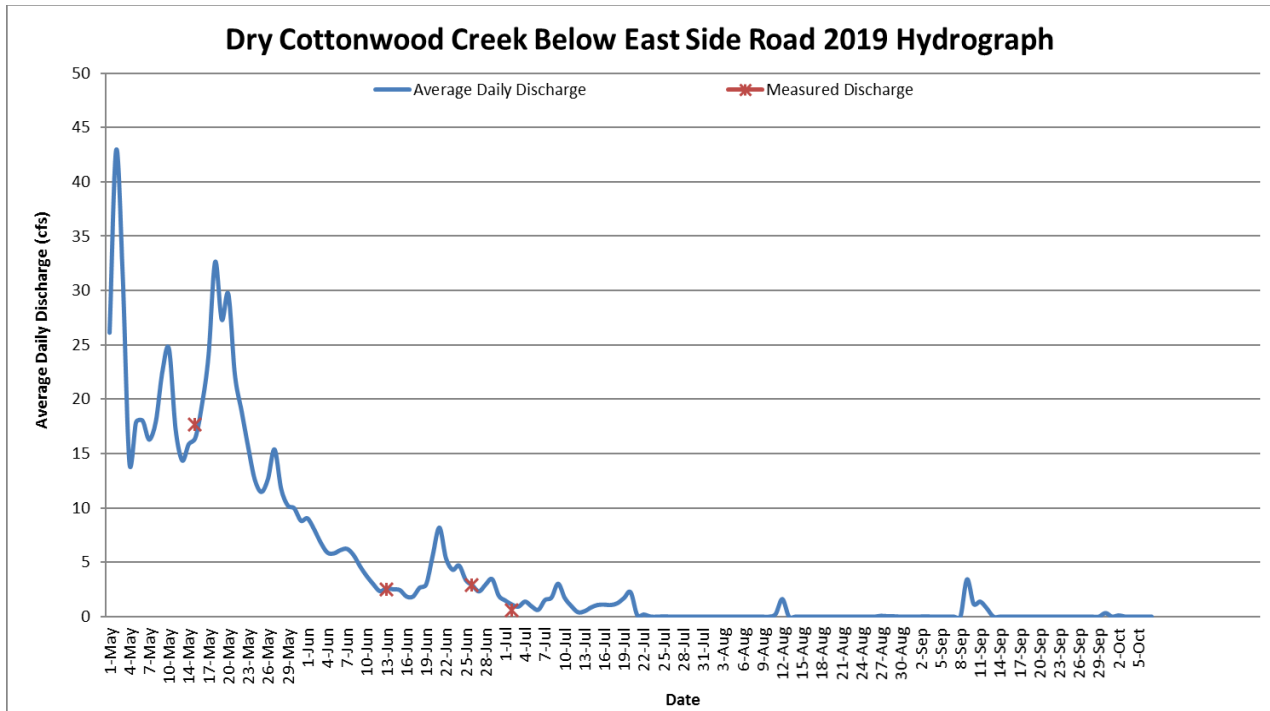


Figure 8- Dry Cottonwood Creek average daily hydrograph for the 2019 irrigation season.

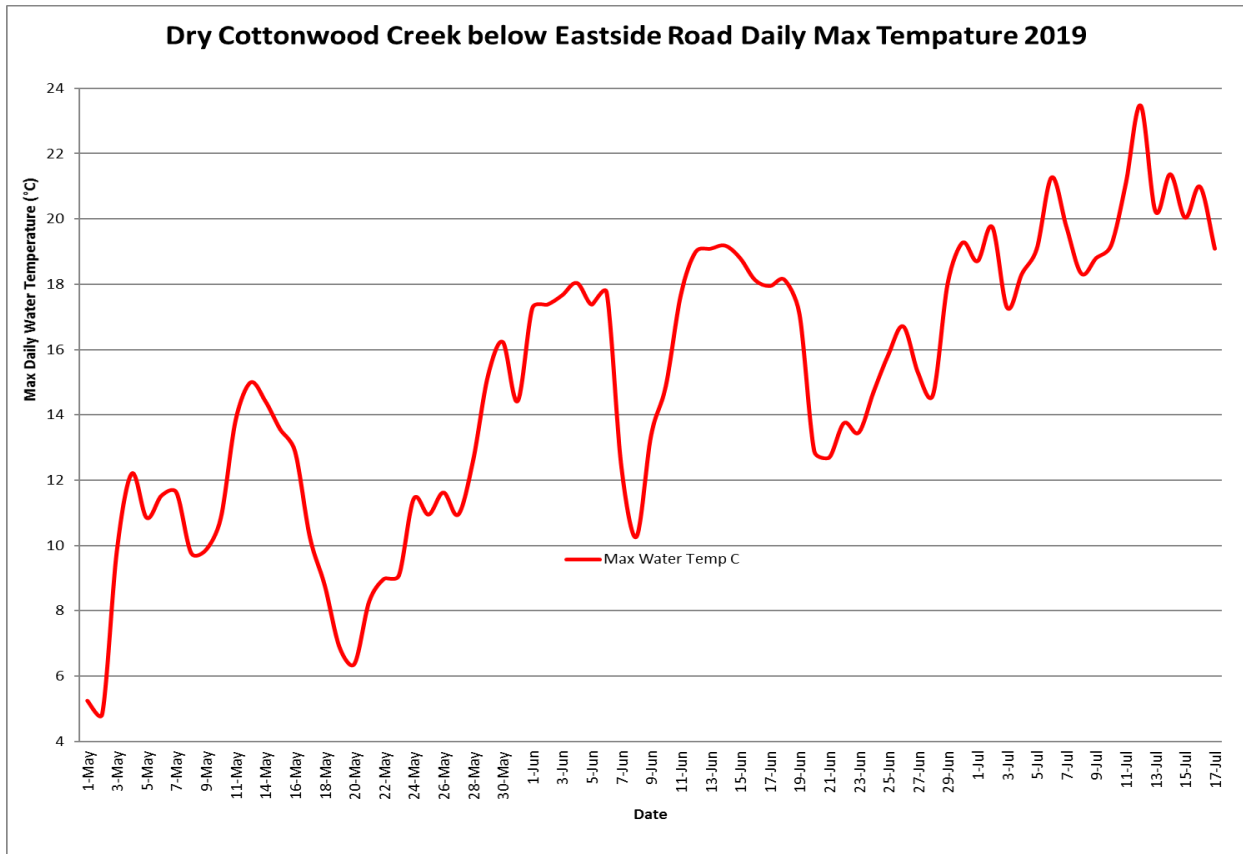


Figure 9- Dry Cottonwood Creek average daily thermograph for the 2019 irrigation season.

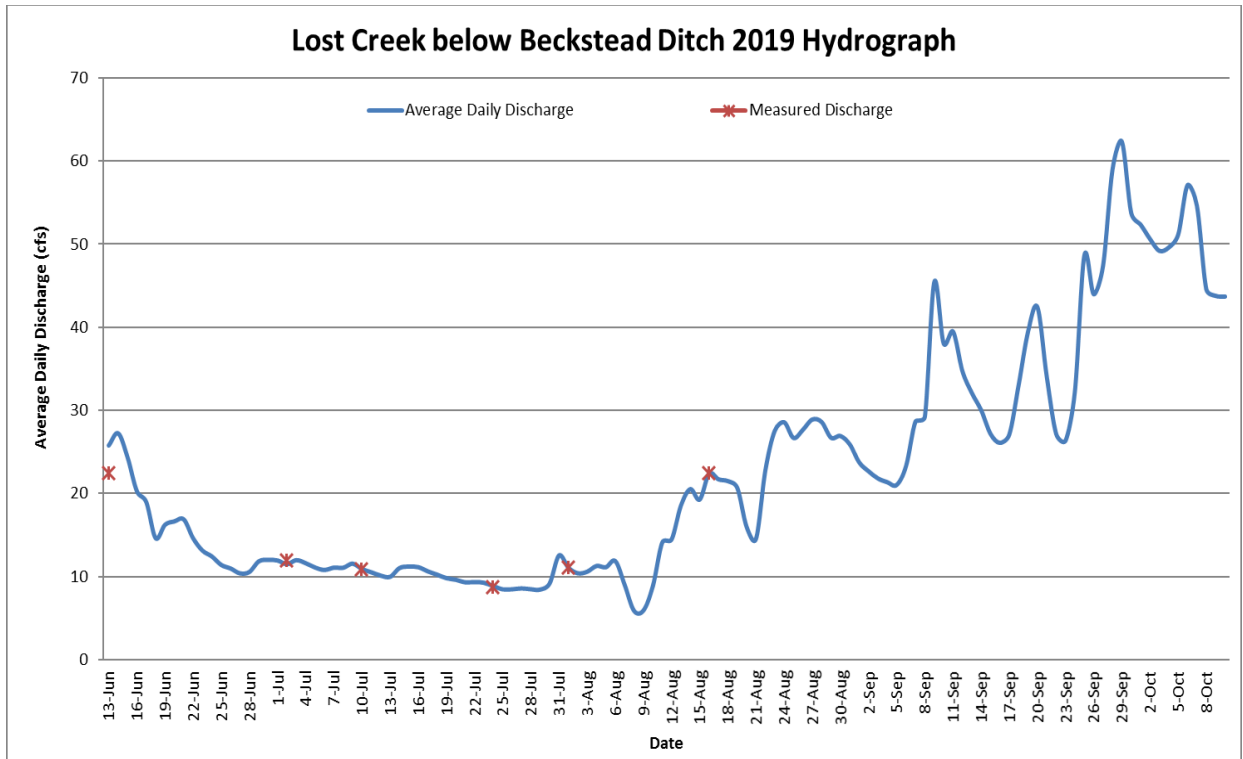


Figure 10- Lost Creek average daily hydrograph for the 2019 irrigation season.

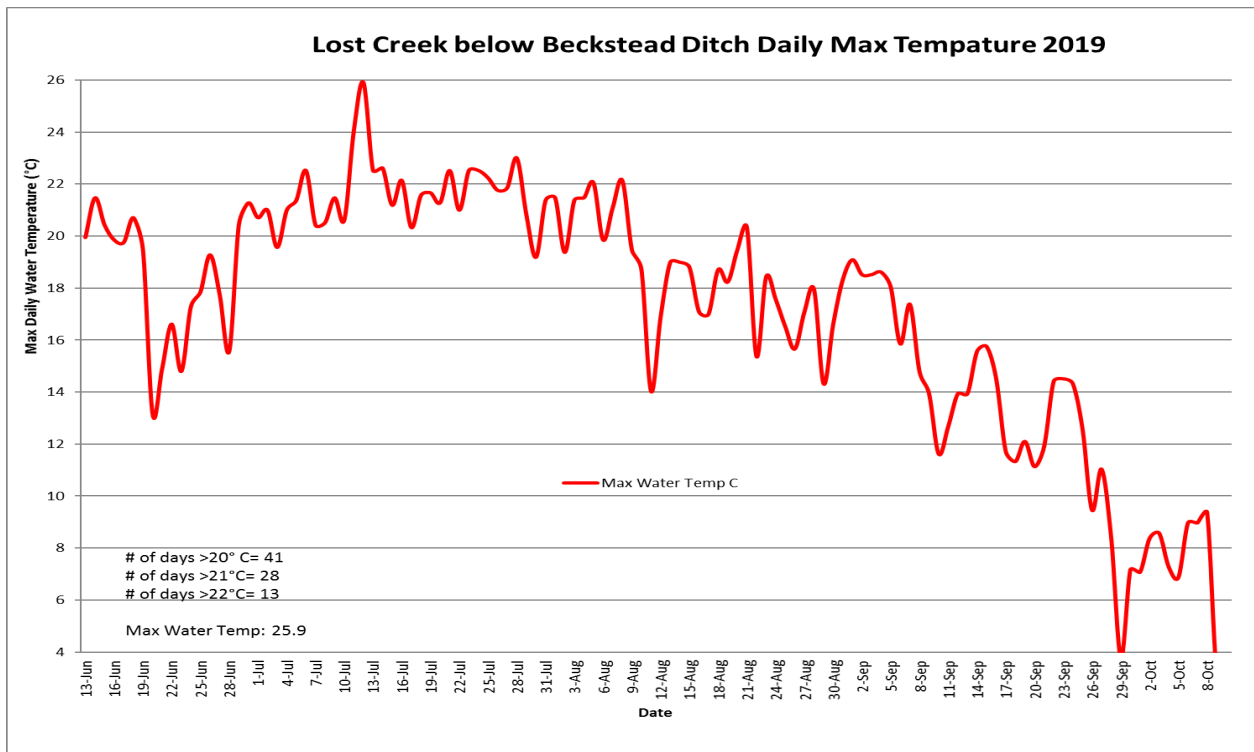


Figure 11- Lost Creek average daily thermograph for the 2019 irrigation season.

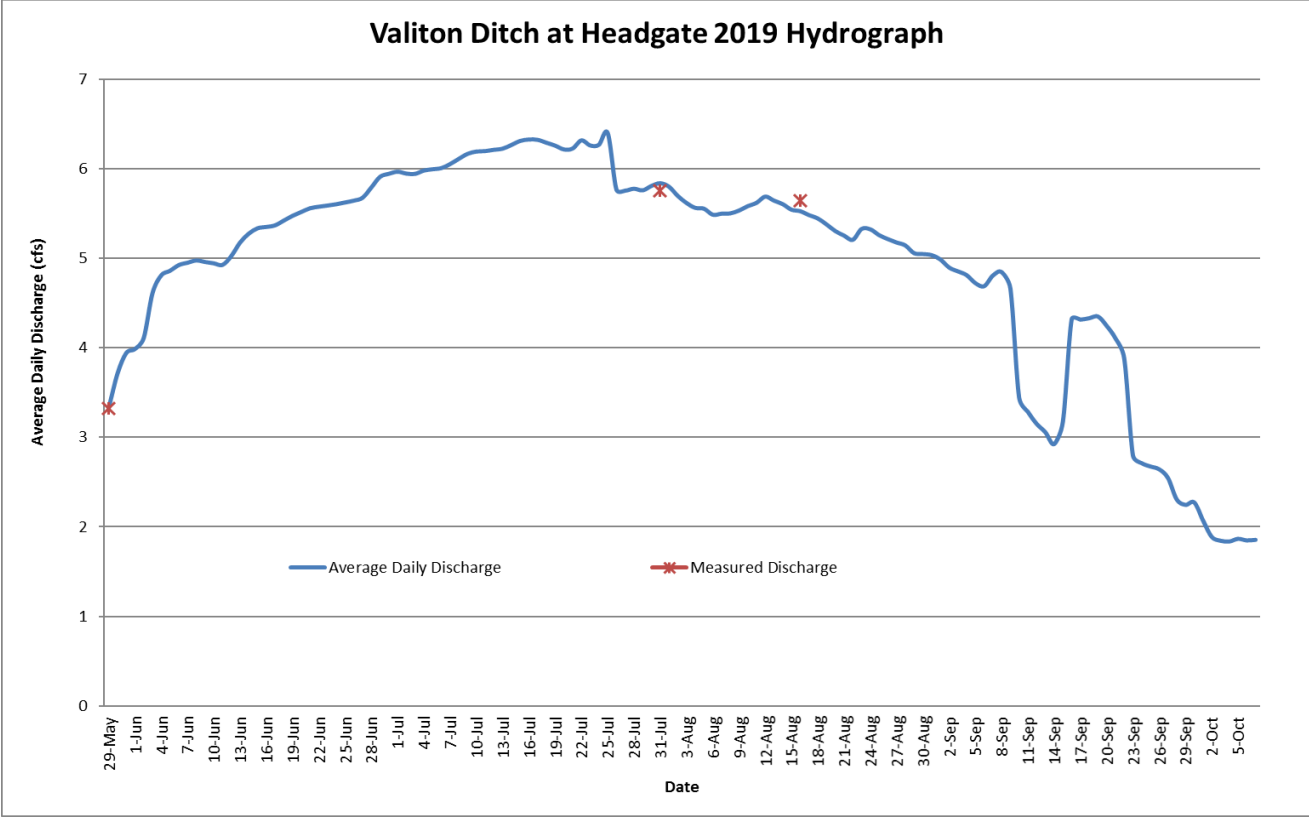


Figure 12- Valiton Ditch below Headgate average daily hydrograph for the 2019 irrigation season.

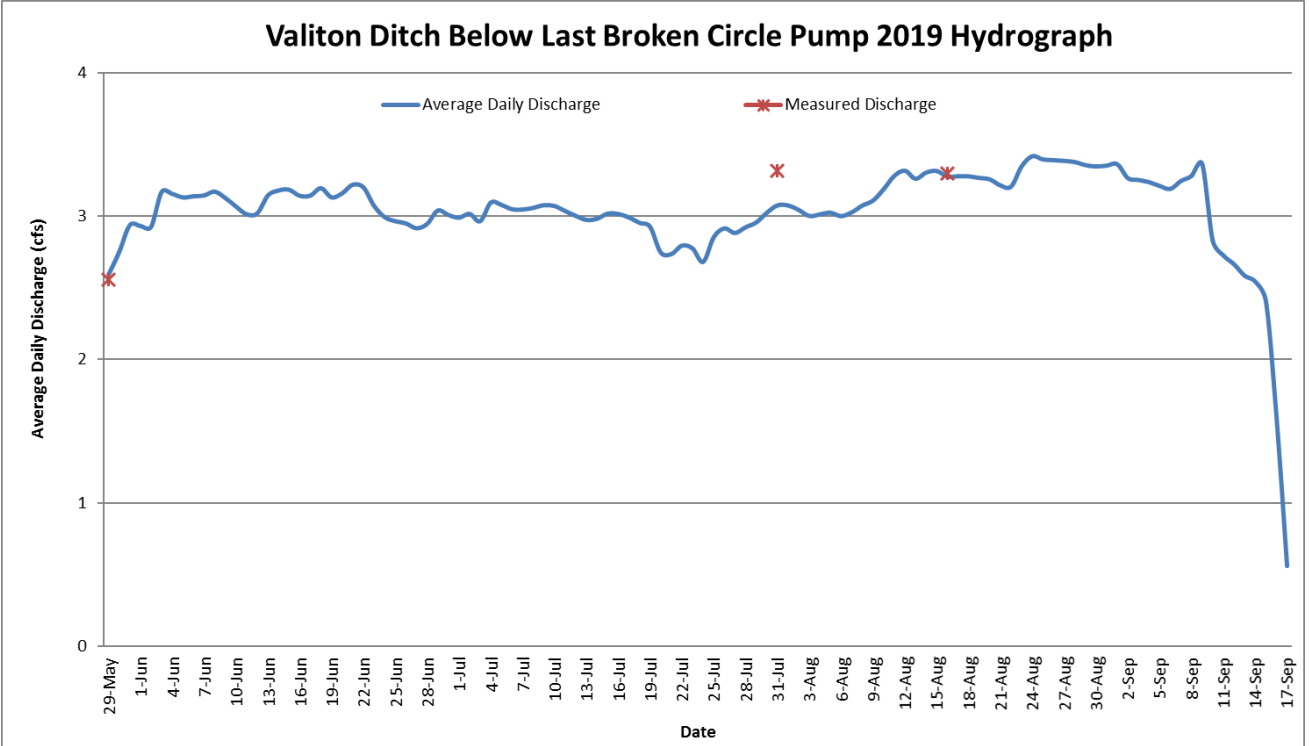


Figure 13- Valiton Ditch below last Broken Circle pump average daily hydrograph for the 2019 irrigation season.

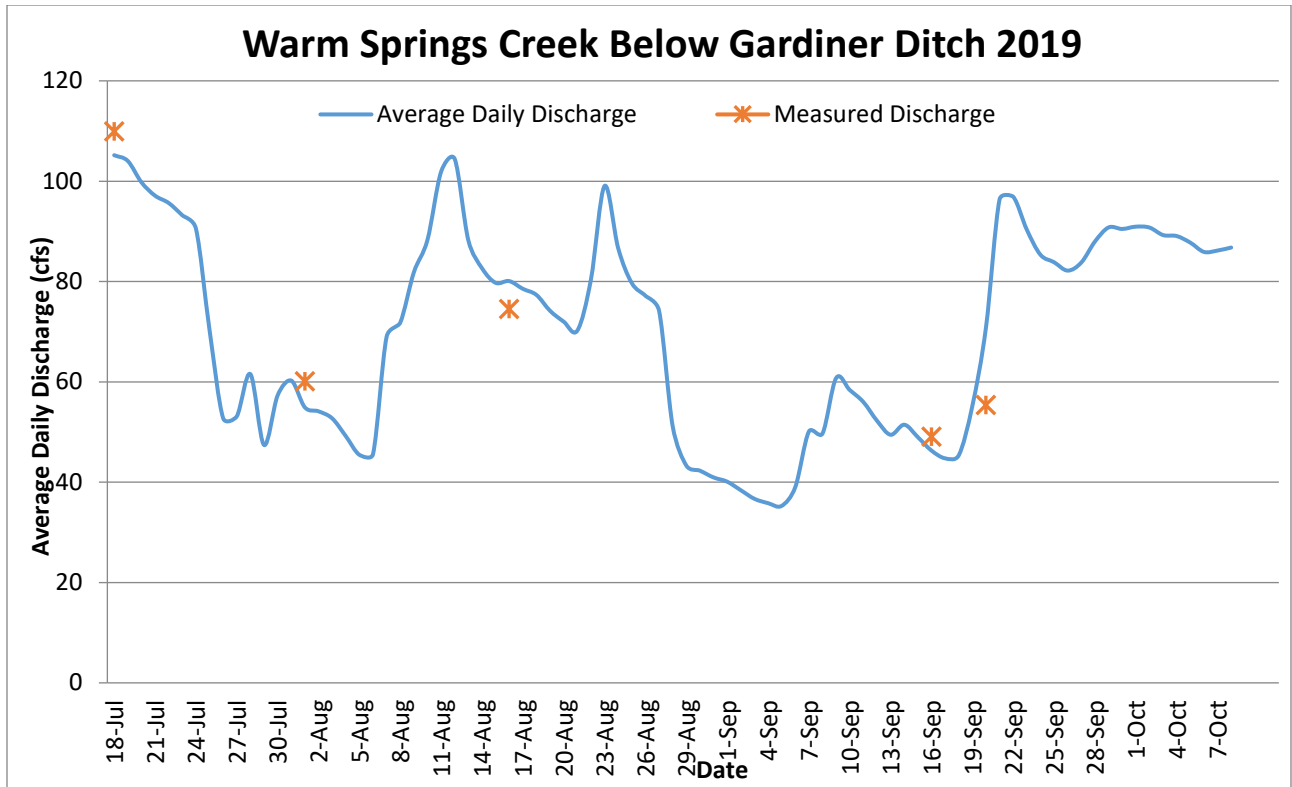


Figure 14- Warm Springs Creek below Gardiner Ditch average daily hydrograph for the 2019 irrigation season.

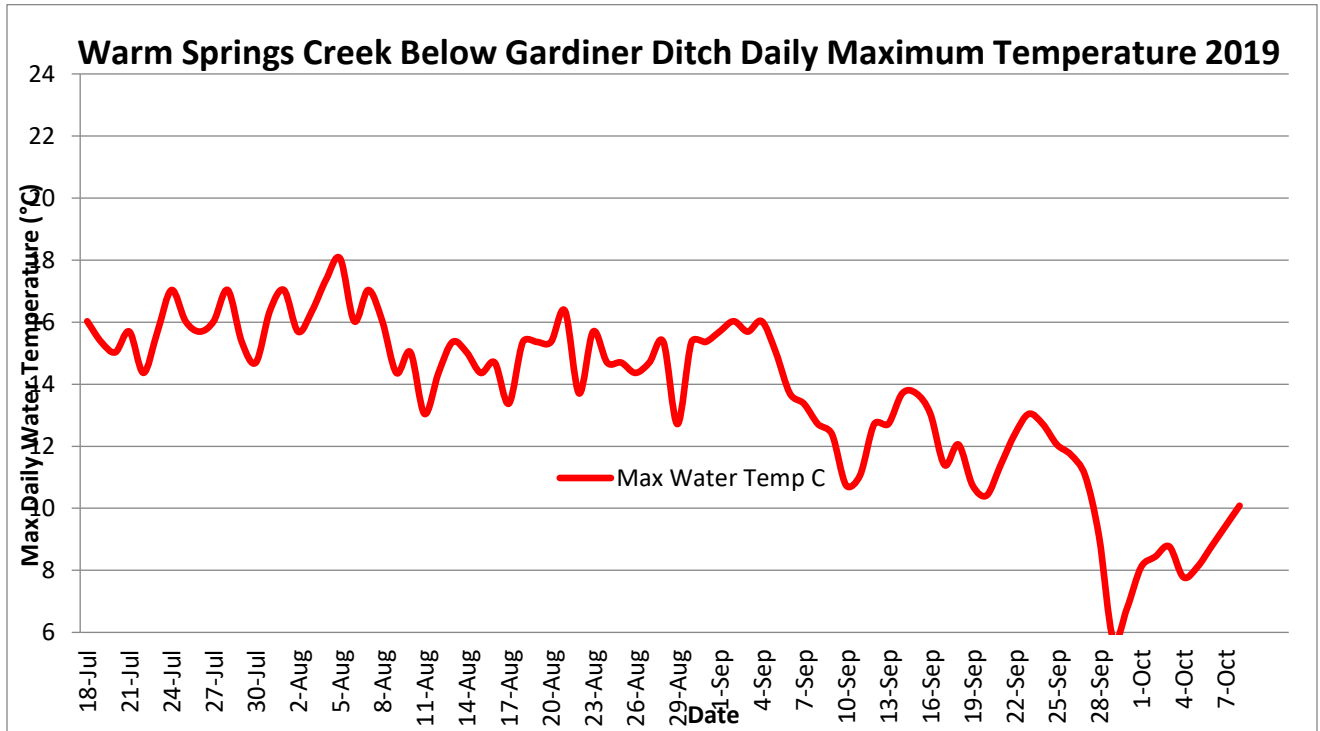


Figure 15- Warm Springs Creek below Gardiner Ditch average daily temperature for the 2019 irrigation season.

<b>Baggs Cr at Pigs Palace Monitoring Station</b>		
Date	Time of Measurement	Discharge
6/26/2019	11:28am	7.826
7/17/2019	1:55pm	3.57
8/20/2019	11:54am	0.953
9/20/2019	12:37pm	2.97
<b>Cottonwood Creek below Applegate Diversion #1</b>		
Date	Time of Measurement	Discharge
6/26/2019	10:29am	10.363
7/17/2019	12:24pm	1.312
8/20/2019	12:30pm	1.839
9/20/2019	1:14pm	4.41
<b>Cottonwood Creek Above Applegate Diversion #2</b>		
Date	Time of Measurement	Discharge
6/13/2019	11:40am	1.681
7/17/2019	11:04am	1.003
8/20/2019	10:39a	1.649
9/20/2019	11:22am	4.83
<b>Cottonwood Creek Below Applegate Diversion #2</b>		
Date	Time of Measurement	Discharge
6/13/2019	11:33am	1.952
7/17/2019	11:36am	0.847
8/20/2019	11:05a	1.543
9/20/2019	11:50am	3.21
<b>Modesty Creek above RR Grade</b>		
Date	Time of Measurement	Discharge
8/1/2019	1:15pm	7.469
8/14/2019	12:39p	7.821
<b>Alvi Beck Ditch at DCCR</b>		
Date	Time of Measurement	Discharge
24-Jun	11:45am	7.232
7/10/2019	11:28am	7.502
7/31/2019	12:00pm	2.97

Table 16- Spot measurements for the 2019 irrigation season.

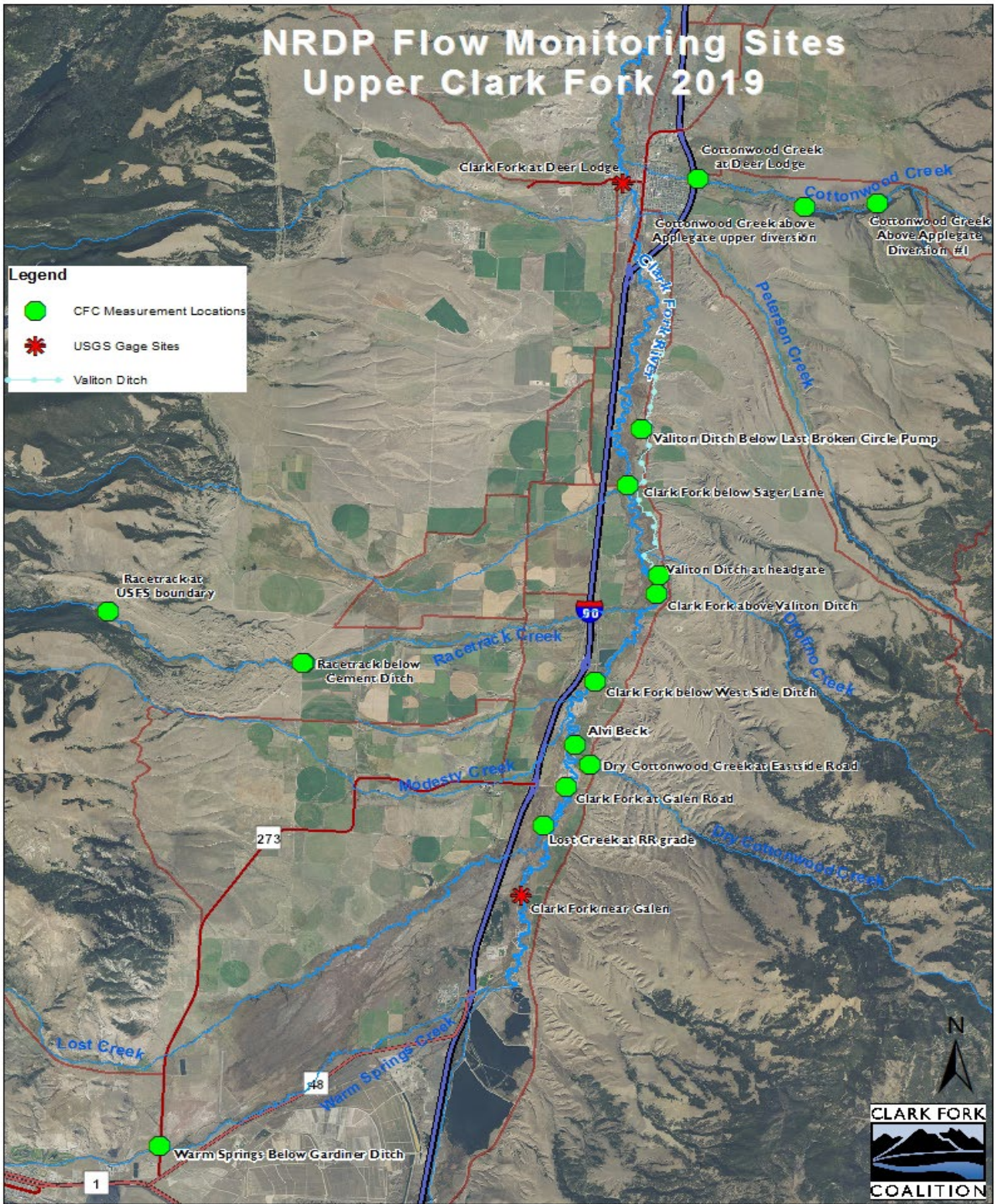


Figure 17- Map of continuous measurements sites for the 2019 irrigation season. Racetrack Lake dam outlet site not included due to map scale.