APPENDIX E

Evaluation of Interim Water Temperature Control Measures

Rock Creek-Cresta Project, FERC No. 1962

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ATTACHMENTS

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1. INTRODUCTION

Pacific Gas and Electric Company (PG&E) operates the Rock Creek-Cresta Hydroelectric Project (Federal Energy Regulatory Commission [FERC] No. 1962) (RCC Project), in the North Fork Feather River (NFFR). During the relicensing of the RCC Project as part of a settlement agreement, PG&E agreed to maintain mean daily water temperatures at or below 20° Celsius (C) in the Rock Creek and Cresta reaches to the extent that PG&E can "reasonably control temperatures." Included in the RCC Project license was a Federal Power Act Section 4(e)[1] condition (Condition No. 4.D) that requires PG&E to submit a report that evaluates whether mean daily temperatures below 20°C or less have or will be achieved in the RCC Project, and if not, whether additional water temperature control measures could be implemented reasonably to meet the stipulation in the settlement agreement. After evaluating options for reducing water temperature, PG&E concluded, and documented in a report, that containing water temperature at or below 20°C in the two reaches is not feasible (2005 Informational Report) (PG&E 2005).

While the 2005 Informational Report did fulfill PG&E's requirement in Condition No. 4.D to address water temperature control measures, it was presented as a document "for informational purposes only." At the recommendation of the Ecological Resources Committee (ERC) and Forest Service staff affiliated with the RCC Project, submission of a report that satisfied the Forest Service Section 4(e) requirement (4.D Report) was postponed until issuance of the impending Upper North Fork Feather River Hydroelectric Project, FERC No. 2105 (UNFFR Project), license. This delay was implemented because of the uncertainty about stipulations in the new license for the UNFFR Project specifically related to the types of flows and project modifications that could affect water temperature in the Rock Creek and Cresta reaches.

In 2012, in lieu of the 4.D Report, FERC required PG&E to develop a proposal in consultation with the ERC and Forest Service to implement interim water temperature control measures (IWTCM). PG&E developed the *Interim Temperature Control Measures Plan* (Plan) and submitted it to FERC on April 30, 2012 (Attachment A). On July 18, 2012, FERC issued an order approving the Plan under Article 401 and Forest Service 4(e), Condition No. 4.D.

PG&E has implemented the IWTCMs since 2012 and reported the resulting water temperatures annually to FERC, the ERC, and the Forest Service. This report provides an evaluation of the IWTCMs that have been implemented. It includes:

- A description of water temperature dynamics in the NFFR from Lake Almanor to the Cresta Reach
- A description of the IWTCMs
- A summary of the impact of each measure to water temperature in the Rock Creek and Cresta reaches for the 2012–2020 period
- An assessment of the effectiveness of the IWTCMs in containing water temperature below 20°C in the Rock Creek and Cresta reaches

[1] Federal Power Act Section 4(e) authorizes federal land managers to impose mandatory conditions on the licensee.

All discussions of flows and water temperature in this report are for the period between June and September of each year, when mean daily water temperatures approach and exceed 20ºC in the Rock Creek and Cresta reaches.

2. SETTING

The RCC Project is in the NFFR Watershed, which houses four other PG&E-operated hydroelectric projects (Figure 1):

- Hamilton Branch Project
- UNFFR Project;
- Bucks Creek Hydroelectric Project, FERC No. 619 (Bucks Creek Project)
- Poe Hydroelectric Project, FERC No. 2107 (Poe Project).

The NFFR Watershed, which drops from elevations above 8,000 feet to less than 900 feet, experiences warm, dry summers that extend between early June and late September. Precipitation in the region occurs predominantly between November and May, with significant annual variability. Snowpack develops at higher elevations during the winter, which can persist until late spring. At lower elevations precipitation transitions to rainfall. Between July and September little to no precipitation falls along the NFFR Watershed.

Climatic variability in the region results in significant fluctuations in air temperature during the summer (Figure 2). Water temperature in the NFFR and its tributaries is driven by ambient air temperature in the canyon, increasing from early spring to late July and early August, before beginning a steady decline. Superimposed on the seasonal variability in air temperatures is a diurnal fluctuation that is also prevalent in stream temperatures.

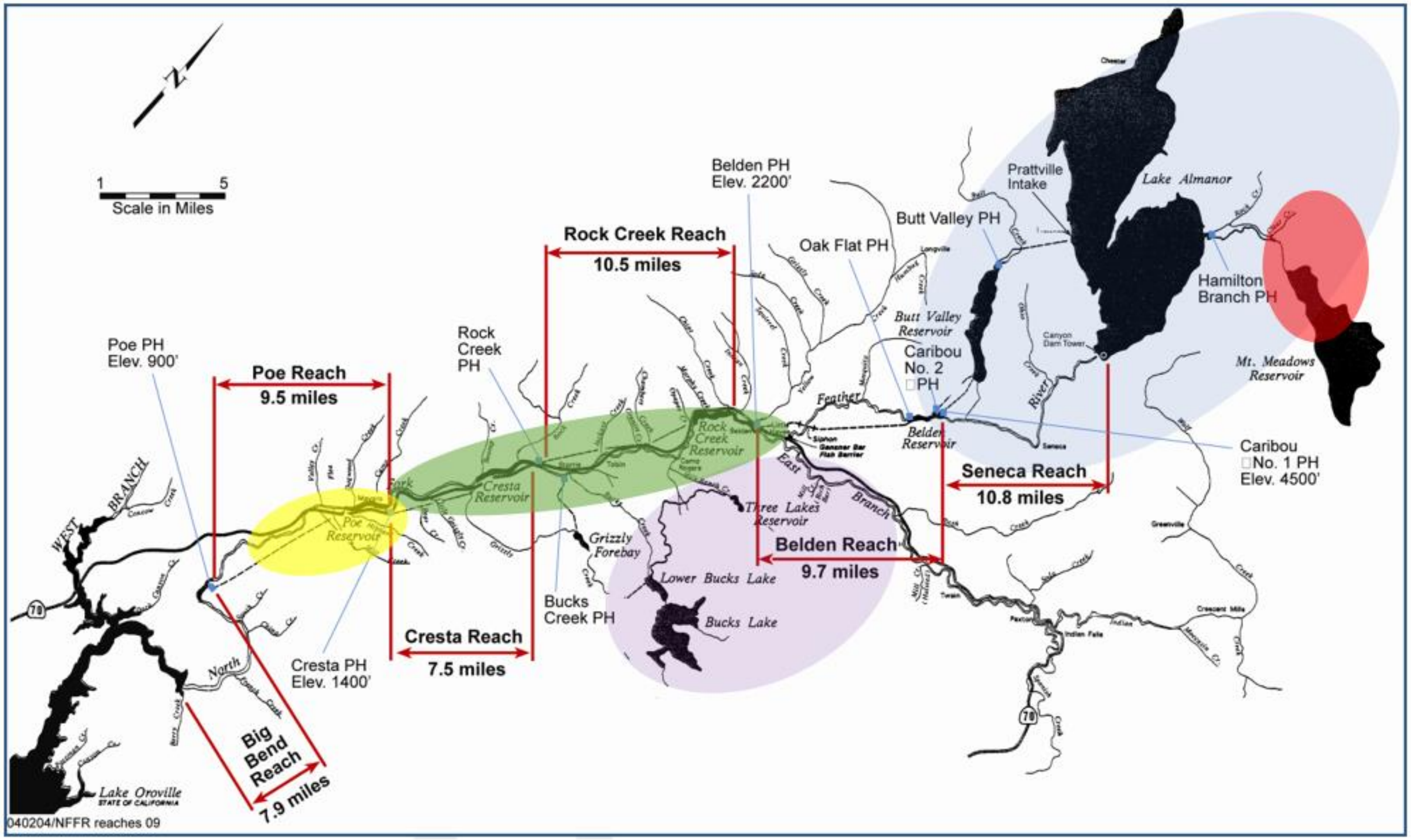


Figure 1: Location of hydroelectric projects along the North Fork Feather River Watershed
The Rock Creek-Cresta Project footprint is shown in green. Included are tributaries to the river.

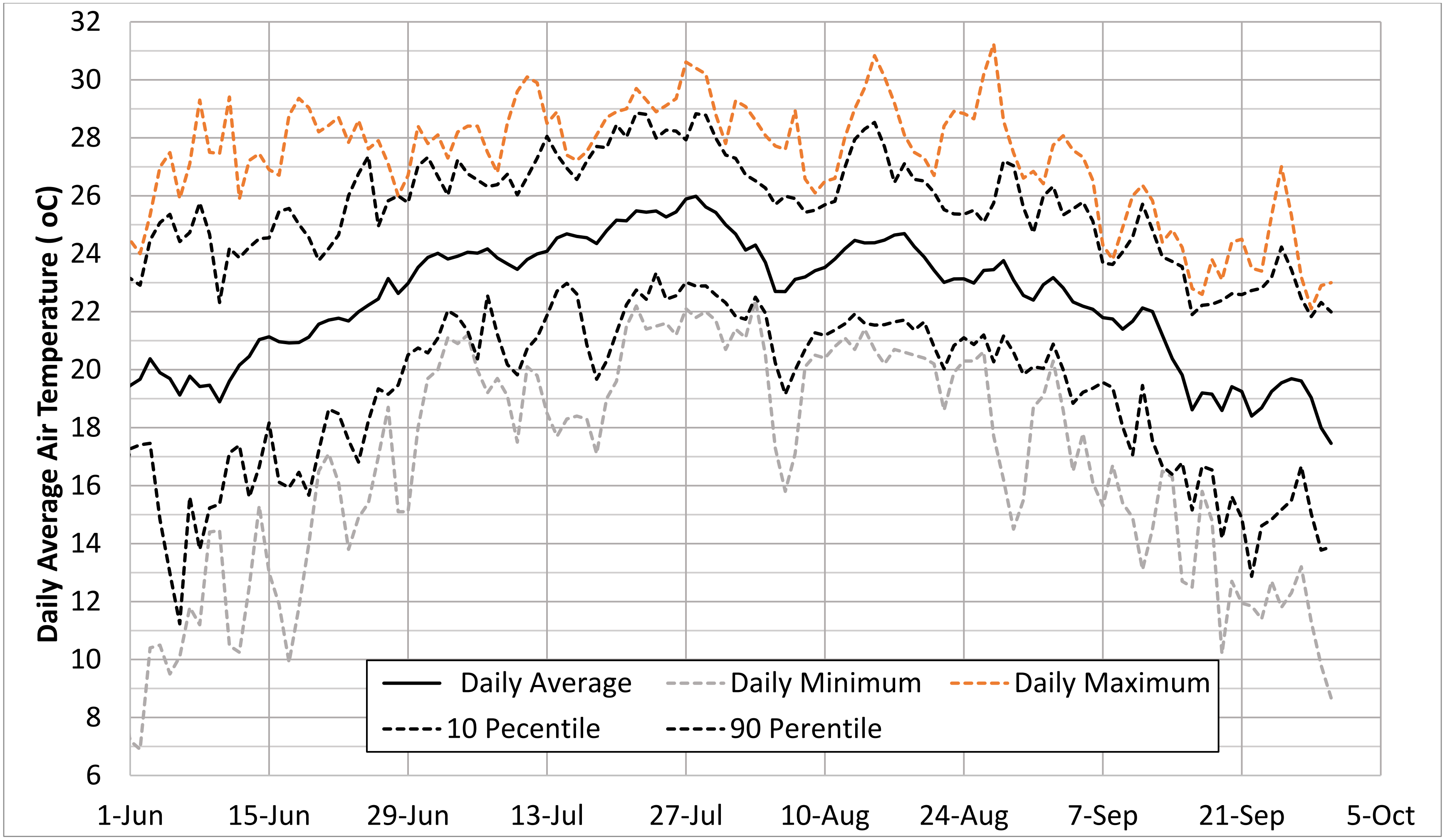


Figure 2: Air temperature measured at Rock Creek Dam (2002–2019)

2.1 HYDROLOGY

The source of water in the NFFR is predominantly snowfall in the higher elevations and rainfall in the lower reaches. Numerous tributaries are distributed along the NFFR (Figure 1) that originate at different elevations. Over the winter, the snowpack serves as a reservoir releasing water as snowmelt in the spring and early summer. In recent years the snowpack has diminished, resulting in less flows to the NFFR and its tributaries and an earlier culmination of the snowmelt period.

Associated with the hydroelectric projects in the NFFR Watershed is PG&E's intricate plumbing system that diverts river flows through a series of tunnels and conduits to supply water to the powerhouses (Figure 3).

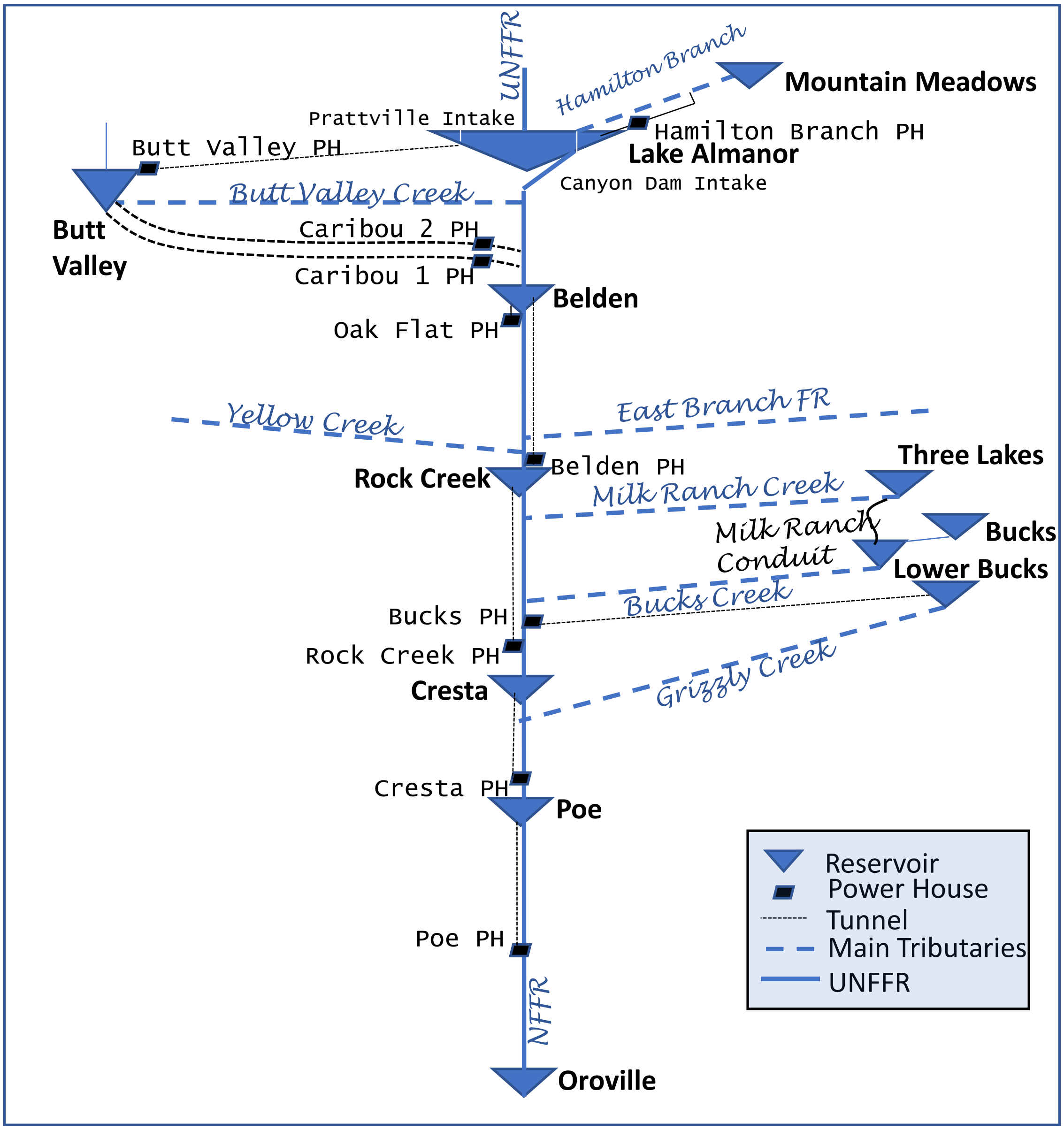


Figure 3: Plumbing along the North Fork Feather River Watershed

Integral to the plumbing system are two prominent reservoirs, Lake Almanor and Butt Valley Reservoir, located at the upstream end of the NFFR. Lake Almanor, which has a maximum storage capacity of approximately 1.143 million acre-feet, is the largest source of water flowing down the NFFR during the summer. Water is released either via Canyon Dam or the Prattville Intake. Water released from Canyon Dam travels down the Seneca Reach for approximately 11 miles before flowing into the Belden Reservoir. Summer flow releases in the Seneca Reach are set to meet minimum instream flow (MIF) requirements of 35 cubic feet per second (cfs) as stipulated in the current UNFFR Project license, but as the data from the 2002–2020 period show, flows were always higher than the MIF requirement (Figure 4a). Water released at the Prattville intake goes through the Butt Valley Powerhouse and into Butt Valley Reservoir.

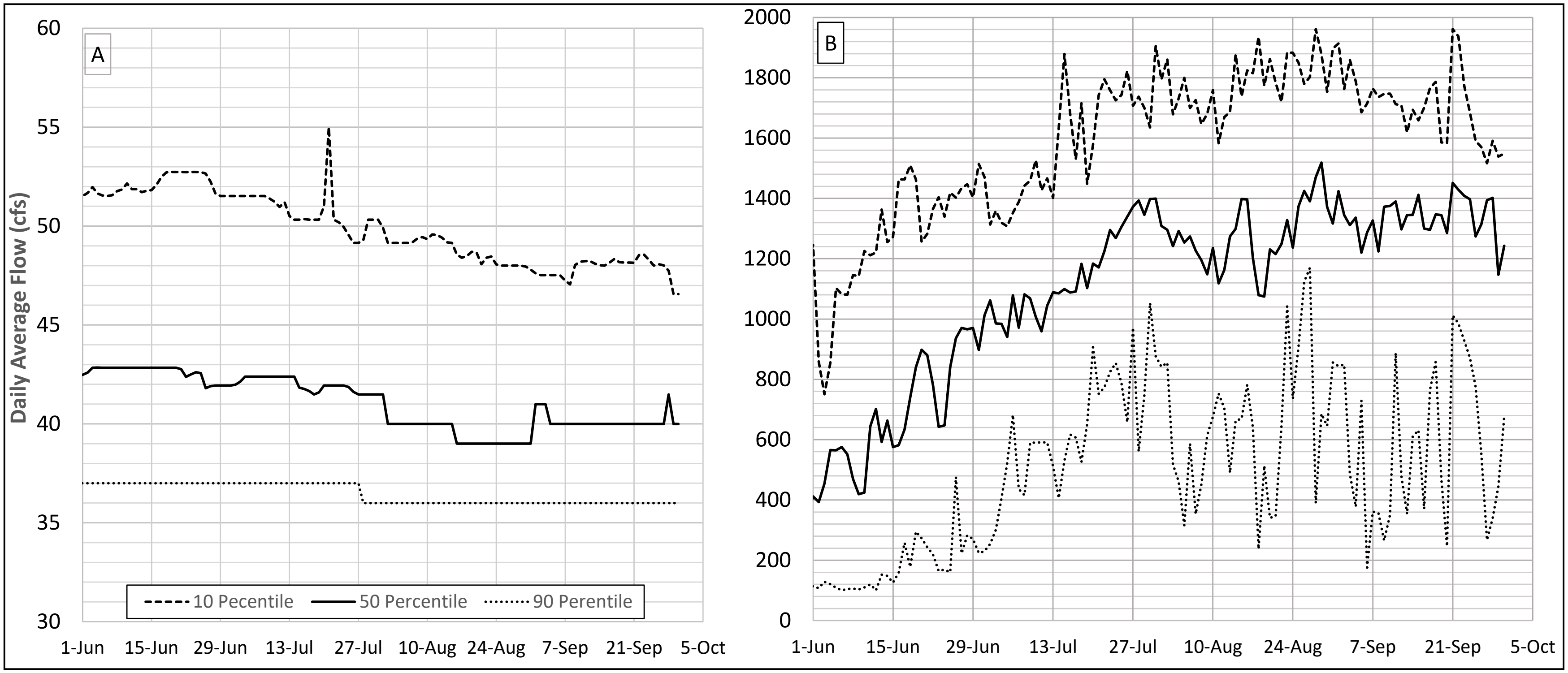


Figure 4: Daily average flows measured between 2000 and 2020 immediately downstream of (A) the outlet at Canyon and (B) Caribou 1 and 2 powerhouses

Flows are expressed in the 10, 50, and 90 percentiles.

Butt Valley reservoir has a storage capacity of approximately 49.9 thousand acre-feet. Water from this reservoir is channeled to the Caribou 1 and 2 powerhouses (referred hereon as the Caribou Complex) from the Caribou 1 and Caribou 2 inlets in Butt Valley Reservoir. For the 2000–2020 period, the daily average summer flows through the Caribou Complex ranged between 500 and 1,500 cfs and were occasionally greater than 2,000 cfs (Figure 4b).

Flows released from the Caribou Complex are discharged to the NFFR at the head of Belden Forebay. The flow of the NFFR includes MIF releases from Canyon Dam and flow accretion along the Seneca Reach (Figures 1 and 3). Releases to the NFFR below Belden Dam (the Belden Reach) are normally made directly or via the Oak Flat Powerhouse located on the base of the dam. The current MIF for the Belden Reach is 60 cfs from Labor Day to the last Saturday in April and 140 cfs from the last Saturday in April through Labor Day. (The Belden Reach extends about 10 miles to Rock Creek Reservoir.) Water from Belden Reservoir is also diverted to the Belden Tunnel, which takes the water to the Belden Powerhouse, from where it is discharged to the Yellow Creek, just above its confluence with the NFFR and Rock Creek Reservoir. The East Branch of the Feather River (EBFR) and Yellow Creek are both tributaries to the Belden Reach.

Water in the Rock Creek Reservoir is normally either diverted through a tunnel to the Rock Creek Powerhouse or released from Rock Creek Dam through the low-level outlet (LLO) and radial gate. During high flows, water is released over the drum gates. Two main tributaries (Milk Ranch Creek and Bucks Creek) drain into the Rock Creek Reach. In addition, flows from Bucks Creek Powerhouse, which receives water from Bucks Lake, Lower Bucks Lake, and Grizzly Forebay, are also released into the NFFR immediately downstream of Bucks Creek.

Water entering Cresta Reservoir includes MIF releases from Rock Creek Dam, releases from Rock Creek and Bucks Creek powerhouses, and flows from Milk Ranch and Bucks Creek. The water in the reservoir is normally either diverted through a tunnel to the Cresta Powerhouse or released from Cresta Dam through the LLO and radial gate. Water enters the Cresta Reach via releases from the Cresta Dam, Grizzly Creek, and Cresta Powerhouse, all of which then flows into Poe Reservoir.

The RCC Project license identifies three test periods (Test Periods 1, 2, and 3) associated with the RCC Project license that were set up to evaluate the effects of a range of MIFs on specific biological resources. Summer MIFs from the Rock Creek and Cresta dams, as prescribed in the current project license, are shown in Table 1. The MIFs for each month of each year were determined on the designation of three water-year type designations (i.e., Normal and Wet, Dry, and Critically Dry) and for three distinct test periods, (i.e., 2002–2006, 2007–2014, and 2015–2020). Figure 5 includes flows measured in Rock Creek and Cresta reaches between 2002 and 2020.

Table 1. Minimum Instream Flows for the Rock Creek and Cresta Reaches (2002–2021)

			Rock Creek Reach				Cresta Reach			
Year	**Water Year Type**	**Test Preriod**	***June***	***July***	***August***	***September***	***June***	***July***	***August***	***September***
2002	Normal	1	220	180	180	180	240	220	220	220
2003	Normal		220	180	180	180	240	220	220	220
2004	Normal		220	180	180	180	240	220	220	220
2005	Normal		220	180	180	180	240	220	220	220
2006	Wet		220	180	180	180	240	220	220	220
2007	Critically Dry	2	150	150	150	150	140	140	140	140
2008	Critically Dry		150	150	150	150	140	140	140	140
2009	Dry		210	210	210	210	400	260	260	260
2010	Normal		260	260	260	260	500	325	325	325
2011	Wet		260	260	260	260	500	325	325	325
2012	Dry		210	210	210	210	400	260	260	260
2013	Dry		210	210	210	210	400	260	260	260
2014	Critically Dry		150	150	150	150	140	140	140	140
2015	Critically Dry	3	150	150	150	150	140	140	140	140
2016	Normal		390	390	390	390	460	440	351	300
2017	Wet		390	390	390	390	460	440	351	300
2018	Normal		390	390	390	390	460	440	351	300
2019	Wet		390	390	390	390	460	440	351	300
2020	Critically Dry		150	150	150	150	140	140	140	140
2021	Critically Dry		150	150	150	150	140	140	140	140

Note: Test Periods 1–3 are the durations over which specific minimum instream flow regimes (MIF) were applied. The MIFs during each test period were determined by water-year type.

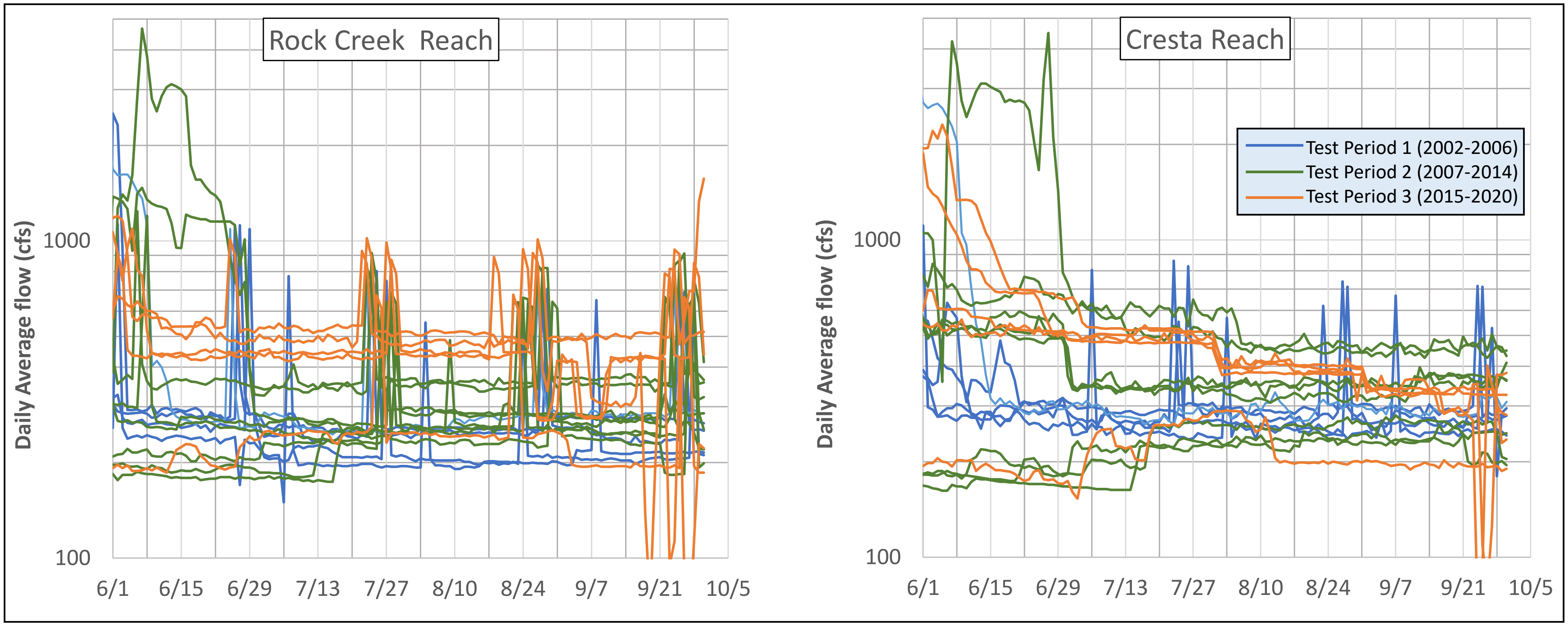


Figure 5: Measured flows in Rock Creek and Cresta reaches

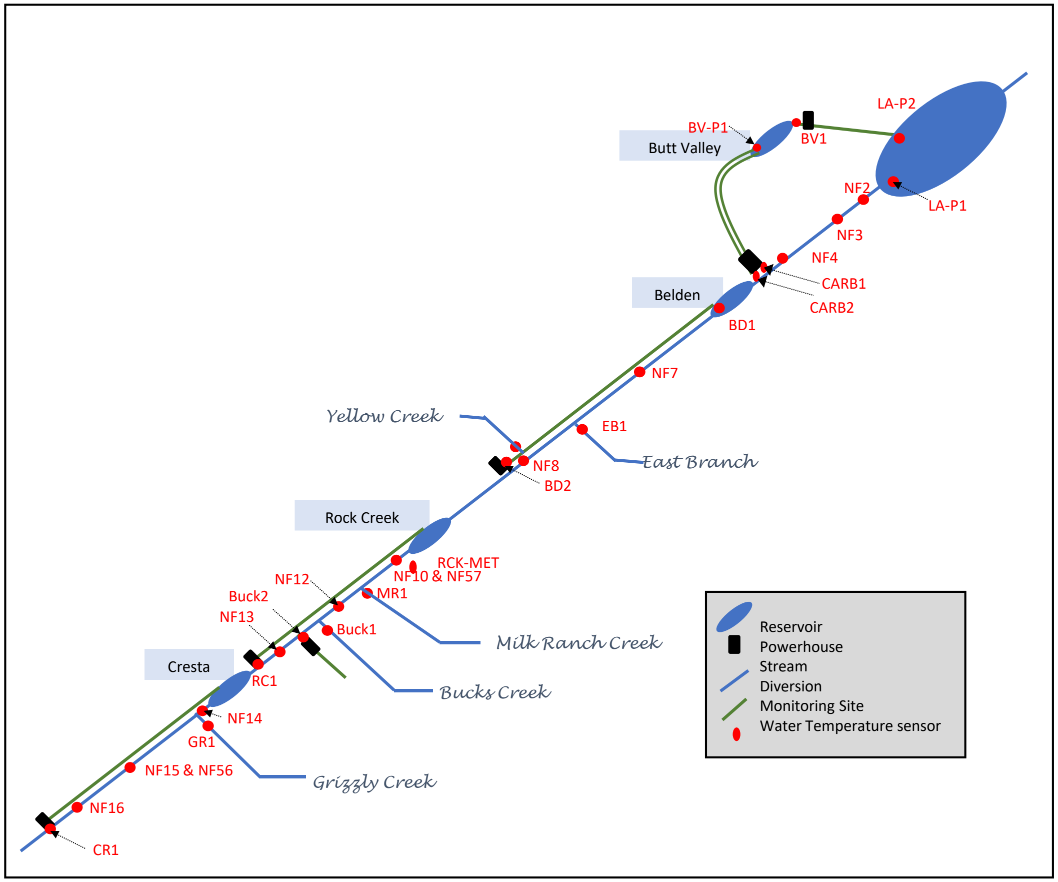
Individual lines include flows for specific years. Line colors indicate specific test periods as identified in the RCC Project License. Flows are for the summer months June–September, the period when water temperatures exceeded 20ºC.

2.2 WATER TEMPERATURE DYNAMICS

Water temperature has been measured along the NFFR since 2002 (Figure 6) as part of the compliance-required activities of the RCC Project license. Observations from this monitoring campaign provide insights about water temperature dynamics along the NFFR during the summer period (i.e., June through September) from 2002 to 2020.

Between 2002 and 2020, each summer the average daily water temperature in Rock Creek and Cresta reaches typically began to exceed 20ºC in June and continued to rise until late July/early August before beginning to decline (Figure 7).

Lake Almanor and Butt Valley Reservoir developed a prominent thermocline over the course of the summer, which then dissipated in the fall as cooler air temperatures prevailed. Water temperature measured close to the peak development of the thermocline in both reservoirs in late June from 2012 through 2022, as shown in Figure 8.



ID	Location	Latitude	Longitude
LA – P1	Lake Almanor near Canyon Dam – near intake	40°10'34.00"N	121°05'19.30"W
LA – P2	Lake Almanor - Offshore of Prattville Intake (LA2)	40°12'59.80"N	121°09'36.80"W
NF2	NFFR below Canyon Dam (at NF-2)	40°10'09.09"N	121°05'33.94"W
NF3	NFFR at Seneca	40°07'02.45"N	121°05'03.87"W
NF4	NFFR above Caribou No.1 Powerhouse	40°05'08.08"N	121°08'48.04"W
BV1	Butt Valley Powerhouse Tailrace	40°10'32.21"N	121°11'25.82"W
BV-P1	BVR at Caribou No. 1 Intake	40°07'00.00"N	121°08'44.90"W
CARB1	Caribou No. 1 Powerhouse (internal)	40°05'07.84"N	121°08'53.98"W
CARB2	Caribou No. 2 Powerhouse tailrace (internal)	40°05'09.27"N	121°08'57.76"W
BD1	Belden Reservoir at powerhouse intake	40°04'32.68"N	121°09'34.68"W
NF7	NFFR near Gansner Bar	40°01'0.54"N	121°13'21.00"W
EB1	East Branch of NFFR above confluence	40°00'51.01"N	121°13'25.74"W
NF8	NFFR at Belden Town Bridge	40°00'23.97"N	121°14'49.56"W
BD2	Belden Powerhouse (internal)	40°00'26.85"N	121°14'58.45"W
YC1	Yellow Creek near mouth	40°00'36.90"N	121°14'55.70"W
RCK-MET	Meteorological Station on Rock Creek Dam	39°59'13.04"N	121°16'59.33"W
NF10	NFFR below Rock Creek Dam at NF-57	39°58'48.10"N	121°16'37.60"W
MR1	Milk Ranch Creek near mouth	39°57'39.72"N	121°16'26.02"W
NF12	NFFR above confluence with Bucks Creek	39°54'56.82"N	121°19'29.61"W
BUCK1	Bucks Creek near mouth	39°54'50.75"N	121°19'34.09"W
BUCK2	Bucks Creek Powerhouse tailrace	39°54'38.42"N	121°19'40.26"W
NF13	NFFR above Rock Creek Powerhouse	39°54'20.61"N	121°20'39.45"W
RC1	Rock Creek Powerhouse (internal)	39°54'17.64"N	121°20'42.87"W
NF14	NFFR below Cresta Dam	39°52'07.53"N	121°22'25.97"W
GR1	Grizzly Creek near mouth	39°52'04.49"N	121°22'22.25"W
NF15	NFFR downstream of Grizzly Creek at NF-56	39°51'08.00"N	121°23'32.84"W
NF16	NFFR upstream of Cresta Powerhouse	39°49'36.86"N	121°24'36.18"W
CR1	Cresta Powerhouse (tailrace)	39°49'33.29"N	121°24'36.05"W

Figure 6: Water temperature monitoring stations used in the assessment of interim water temperature control measures
The embedded table includes a brief description of the location of the stations.

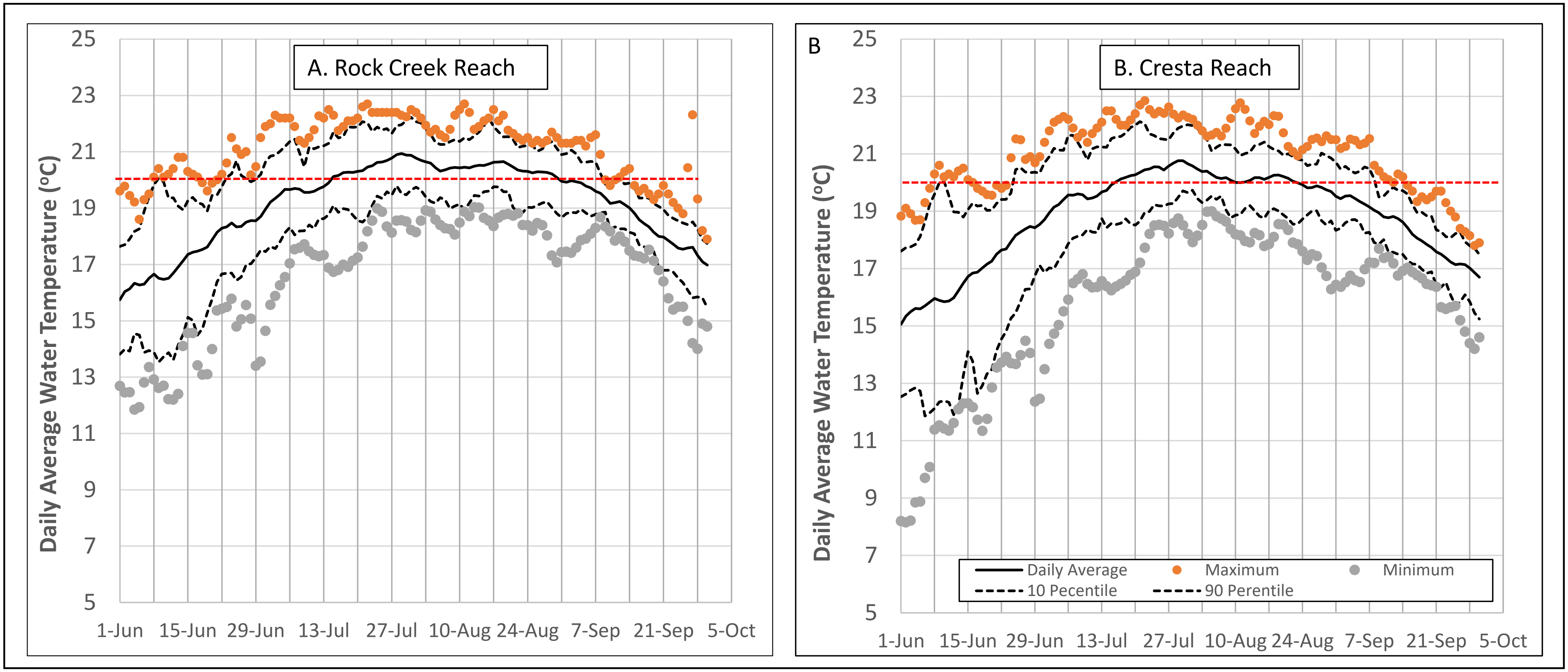


Figure 7: Statistics related to average daily water temperature measured for the 2002–2020 period
Dashed redline indicates the 20ºC threshold.

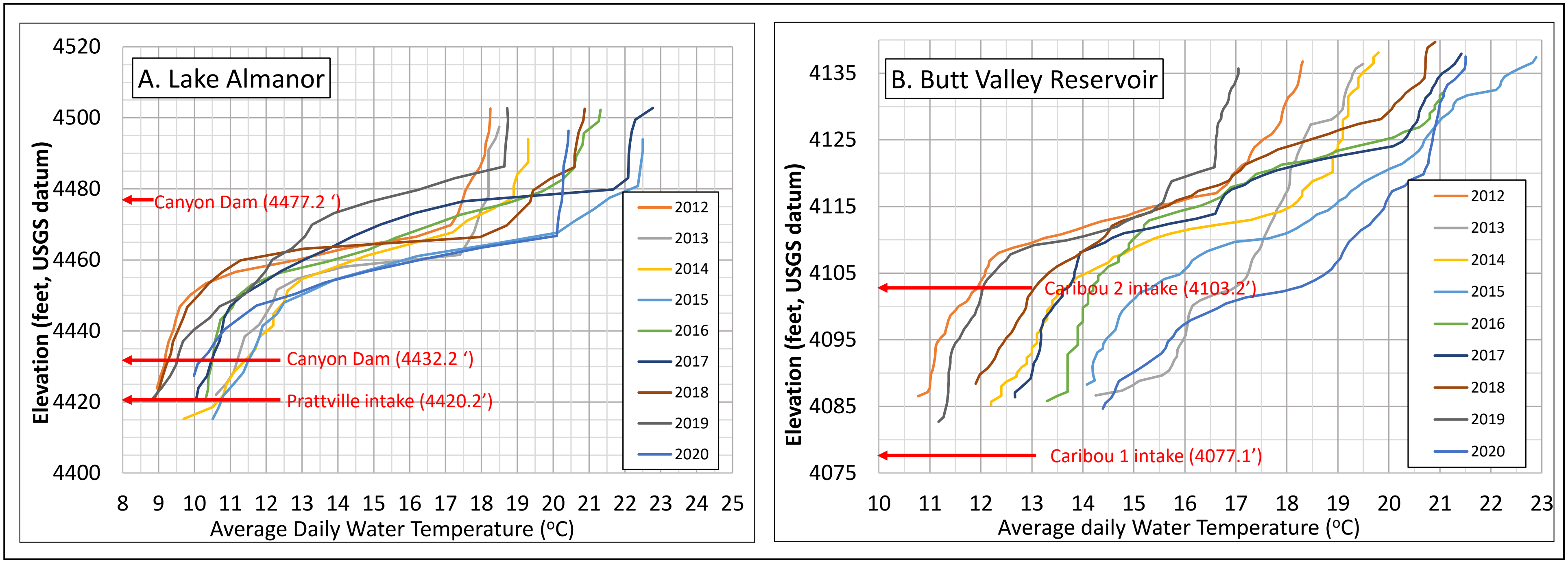


Figure 8: Water temperature measured along the vertical profile of Lake Almanor and Butt Valley Reservoir during the last week of June, from 2012 to 2020

Included are the approximate locations of the inlets in both reservoirs. Note the intakes for Canyon dam releases are at two elevations.

During the summer water released through the Prattville intake was 0.2–0.5ºC cooler than the releases from Canyon Dam LLO (Figure 9). The releases were cooler because the Prattville intake generally accesses colder water from deeper in the reservoir. As water from the Prattville intake traveled to the Caribou 2 intake in Butt Valley Reservoir, the temperature increased by 3–8.5ºC (Figure 9). A cooler pool of water (about 8,000 acre-feet) can be found in Butt Valley Reservoir, located below the elevation of the Caribou 2 intake during the summer. Between 2002 and 2020, this pool was up to 1–3.5ºC cooler than the water released into the Caribou 2 intake (Figure 8b). The Caribou 1 Powerhouse taps into this pool, but the cooler water in this pool is rapidly depleted because the pool is relatively small, and as water is drawn down it likely mixes with the warmer overlying water. Between 2002 and 2020, flows to the Caribou Complex were typically close to 1,000 cfs around late June/early July.

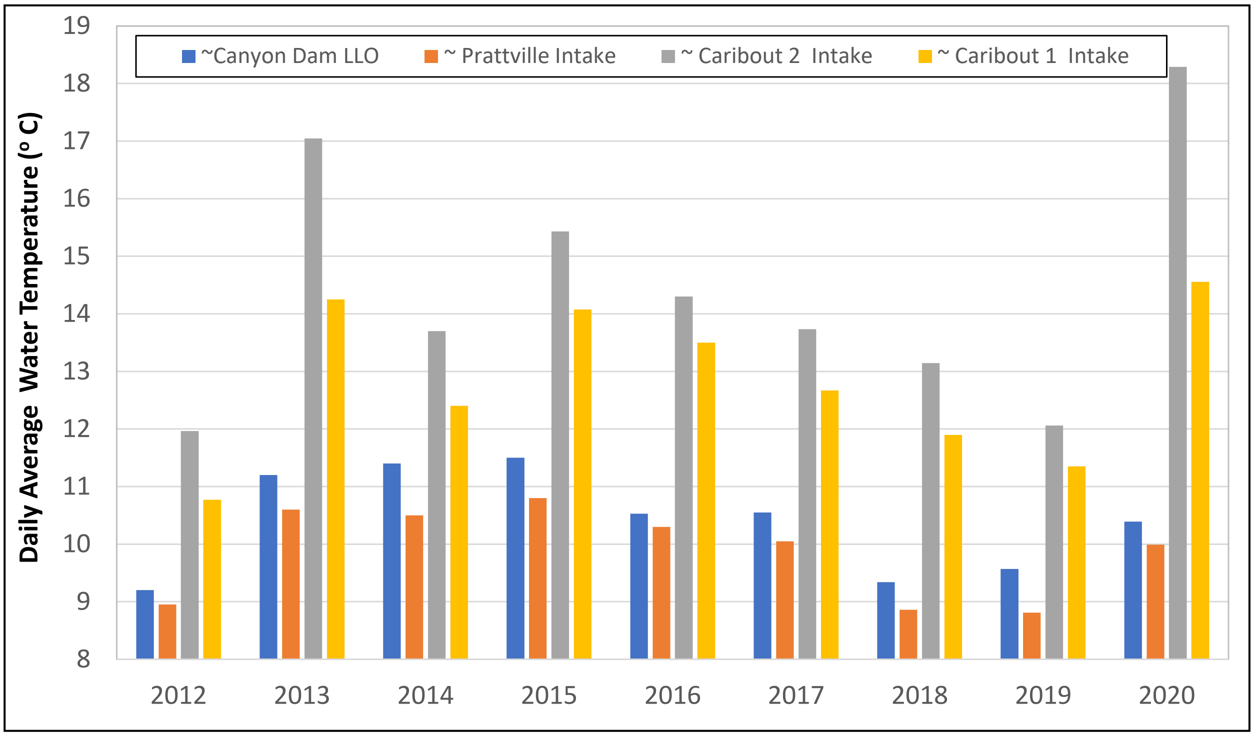


Figure 9: Average daily temperature measured during the last week of June at Lake Almanor water release points (Canyon Dam and Prattville) and Butt Valley Reservoir (Caribou 1 and 2)

Water exiting Canyon Dam and traveling down Seneca Reach warmed by up to 2.5ºC before reaching the Caribou Complex releases (Figure 10). Once it mixed with the warmer Caribou Complex releases, water temperature in the NFFR increased by approximately 5ºC. Flows along the Belden, Rock Creek, and Cresta reaches remained close to or slightly warmer than the water released from Belden Reservoir, with notable changes observed at the confluence of the East Branch of the NFFR (i.e., warming at NF8) and Bucks Creek (i.e., cooling at NF13).

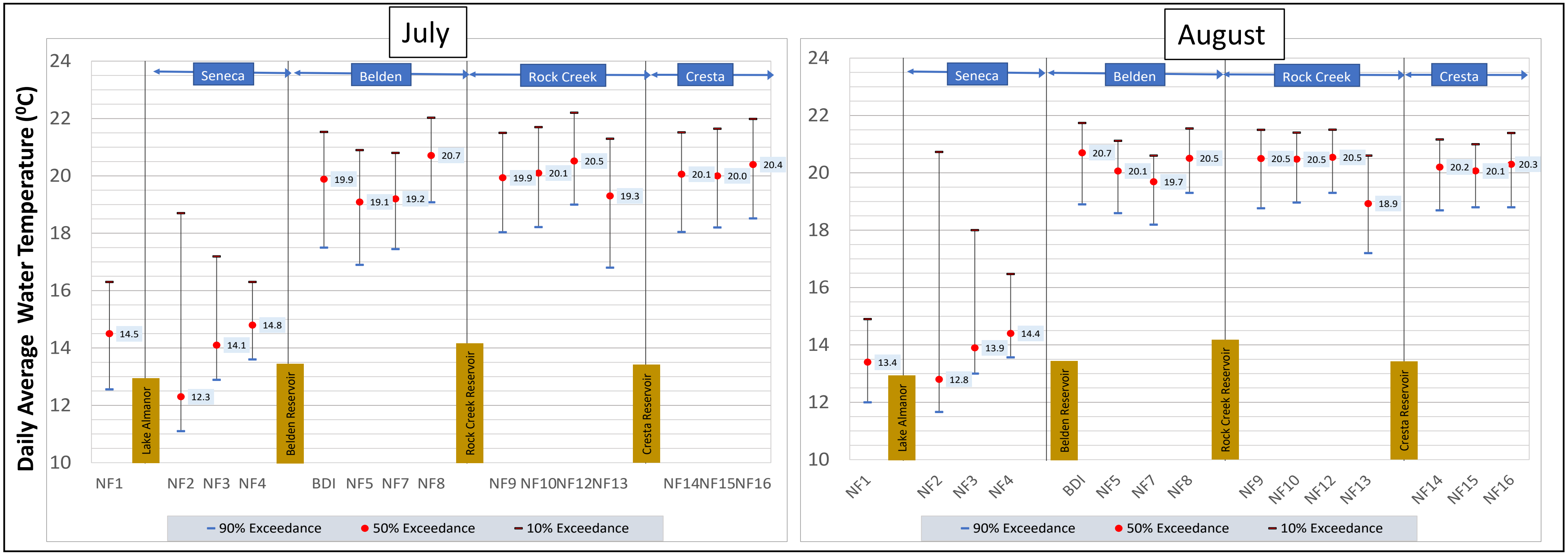


Figure 10: Water temperature exceedances (10%, 50%, and 90%) along the NFFR measured 2002–2020 in July–August
The lower x axis is the name of monitoring stations located on each reach along the NFFR (as identified in Figure 6).

The consistent water temperature that predominantly persists along the approximately 30 miles between Belden Reservoir and Poe Reservoir are influenced by flow diversions through the Belden, Rock Creek, and Cresta powerhouses. In each case a relatively large volume of water (i.e., typically greater than 1,000 cfs) is diverted into tunnels from each reservoir. This water maintains its temperature as it travels along approximately 10 miles of tunnels in each reach, because it is not exposed to atmospheric warming. Because the MIFs are significantly smaller (i.e., less than 350 cfs) the temperature of the water after mixing remains closer to that of the water released through the tunnels and powerhouses. Also, all three powerhouse tailraces discharge directly to the small forebay of the downstream unit, so air temperature does not influence flows as much. As a result, the bulk temperature of water entering each of the three reservoirs remains similar.

3. INTERIM WATER TEMPERATURE CONTROL MEASURES

Five IWTCMs are described in a document submitted to FERC in 2012 (Attachment A), and the descriptions are summarized below:

Measure 1

If the daily average water temperature in the Rock Creek or Cresta reach exceeds the 20ºC criterion for 2 consecutive days, PG&E will maximize the release of the minimum instream flow requirement at each reservoir to the LLO located approximately 30 feet below the invert of the radial gates. The change in the water release from the surface radial gate to the LLO could potentially provide deeper, cooler water to the Cresta and Rock Creek reaches.

Measure 2

PG&E will implement a program that will preferentially operate the Caribou 1 Powerhouse over the more efficient Caribou 2 Powerhouse once the temperature criterion is exceeded. Caribou 2 primarily withdraws surface water whereas Caribou 1 Powerhouse has the potential to access a limited amount of colder water from the deeper portions of Butt Valley Reservoir and deliver to the Rock Creek and Cresta reaches. To preserve the finite amount of colder water in Butt Valley Reservoir, PG&E will attempt to maintain Butt Valley Reservoir at maximum pool and minimize the operation of Caribou 1 until July 15 or the first occurrence of average daily temperatures in either the Rock Creek Reach (NF-57) or Cresta Reach (NF-56) exceeding 20ºC for 2 days, whichever occurs sooner. During this special Caribou 1 operation, Caribou 2 will reduce its operation as much as is reasonably possible to minimize mixing the colder water with surface water. This operation lasts 5 days because effective cold-water withdrawal from Caribou 1 diminishes after this period.

Measure 3

PG&E will continue to operate the Bucks Creek Powerhouse in a manner that helps reduce daily average water temperatures both in the lower Rock Creek Reach (between Bucks Creek and Rock Creek powerhouses) and the Cresta Reach. Bucks Creek Powerhouse discharges to the NFFR approximately 1 mile upstream of Rock Creek Powerhouse and has significantly cooler water, which will benefit the lower Rock Creek Reach (about 12 percent of the total Rock Creek Reach) and the Cresta Reach.

Measure 4

During critically dry years, after implementing Interim Measures 1 through 3 and when daily average temperature at NF-57 or NF-56 are above 20ºC, the minimum instream flow from the Rock Creek (150 cfs) and Cresta (140 cfs) dams will be increased to 200 cfs, or to any flow in between 150/140 cfs to 200 cfs, to the extent necessary to contribute to the maintenance of mean daily temperatures of 20ºC or less in the respective reach. The increase will be in daily increments of approximately 20 cfs until which time the daily average temperature is less than or equal to 20ºC or the flow release is 200 cfs.

Similarly, this increased flow shall be reduced back to the minimum instream flow, when not required to maintain mean daily temperatures of 20ºC. Any flow adjustments will be made in the early morning to allow enough time to reflect any temperature change at NF-57 and NF-56 that peaks in the late afternoon.

Measure 5

PG&E, the USFS, and the ERC will finalize a letter of intent (LOI) to participate in ongoing efforts to address fish and amphibian passage issues in tributaries to the North Fork Feather River. This LOI could provide access to cold-water refugia and potentially increase the overall aquatic productivity in the NFFR. PG&E, the USFS, and the ERC recognize that access for aquatic biota to the NFFR tributaries is an issue of great importance not only within the Project waters, but for the health of the entire watershed.

Of these, Measures 1–4 involve manipulations to project operations that alter flows and are evaluated in this report.

4. EFFECTIVENESS OF MEASURES

4.1 MAXIMIZED USE OF THE LOW-LEVEL OUTLETS AT ROCK CREEK AND CRESTA DAMS (MEASURE 1)

The rationale for implementing Measure 1, as indicated in the 2012 report, is that the “The water released from the LLO is cooler than the releases closer to surface.” This implies that a cooler pool of water is available and accessible at the LLO in the Rock Creek and Cresta dams and that the LLO is the only source for releases to the downstream reaches.

Rock Creek and Cresta dams are similarly designed with a 30-inch valve located at mid elevation and a radial gate located approximately 30 feet higher (Figure 11). Sediment buildup exists at both dams: it rises to the LLO in Rock Creek Dam and remains 15–25 feet below the LLO at Cresta Dam.

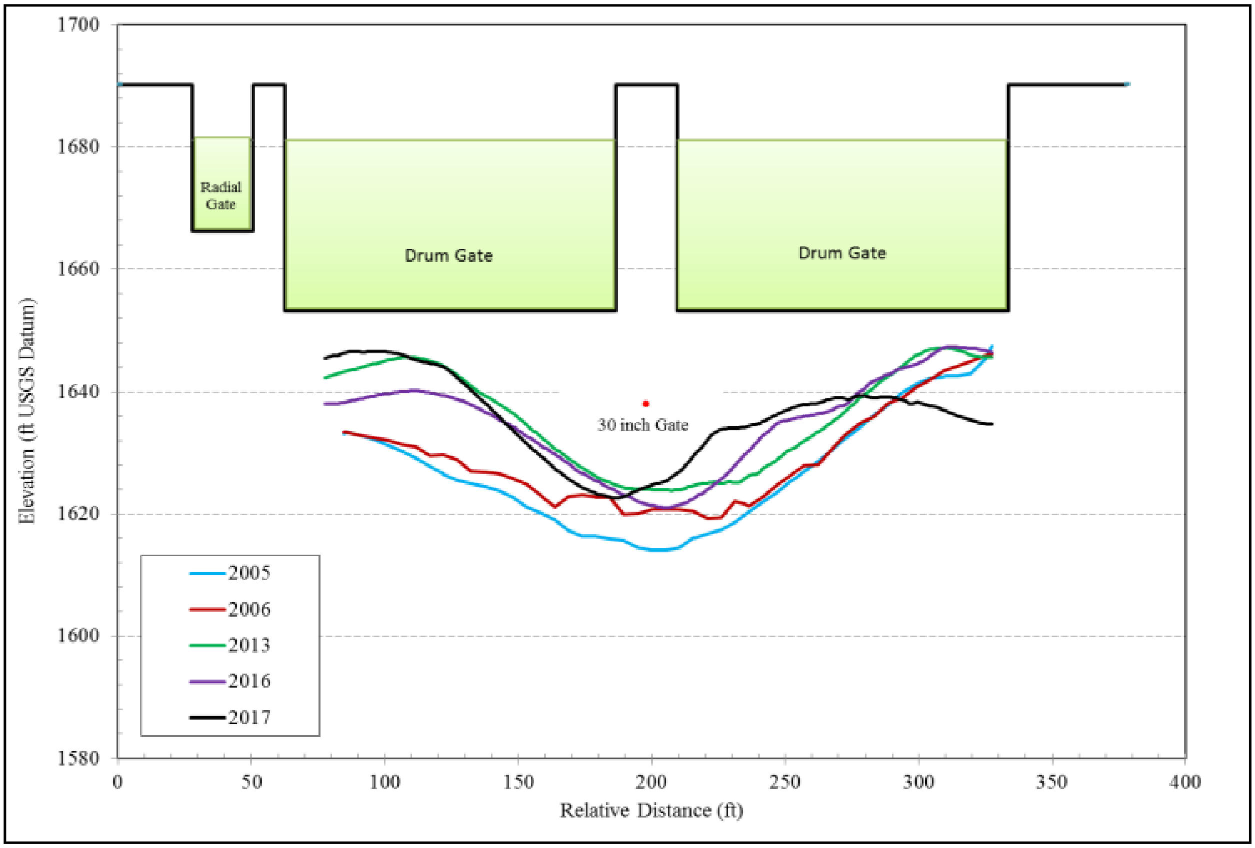


Figure 11: Cresta Dam showing location of 30-inch gate used for minimum instream flows and the radial gate used to supplement flows

Included in the figure are the profile of the sediment buildup along dam at different years. Rock Creek Reservoir is similarly constructed.

The configuration and operations of both dams does not facilitate development of a cooler, deeper pool in the reservoirs because of the small storage capacity of both reservoirs, which translates to a short residence time (i.e., 1.3–1.6 days). Further, water in both reservoirs is diverted to the Rock Creek and Cresta powerhouses via inlets located close to the reservoir bottom, resulting in mixing of near-surface waters with the deeper water. The State Water Resources Control Board recognized this mixing of reservoir water, as is indicated in the modeling studies associated with the *Level 3 Report* (Stetson Engineers Inc., 2009), where the water temperature in each reservoir is assumed to be uniformly distributed.

The absence of a vertical thermal gradient in the two reservoirs precludes effectiveness of Measure 1 in providing cooler water to the Rock Creek and Cresta reaches.

4.2 PREFERENTIAL OPERATIONS AT CARIBOU 1 POWERHOUSE OVER CARIBOU 2 POWERHOUSE (MEASURE 2)

The rationale for implementing Measure 2 as indicated in the 2012 report is that "Caribou 2 primarily withdraws surface water whereas Caribou 1 Powerhouse has the potential to access a limited amount of colder water from the deeper portions of Butt Valley Reservoir and deliver to the Rock Creek and Cresta reaches."

In Butt Valley Reservoir, the invert of the Caribou 1 intake is located at an elevation of 4,077.1 feet (U.S. Geological Survey datum) and the Caribou 2 invert is at an elevation of 4,103.2 feet (Figure 12a). During the summer, the near-surface water in the reservoir warms at a faster rate than in the deeper profile. Thus, by late June or early July, when Measure 2 is likely to be initiated, a gradient of greater than 2ºC can exist between the temperature of the water accessible to the Caribou 2 and Caribou 1 inlets. However, the volume of cooler water accessible to Caribou 1 is limited, typically lasting for up to 5 days depending on the rate of flow at Caribou 1 Powerhouse.

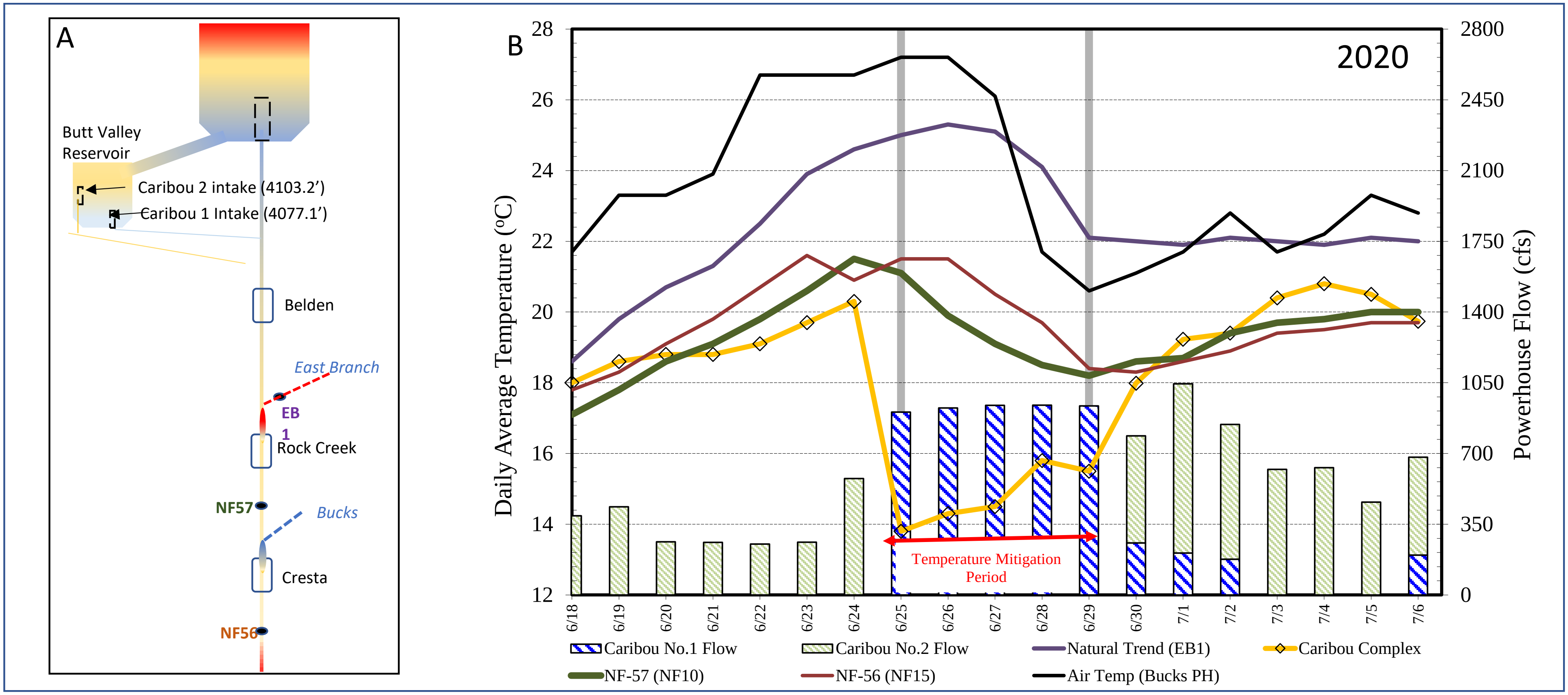


Figure 12: (A) Plumbing layout for Caribou Complex flow releases and location of water temperature monitoring stations. (B) Water temperature response in Rock Creek (NF57) and Cresta (NF56) reaches during cooler water release in 2020 via Caribou 1 intake in Butt Valley Reservoir. The left y axis includes the air and water temperature measurements, and the right y axis shows the flows from the Caribou 1 and 2 powerhouses. Included is the water temperature measured at tributary to the NFFR, the East Branch (EB1), which indicates water temperature trends independent of Caribou 1 releases.

Preferential operation of the Caribou 1 intake over the Caribou 2 intake in the summer has been implemented by PG&E since 2003, 9 years before the other IWTCMs. Typically, these events were triggered by the first occurrence of 2 consecutive days when the average daily water temperature in the Rock Creek and Cresta reaches exceeded 20°C. The data to assess the effectiveness of this temperature control measure is not available from all years since 2003, because in certain years (e.g., 2008) Measure 2 could not be implemented, and in other years flows were not exclusive to the Caribou 1 inlet (e.g., 2012, 2014, 2017, and 2019). Therefore, there are 8 years (i.e., 2007, 2009, 2010, 2013, 2015, 2016, 2018, and 2020) when the two key components of Measure 2 were achieved (i.e., 2 consecutive days with greater than 20ºC water temperature in the Rock Creek and Cresta reaches, and release of flows via the Caribou 1 inlet (with no flows through the Caribou 2 inlet) for up to 5 consecutive days.

For the 2012–2020 period, the water temperature at the Prattville intake ranged from slightly below 9ºC to slightly below 11ºC during late June and early July (Figure 9). Within the deeper sections of Butt Valley Reservoir (i.e., close to the Caribou 1 inlet) the water temperature ranged between 10.5 and 14.5ºC for the same period. On average a 3ºC difference existed between the water temperatures at the Prattville and Caribou intakes.

The typical temperature response in the Rock Creek and Cresta reaches during activation of the Caribou 1 flows is shown in Figure 12. (Responses from all other years are included in Attachment B.) As seen in the figure, on June 23 and 24, 2020, water temperatures in the Rock Creek and Cresta reaches exceeded 20ºC for 2 consecutive days, which prompted releases from Butt Valley Reservoir exclusively to Caribou 1 Powerhouse for a period of 5 days. As flows from Caribou 1 were initiated, the temperature of the water in the Caribou Complex dropped from slightly above 20ºC to below 14ºC. Over the next 4 days, as releases from Caribou 1 continued, and the cold-water pool in Butt Valley Reservoir diminished, the water temperature at the confluence with the NFFR steadily increased. Farther downstream, in the Rock Creek and Cresta reaches (NF57 and NF56 in Figure12), water temperatures dropped incrementally over a 5-day period by approximately 3ºC before resuming a rising trend. This drop in temperature in the Rock Creek and Cresta reaches, however, cannot be solely attributed to the releases from the Caribou 1 inlet, because the East Branch of the Feather River, a tributary to the NFFR, also exhibited a similar temperature response pattern, dropping approximately 3ºC during the same period. This drop in water temperature appears to have been caused by changes in air temperature, which fell by approximately 6ºC during the period when flows were diverted through the Caribou 1 inlet. Similar responses that can be attributed to air temperature are included in Attachment B (e.g., Figures 2-2, 2-3, and 2-5).

Change in water temperature during exclusive releases from the Caribou 1 Powerhouse for the years that the criteria for Measure 2 were met are shown in Figure 13a. Included in the figure are water temperature changes measured at the East Branch of the Feather River (EB1 in Figure 6). This location provides an indication of ambient trends in the larger watershed, because it is not on the NFFR. In 4 of the 6 years (i.e., 2013, 2015, 2016, and 2020), independent of the cooler releases, air temperature also dropped in the watershed (Attachment B). These drops in air temperature contributed to the large reductions in the water temperature. Figure 13b shows the maximum change in water temperature in the Rock Creek and Cresta reaches that can be attributed to the Caribou1 releases. It is important to note that the temperature changes shown represent the maximum change in temperature. As seen in the figure, these changes were up to almost 3ºC in the Rock Creek Reach and 1.7ºC in the Cresta Reach.

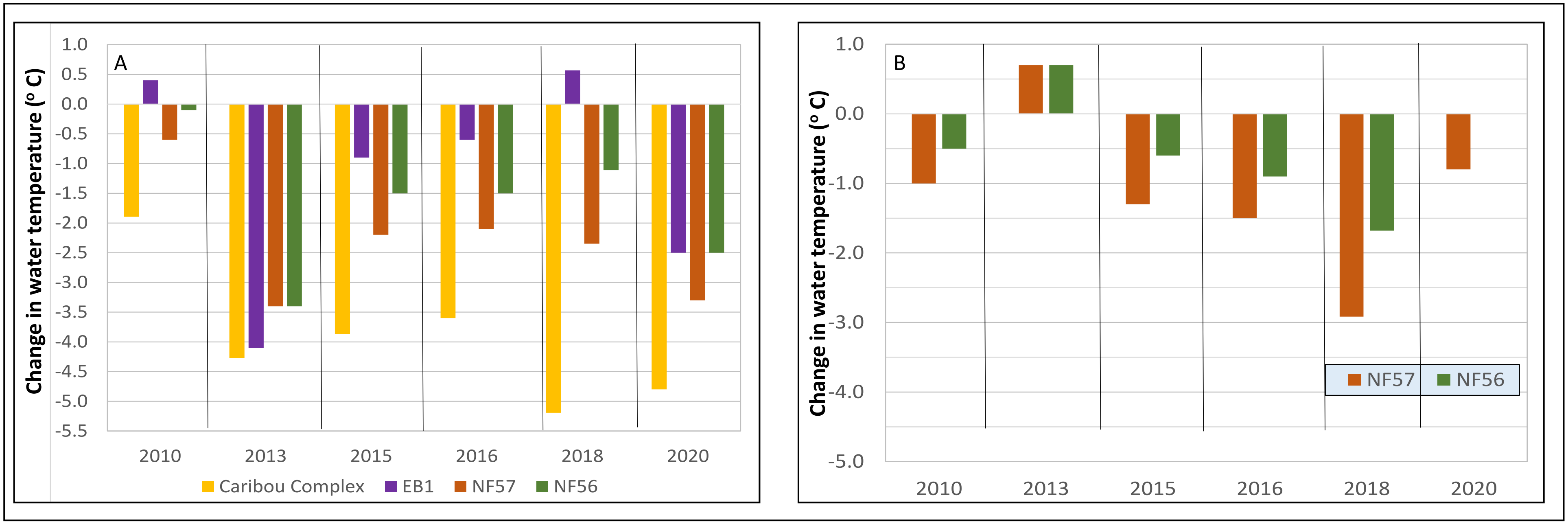


Figure 13: (A) Water temperature changes measured after implementation of Measure 2. (B) Temperature changes observed in the Rock Creek and Cresta reaches immediately after conclusion of Caribou 1 releases, with possible influences of air temperature removed (i.e., the measured changes in EB1).

Temperature change is the difference between the water temperature on the day before the Caribou 1 releases begin and that on the last day of the release. The measurements are from the Caribou Complex (i.e., at the tailrace of the Caribou Powerhouses, the East Branch of the Feather River (EB1), and the Rock Creek (NF57) and Cresta (NF56) reaches.

As indicated in the guidelines for Measure 2, the Caribou 1 releases are to be initiated either by July 15 or the first occurrence of average daily temperatures in either the Rock Creek Reach (NF57) or Cresta Reach (NF56) exceeding 20ºC for 2 days. This attempt to suppress temperatures before mid-July is premature because the period when temperatures in the Rock Creek and Cresta reaches can exceed 20ºC is typically from mid-July through August of each year (Figure 14). Further, any drop in temperature associated with the implementation of Measure 2 is short-lived (i.e., 2–4 days), which likely provides no benefit to the cold-water fish in the two reaches.

The early summer release of the cold-water pool has the potential to impact the cold-water fishery in Butt Valley Reservoir. While this impact has not been assessed, it is likely to be minimal. This is because fish can access the upstream section of the reservoir which remains cool from the water diverted from Lake Almanor via the Butt Valley powerhouse.

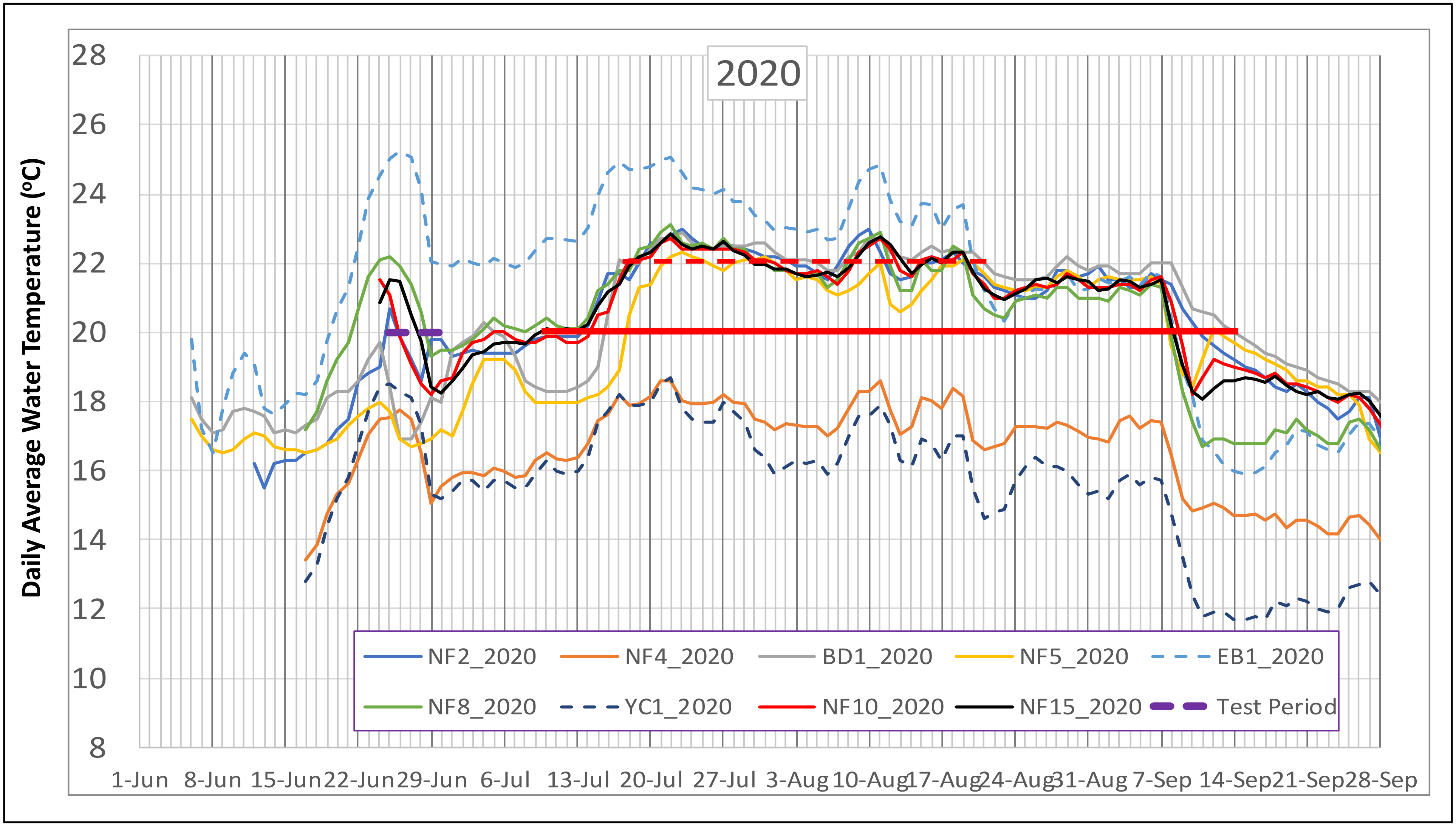


Figure 14: Water temperature measured at different locations along the NFFR in 2020

Water was released at Caribou 1 the last week of June. However, temperatures mainly exceeded the 20ºC threshold in mid-July through late August, well after the Caribou 1 releases.

4.3 CONTINUED OPERATION OF THE BUCKS CREEK POWERHOUSE (MEASURE 3)

The rationale provided for implementing Measure 3 is that "water flowing through Bucks Creek Powerhouse is cooler than the water in the NFFR" (Attachment A). PG&E determined that the current configuration and operation of the Bucks Project provided favorable water temperature benefits to the NFFR (PG&E, 2005). This measure was anticipated to benefit the lower Rock Creek Reach (about 12 percent of the total Rock Creek Reach) and the Cresta Reach (PGE, 2005).

Between 2002 and 2020, summer flows in the Rock Creek Reach were typically between 200 and 350 cfs, depending on the type of water year (Table 1). Flows in the Bucks Creek Reach were relatively small (i.e., less than 10 cfs) while flows through Bucks Creek Powerhouse ranged between 100 and 200 cfs when the powerhouse was activated. Farther downstream, flows from Rock Creek Powerhouse to the NFFR were up to 2,000 cfs. During the summer, the water temperature in the Rock Creek Reach was close to or above 20ºC, while water temperature in the Bucks system (i.e., Bucks Creek and flows through the powerhouse) remained approximately 5ºC lower.

The temperature of water immediately downstream of the Bucks system releases to the NFFR is determined by the relative volumes of water flowing in the NFFR and Bucks system. If flows from the Bucks system are only from the Bucks Creek Reach (i.e., less than 10 cfs), then the warmer and relatively larger flows in the NFFR (i.e., greater than 200 cfs) immediately overwhelm the colder water such that downstream of the Bucks releases the water temperature is the same as the NFFR upstream of the Bucks system confluence. However, when Bucks Creek Powerhouse is operating, the relatively large volume of cold water released is sufficient to cool approximately 0.8 miles of the NFFR between Bucks Creek Powerhouse and immediately upstream of the releases from Rock Creek Powerhouse. Residual cooling is downstream of Rock Creek Powerhouse as water flows into the Cresta Reservoir and then the Cresta Reach. The extent of cooling is influenced by the amount of warmer water that is released from the Rock Creek Powerhouse.

The temperature dynamics associated with and without releases from the Bucks system are illustrated in Figure 15 and Attachment A, Figure 3-3. Additional information on how water temperatures in the NFFR responded to cold-water releases from Bucks Powerhouse between 2012 and 2020 is included in Attachment C, Figures 3-1 to 3-9. Included in the figures are the measured flows in the Rock Creek and Cresta reaches and the Bucks Creek and Rock Creek powerhouses. Figure 15a shows the temperature profile in the Rock Creek Reach during the summer of 2014 when Bucks Creek Powerhouse remained offline for most of the time, with flows from the Bucks system remaining less than 10 cfs and coming predominantly from the Bucks Creek Reach. As seen in the figure, the water temperature below the Bucks system releases (at NF13) was similar to water temperatures in NF12, which is upstream of the Bucks system confluence. Farther downstream, in the Cresta Reach (i.e., at NF14), there was no evidence of cooling.

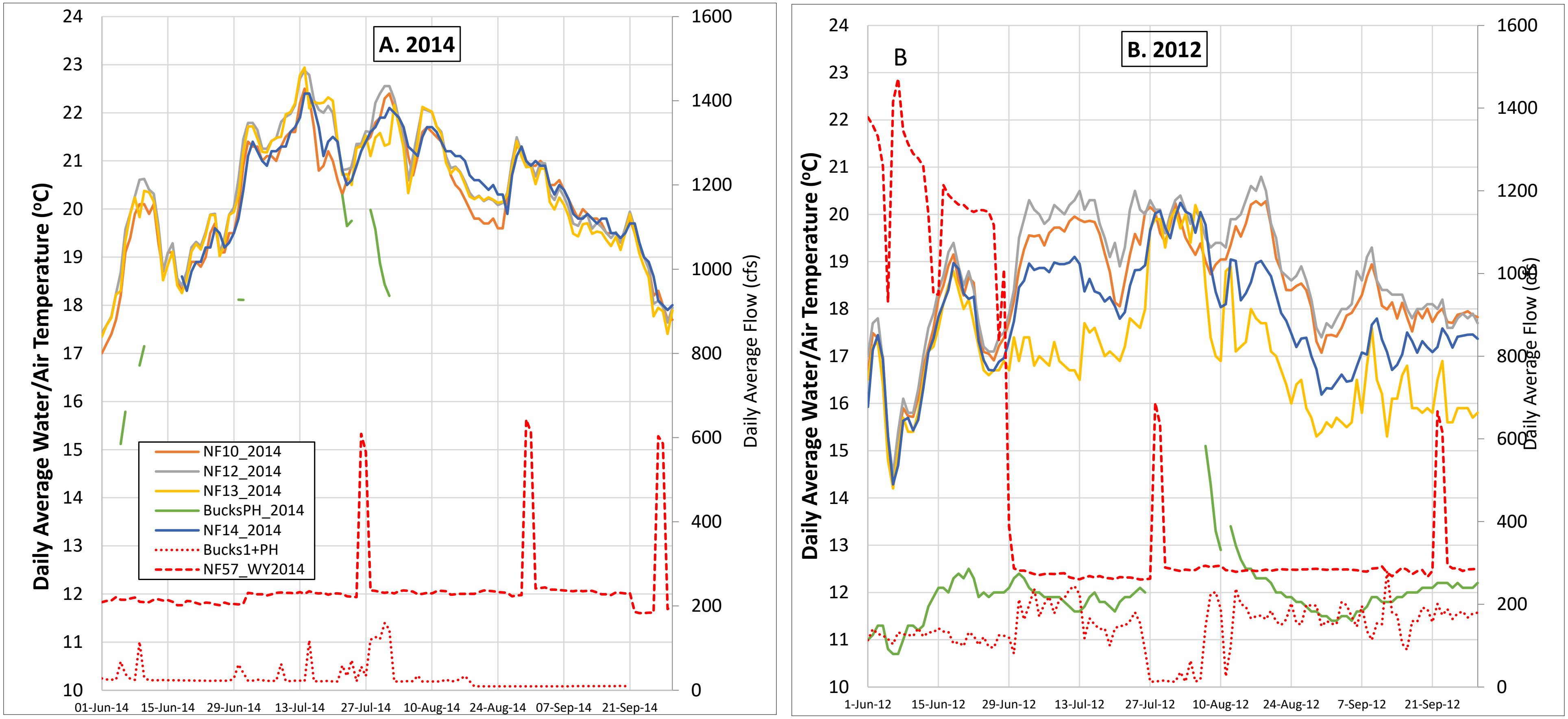


Figure 15: Water temperature response to releases from Bucks Powerhouse in (A) 2014 and (B) 2012

Solid lines include water temperature measurements and red dashed lines include flow measurements. Both figures show the response at NF13 located ~0.8 miles downstream of the Bucks releases (Figure 6 shows station locations) and at NF14 (in Cresta Reach). In 2014 the Bucks Powerhouse remained inactive for most of the summer with the colder water releases mainly from Bucks Creek. In 2012 Bucks Powerhouse was active for most of the summer, releasing flows between 100 and 250 cfs. The green line indicates the water temperature of water passing through Bucks Powerhouse.

In 2012, the Bucks Creek Powerhouse was continuously active for most of the summer, with a 2-week break from late July to early August (Figure 15b). From mid-June onward, when the powerhouse was operating, flows from the Bucks system fluctuated around 200 cfs, while flows from Rock Creek Dam (measured at NF57) were slightly above 250 cfs. No water was released from Rock Creek Powerhouse until late June, after which flows went up to 1,000 cfs for the next month before dropping to approximately 300 cfs for the rest of the summer (Attachment A, Figure 3-1). As seen in Figure 15b, during the period of high flows in the Bucks system, the water temperature at NF13, the monitoring station located downstream of the cold-water releases, was 2–3ºC cooler than the water temperature upstream of the releases (i.e., monitoring stations NF10 and NF12). When Bucks Creek Powerhouse releases stopped for the 2-week period at the end of July, the temperature differences were eliminated, and the entire reach had a relatively similar water temperature. In the Cresta Reach (NF14), for the periods when Bucks Powerhouse remained active, the water temperature was 1–1.5^{0}C cooler than upstream of the Bucks releases. This temperature suppression ceased immediately after releases from the Bucks Creek Powerhouse stopped.

These observations show that with the implementation of Measure 3, when the Bucks system is releasing large volumes of water (i.e., greater than 100 cfs), the 0.8-mile stretch of the Rock Creek Reach is cooled up to the point where water from Rock Creek Powerhouse is released into the river. At that point the warmer flows from the Rock Creek Powerhouse partially dilute the cooler flows; however, despite the addition of the warmer releases from Rock Creek Powerhouse, the water remains cooler as it travels through the Cresta Dam and into Cresta Reach.

4.4 INCREASED MINIMUM INSTREAM FLOWS FROM ROCK CREEK AND CRESTA DAMS (MEASURE 4)

No rationale is provided for implementing Measure 4, which prescribes increased MIFs during critically dry water years. The guidance for implementing the measure is "[Flow] increase will be in daily increments of approximately 20 cfs until which time the daily average temperature is less than or equal to 20ºC or the flow release is 200 cfs."

Higher releases cannot result in cooling of water unless the increased flows have a cooler temperature. That is not the case in this situation because the additional flow in the Rock Creek and Cresta reaches is from the same pool of water. However, this measure could reduce additional rise in water temperature with higher flows through the Rock Creek and Cresta reaches.

To evaluate this potential rationale, ideally temperature changes along the two reaches, during flows of 150 cfs and then 200 cfs, would be used to determine the effectiveness of Measure 4 in containing water temperature. However, between 2002 and 2020, flows were never maintained at 150 cfs for the duration of the summer months (Attachment D), so a comparison of the temperature response to the two flows (i.e., 150 and 200 cfs) is not possible. Instead, three distinct flow regimes are associated with the MIF prescriptions between 2002 and 2020 and the water-year types (Table 1) that can be used to determine whether higher flows have fewer temperature increases than lower flows in the Rock Creek and Cresta reaches.

These three flow regimes were identified from the three test periods associated with the RCC Project license. The test periods were set up to evaluate the effects of a range of MIFs on specific biological resources. However, each test period as a block is not suitable for this type of analysis because the composition of water-year types varied in each test period, as did the duration of the three test periods (Table 1). Thus, each test period cannot be considered a distinct flow treatment. Given that wet/normal water years were clustered in Test Periods 1 and 3, with each test period assigned a significantly different flow regime for that water-year type, and all critically dry water-year types had the same prescribed flows (irrespective of test period), three distinct flow prescriptions can be evaluated for their impact on water temperature (Figure 16). These include flows during (1) Critically Dry water years 2007, 2008, and 2014 during Test Period 2, and Critically Dry water years in 2015 and 2020 during Test Period 3 (referred to hereon as CD), (2) Wet/Normal water years 2002–2006 during Test Period 1 (referred to hereon as WN TP1) and (3) Wet/Normal water years 2016–2019 during Test Period 3 (referred to hereon as WN TP3).

To evaluate the possible effectiveness of Measure 4 in containing water temperature increases along the Rock Creek and Cresta reaches, water temperature measured during the three flow groupings identified above (i.e., CD, WN TP1, WN TP3) was analyzed as follows:

- The number of days in June, July, August, and September when daily average water temperature surpassed 20ºC were compared upstream and downstream of both reaches, to determine whether large MIFs were associated with fewer days with warmer water temperature than low MIFs.
- The magnitude of water temperature changes over the Rock Creek and Cresta reaches were analyzed to determine whether large MIFs were associated with smaller water temperature gains than smaller MIFs.

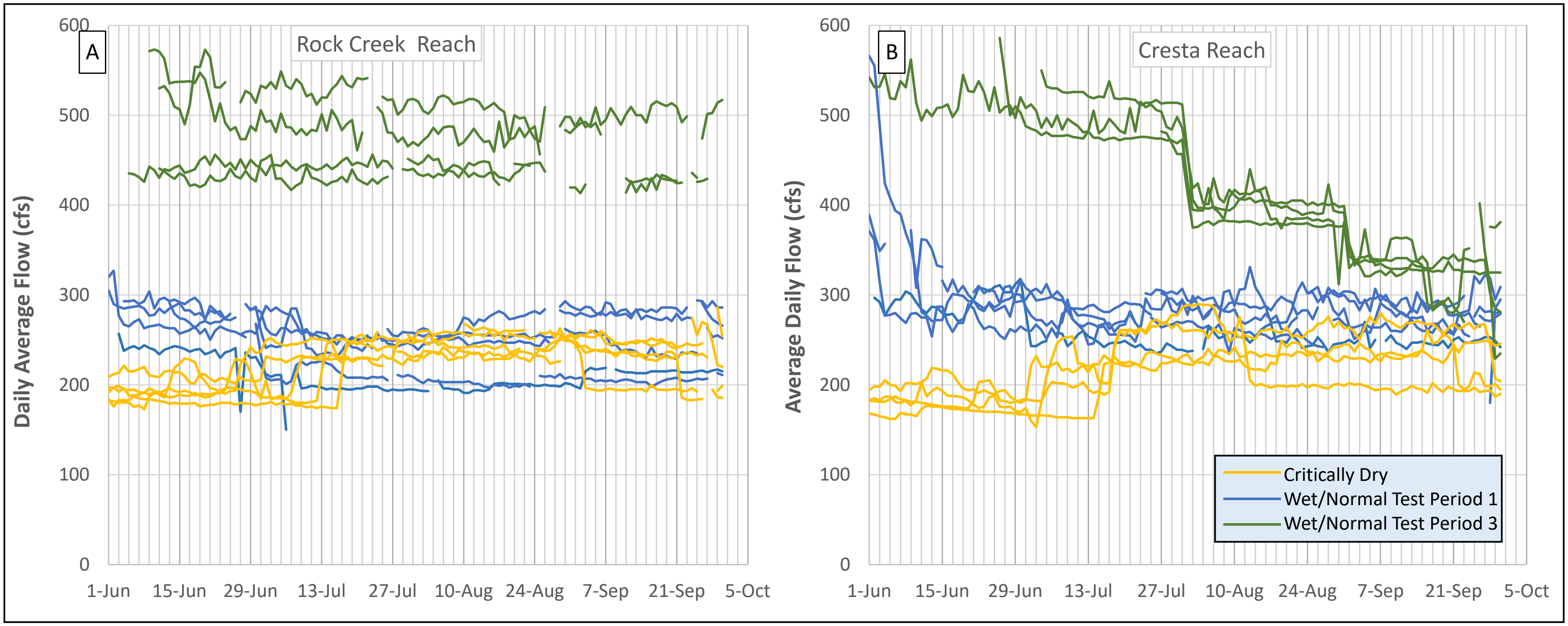


Figure 16: Grouping of flow regimes used to evaluate the of flow rates' impact on water temperature increases in Rock Creek and Cresta reaches
Individual lines include flows for specific water-year types. Line colors indicate specific flows regimes
(i.e., Critically Dry, Wet/Normal Test Period 1, Wet/Normal Test Period 3).

4.4.1 Number of Days with Daily Average Water Temperature Exceeding 20ºC

During the warm summer months, the temperature of water released from Rock Creek and Cresta dams is affected by ambient air temperature as it flows through the two reaches. The warmer air temperature is likely to result in larger temperature gains for lower MIFs than higher MIFs if other factors that may counter that affect are absent. Water temperature data collected in the two reaches was assessed to determine the change in the number of days when water temperature exceeded the 20ºC threshold as it flowed through the reaches during the summer months.

In the Rock Creek Reach, temperature was evaluated between Monitoring Stations NF10 and NF12 (Figure 6), which are located 6.3 miles apart. These locations were chosen because of the distance between the two locations and because there was very little flow entering this section of NFFR from tributaries. In the Cresta Reach, the two locations chosen were NF15 and NF16, which are 2.8 miles apart.

Figure 17 shows the number of days in each of the four summer months when the daily average water temperature exceeded the 20ºC threshold, immediately upstream of the RCC Project boundary (i.e., NF8) and in both the Rock Creek (NF10 and NF12) and Cresta Reaches (NF15 and NF16). As would be expected, the largest number of days with temperatures exceeding the 20ºC threshold were in July and August. In June, July, and August the number of days exceeding the threshold were highest during periods when CD flows were implemented. During July, the next highest number of days crossing the threshold was during WN TP1, with WN TP3 having the lowest number of days at all locations along the Rock Creek and Cresta reaches. In the other months (i.e., June, August, and September), often WN TP3 had more days when temperatures exceeded the 20ºC threshold than WN TP1. This indicates that higher MIFs were not more effective than the lower MIFs in containing water temperature below the 20ºC threshold.

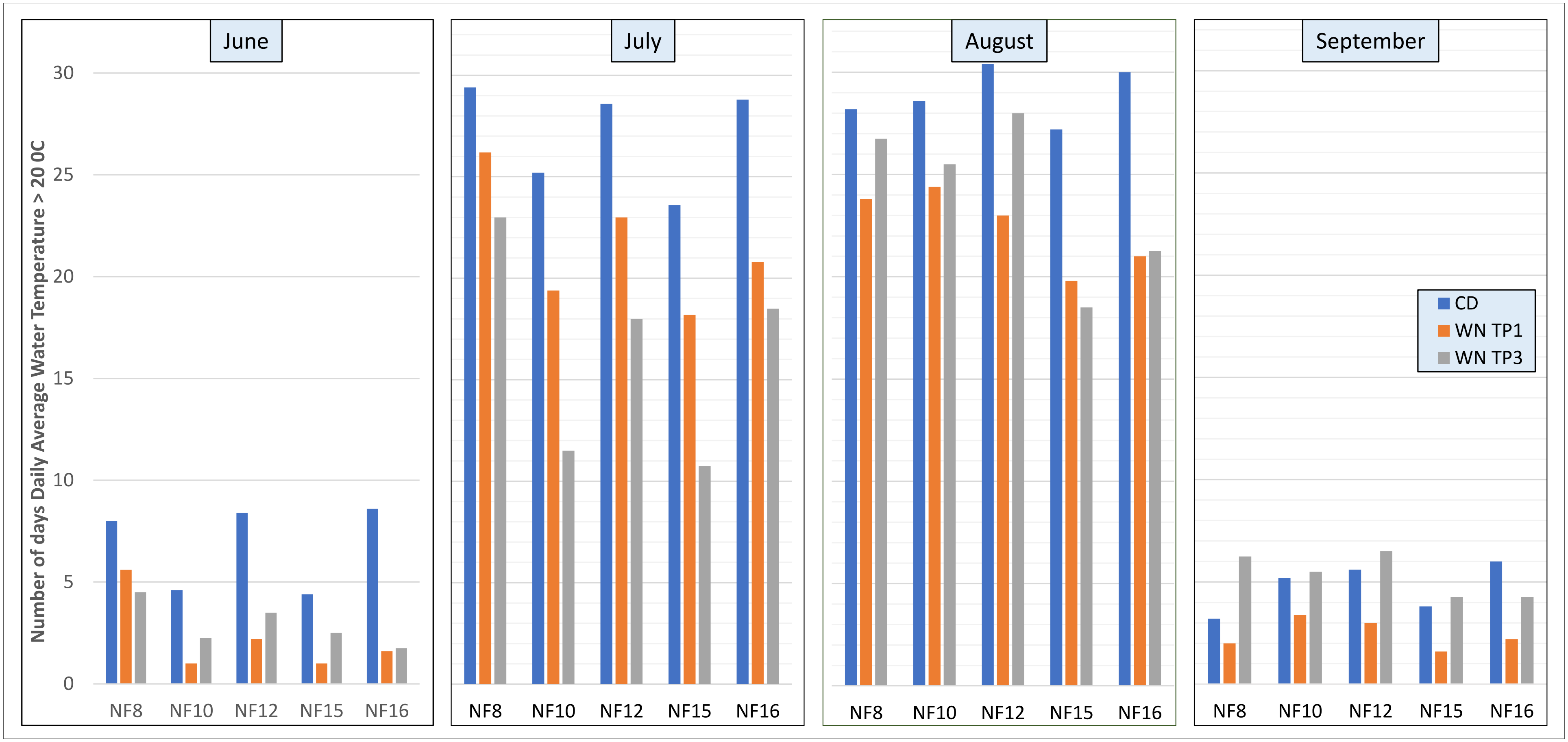


Figure17: Average number of days when water temperature exceeded 20°C during summer months under the three flow regimes
Monitoring locations include NF8 in Belden Reach, NF10 and NF12 in Rock Creek Reach, and NF15 and NF16 in Cresta Reach. Individual lines include flows for specific water year types. Line colors indicate specific flows regimes (i.e., Critically Dry, Wet/Normal Test Period 1, Wet/Normal Test Period 3).

Figure 18 includes the results of an evaluation of the change in the number of days exceeding the 20°C threshold as water flowed along both the reaches. For the evaluation, change in days exceeding the threshold were normalized for the three flow regimes (i.e., CD, WN TP1, and WN TP3) as:

$$\% \, Change = \frac{No.days \, DS > 20^{o}C - No.days \, US > 20^{o}C}{No.days \, US > 20^{o}C}$$

Where:

- % Change = the percent change between upstream and downstream location in days with daily average water temperature >20°C
- DS= Downstream location
- US= Upstream location

A positive % Change indicates that for a particular month there were more days with greater than 20°C water temperatures downstream in each reach.

As seen in the figure, the changes varied from month to month in both the reaches.

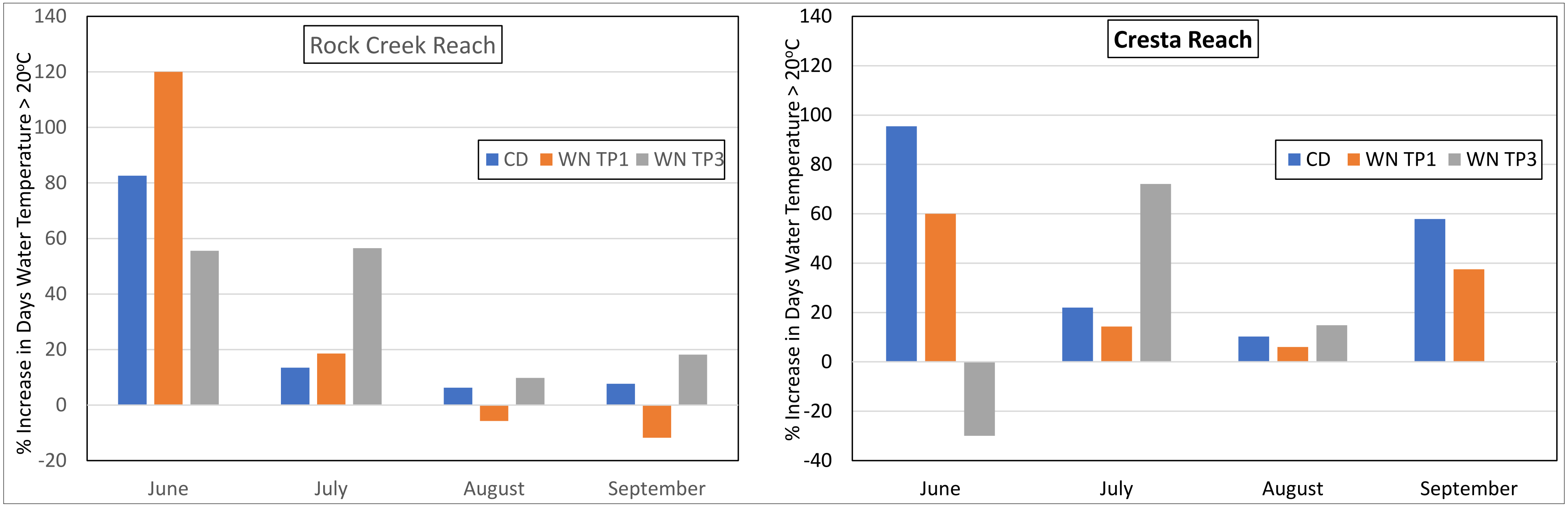


Figure 18. Percentage change in number of days with >20ºC water temperature between upstream and down sections of the Rock Creek and Cresta reaches under the three flow regimes (i.e., Critically Dry, Wet/Normal Test Period 1, Wet/Normal Test Period 3)
Monitoring locations used are NF10 and NF12 in Rock Creek Reach and NF15 and NF16 in Cresta Reach. Percentage change for each month was calculated as the percentage of (Number of days downstream with >20ºC - Number of days upstream with >20ºC)/(Number of days upstream with >20ºC). A positive number indicates a larger number of days downstream with >20oC than upstream.

Along the 6.3-mile section of Rock Creek Reach, the relative number of additional days with greater than 20°C at the downstream location were highest during June for all flow regimes, with the maximum for TP1 WN. In July the magnitude of changes for CD and TP1 WN decreased substantially, while TP3 WN remained the same as June. This indicates that in July there was more warming of the Rock Creek Reach flows during the higher TP3 WN flows. In August and September, during the TP1 WN flows there were more days with greater than 20°C water temperatures upstream in the reach than downstream. For the same period both CD and TP3 WN flows continued to have more days with greater than 20°C water temperatures downstream than upstream, though the differences were small.

Along the 2.8-mile section of Cresta Reach during CD and TP1 WN flows in June, there were relatively more days with greater than 20°C water temperatures downstream than upstream, while with TP3 WN the situation was reversed. For the warmer months of July and August, during all flows consistently more days had water temperatures greater than 20°C downstream than upstream, with the relative difference being more during the higher TP1 WN flows.

These observations show that there is no clear correlation with increased days with greater than 20°C water temperatures downstream and the magnitude of MIF. However, the data show that during the warmest summer months the higher TP3 WN flows had the largest relative increase in greater than 20°C water-temperature days.

4.4.2 Magnitude of Water Temperature Changes Associated with the Three Flow Regimes

Water temperature data collected in the Rock Creek Reach was assessed to determine whether the change in water temperature observed as water flowed along the 6.3 miles of the reach was correlated with the magnitude of the summer MIFs. (This analysis was not done for the Cresta Reach because the data available was only for a maximum length of 2.8 miles of reach.) The implied rationale for Measure 4 suggests that with increased flows, water temperatures would increase less.

The daily average water temperature measured at NF10 and NF12 during CD, TP1 WN, and TP3 WN is shown in Figure 19. The individual year responses, irrespective of the flow regime, show that for the first part of the summer the upstream temperatures (NF10) were generally cooler than the downstream temperatures (NF12), suggesting that the water heated as it flowed along the reach. For the remainder of the summer this trend was less pronounced with the upstream temperatures sometimes being warmer than the downstream temperatures, despite air temperature being consistently warmer than the water temperature in UNFFR. This suggests any potential warming of the water by the air temperature was overwhelmed by other factors.

The difference in daily average water temperature, averaged for each of the three flow regimes, between NF10 (downstream) and NF12 (upstream), is shown in Figure 20. The figure shows a consistent pattern for the three flow regimes, with steadily increasing differences in water temperatures June through mid-July (i.e., downstream temperatures getting progressively warmer relative to upstream temperatures), and then differences reaching a peak value between the end of June and end of July before declining. In late August the water temperature becomes similar at both locations, after which the lower section of the reach can become cooler than the upper section.

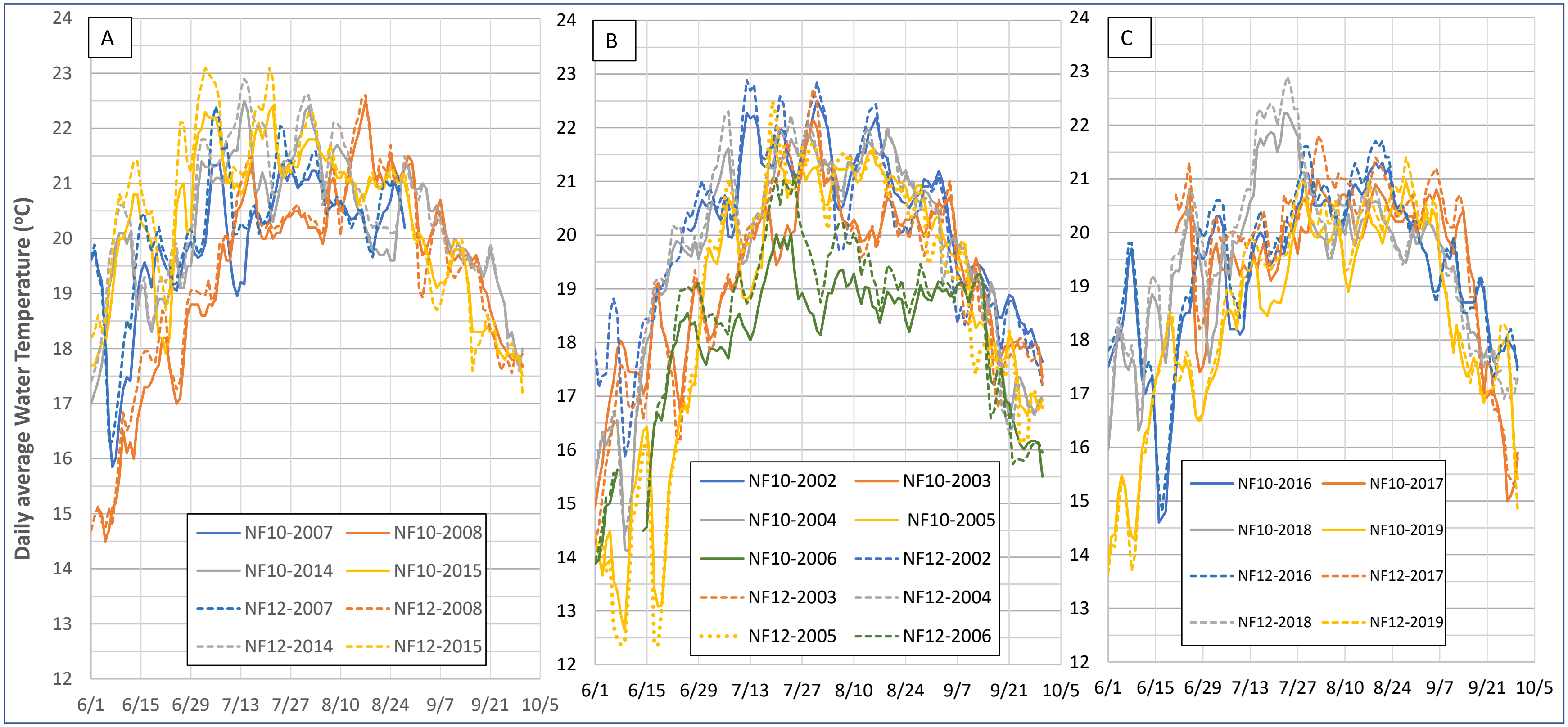


Figure 19: Water measurements are for the upstream (NF10) and downstream (NF12) monitoring stations in the Rock Creek Reach
The NF10 measurements are shown in solid lines and the NF12 measurements appear as dashed lines. The difference in water temperature between the solid and dashed lines indicate the temperature difference between the two locations at any given time.

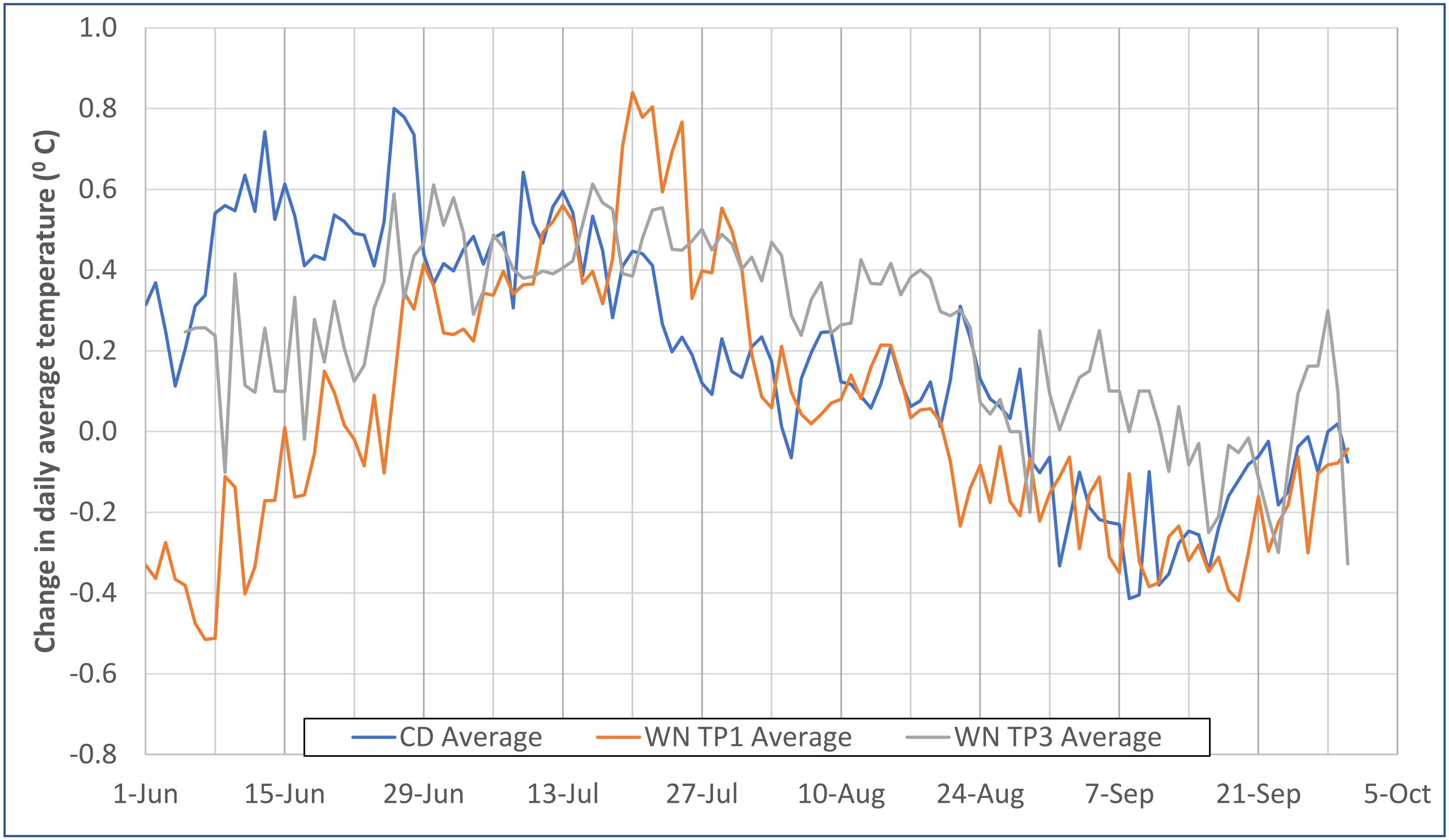


Figure 20: Daily average water temperature measured during (A) critically dry water years and (B) wet/normal water years during Test Period 3

Water measurements are for the upstream (NF10) and downstream (NF12) monitoring stations in the Rock Creek Reach. The NF10 measurements are shown in solid lines and the NF12 measurements appear as dashed lines. The difference in water temperature between the solid and dashed lines indicate the temperature difference between the two locations at any given time.

The temperature difference between NF10 and NF 12 was largest in June during CD years with the temperature downstream being on average 0.2 to 0.8°C warmer downstream. During WN TP1, which had slightly higher flows in June than CD, the temperature gradient ranged from -0.4 to 0.5°C. During WN TP3 the average temperature gradient in June was between that observed for the CD and WN TP1 flows. This difference is interesting because the WN TP3 flows were higher than WN TP1 flows (i.e., greater than 400 cfs [WN TP3] to greater than 300 cfs [WN TP1]). These differences suggest that higher flows did not necessarily result in lower water temperature rises in the Rock Creek Reach.

5. CONCLUSIONS

The IWTCMs identified and then implemented in 2012 have generated a large body of data that is available to assess the effectiveness of each measure. As seen in the analysis provided in the previous section, two of the measures (preferential releases from Caribou 1 Powerhouse and increased cold-water releases from Bucks Creek Powerhouse) have the potential to reduce water temperature, but these reductions are temporally and/or spatially limited.

Measure 1, which calls for flows from the LLO outlets in Rock Creek and Cresta dams is ineffective, because no cooler pool of water exists in either reservoir because of the small size of each reservoir and the mixing that occurs in them.

Measure 2, which involves the use of the cold-water pool in Butt Valley Reservoir, has the potential to temporarily reduce the water temperature in the Rock Creek and Cresta reaches early in the summer (i.e., before mid-July). However, because the cold-water pool is relatively small and temperature reductions occur for a short period (i.e., 1–4 days). Further, this is not a guaranteed source of cooling later in the summer as the cold-water pool in Butt Valley Reservoir becomes increasingly susceptible to warming.

Measure 3, which is use of the Bucks Creek Project to provide cooler water, is effective in significantly reducing the water temperature in the approximately 0.8 miles of Rock Creek Reach and to a lesser extent in the Cresta Reach. This measure relies on the operation of Bucks Creek Powerhouse, which is likely to run during the warm periods when water temperatures in the NFFR are high.

Measure 4 provides no clear indication that water temperature increases can be mitigated in the Rock Creek and Cresta reaches by increasing flows from 150 to 200 cfs during Critically Dry years. Some potential exists for the intended mitigation to be effective in June, but the data also show the opposite effect during the latter part of the summer, with higher flows sometimes aligning with larger increases in water temperature downstream.

Figure 21 provides a summary of the daily average water temperature in the Rock Creek and Cresta reaches for the period prior to, and during the implementation of the IWTCMs. For both reaches the average water temperature was consistently higher for the duration of the summer when IWTCMs were implemented. This suggests that not only is the current strategy of controlling water temperatures ineffective, but also that they are other significant factors influencing water temperature in the two reaches.

Given that Measures 1 and 4 are relatively ineffective, they should not continue to be implemented. Measure 2 may provide a very short-term and near-field benefit, while Measure 3 provides a relatively clear but very near-field benefit. Because these two measures are limited (spatially and temporally) in reducing water temperatures, an assessment should be made as to whether the appreciable biological benefits warrant continued implementation.

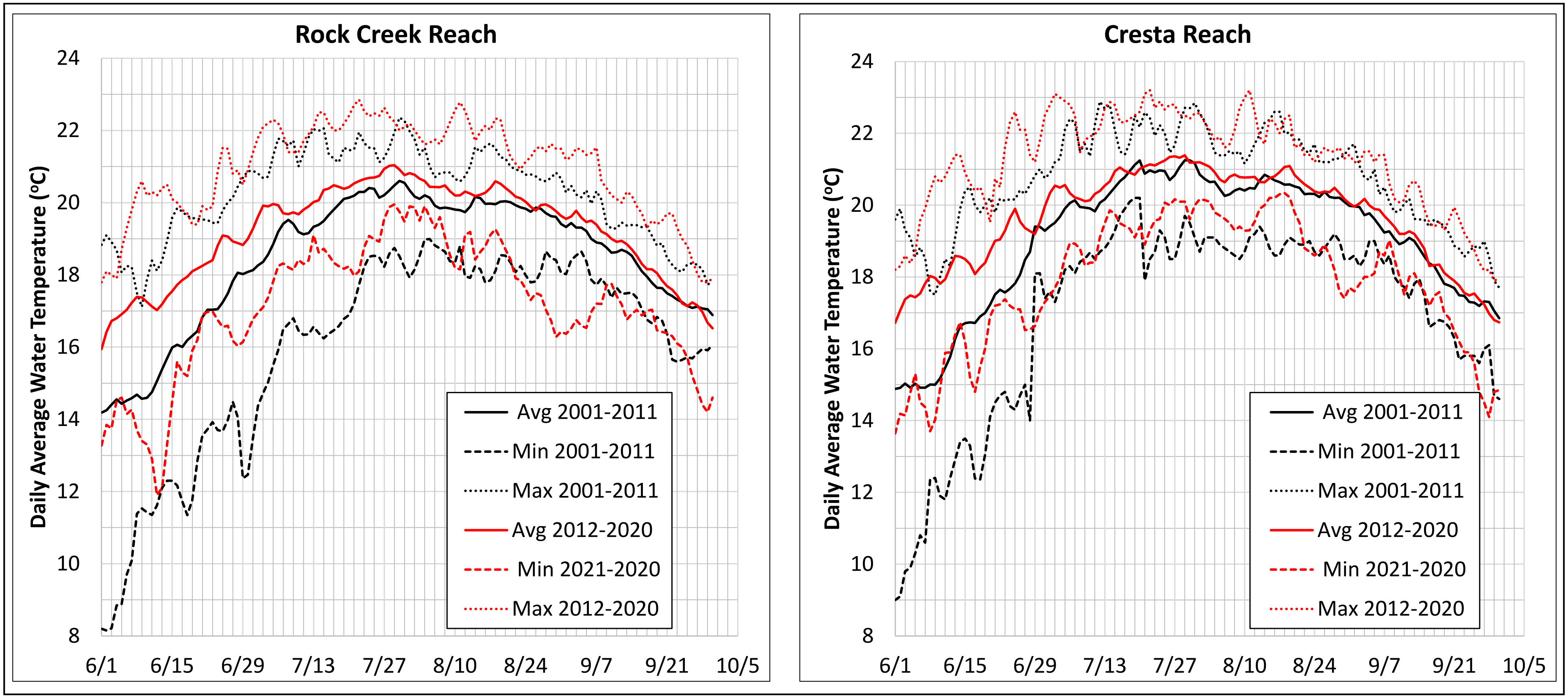


Figure 21: Average daily water temperature measured in Rock Creek and Cresta reaches between 2001 and 2011 (period before implementation of interim control measures) and 2012 to 2020)

In the Rock Creek Reach the average daily temperature was consistently higher during the period the interim temperature control measures were implemented. In the Cresta Reach, besides the first 3 weeks in June, the water temperature was the same for both periods.

6. REFERENCES

Pacific Gas and Electric Company. 2005. *North Fork Feather River Study Data and Informational Report on Water Temperature Monitoring and Additional Reasonable Water Temperature Control Measures.* Filed with FERC on September 19, 2005.

Stetson Engineers, Inc. 2009. *Level 3 Report.* Prepared for California State Water Resources Control Board.

ATTACHMENT A

DESCRIPTION OF INTERIM WATER TEMPERATURE CONTROL MEASURES

Pacific Gas and Electric Company®

Power Generation

245 Market Street
San Francisco, CA 94105

Mailing Address
Mail Code N11C
P. O. Box 770000
San Francisco, CA 94177

April 30, 2012

Via Electronic Submittal (E-filing)

The Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
Hydropower Compliance and Administration
888 First Street, NE
Washington, DC 20426

Re: Rock Creek - Cresta Project (FERC No. 1962-191)
Submittal of the Water Temperature Under Article 401 and Appendix Condition 4D – Interim Control Measures

Dear Secretary Bose:

The Federal Energy Regulatory Commission (FERC) issued a new license to Pacific Gas and Electric Company (PG&E) for the Rock Creek-Cresta Hydroelectric Project, FERC No. 1962 (Project) on October 24, 2001 (97 FERC ¶ 61,084). Condition 4(d) of the license requires PG&E to prepare a report that evaluates whether mean daily temperatures of 20 degrees Celsius (°C) or less have been achieved in the Rock Creek and Cresta reaches, and, if not, whether additional reasonable control measures are available. The report was to include recommendations for the implementation of any such measures.

PG&E conducted an evaluation of measures to enhance coldwater habitat that could be funded under License Condition 4(e). The primary measures modeled and evaluated were modifications to achieve the withdrawal of colder water from the upstream reservoirs of the Upper North Fork Feather River Project (FERC No. 2105). An informational progress report on water temperature monitoring, modeling and control options was filed by PG&E on September 21, 2005. The Project No. 2105 license expired on October 31, 2004, and is currently operating under an annual license. The current evaluation efforts are focused on the environmental review process in support of a 401 certification by the California State Water Resources Control Board (Board).

PG&E's July 24, 2007 letter noted that this study effort was expected to produce valuable information for reasonable control measures evaluation. PG&E's July 31, 2008 letter noted the Board had completed a level 1 and level 2 analysis and had progressed to a level 3 analysis, which is taking a more focused look at the most promising water temperature control options. At its January 14, 2009 meeting, the Rock Creek – Cresta Ecological Resources Committee (ERC) and United States Forest Service (FS) discussed the status of the study efforts under the Project 2105 environmental review process. The Board representative stated that the level 3 analysis was nearing completion. In addition, the Board representative stated that the analysis would be included as an appendix to the draft Environmental Impact Report (EIR).

The ERC and FS has recognized that the draft EIR and accompanying level 3 analyses will greatly assist in the discussion of primary temperature control measures, as well as any additional reasonable control measures. During the April 2011 ERC meeting, PG&E informed the ERC that we would prepare a letter to FERC requesting an extension to the Condition 4(d) report, in the anticipated release schedule of the draft EIR. The ERC supported the proposed time extension to August 31, 2012.

FERC granted an extension to May 1, 2012, but indicated that any additional request for extension of time to file the Additional Reasonable Control Measures Report shall be accompanied by a proposal, developed in consultation with the ERC, to implement interim water temperature control measures. FERC also required that this filing include copies of the comments and recommendations of the ERC regarding the interim control measures and the licensee's description of how the proposed interim control measures accommodate the comments of the ERC and FS. The licensee was also required to allow a minimum of 30 days for the ERC and FS to comment and to make recommendations before filing any request for an additional extension of time and proposed interim temperature control measures with the FERC. Attached is the "*Interim Temperature Control Measures Plan*." These interim control measures were discussed at the January, February, March, and April 2012 ERC meetings. The draft Plan was e-mailed to the members of ERC and FS, and PG&E received concurrence on the Plan from all currently active ERC members, including: the United States Forest Service, California Department of Fish and Game, California State Water Resources Control Board, California Sportfishing Protection Alliance, Plumas County, and American Whitewater (attached). PG&E received one comment pertaining to the on-going discussions during the ERC meetings to support fish and amphibian passage into the tributaries, and this was included as Interim Measure 5 in the attachment. No other comments were received.

As of the date of this letter, the draft EIR for Project 2105 has still not been distributed by the Board. The ERC and FS, consequently, requests an extension of time to receive and review the EIR in order to conduct the appropriate evaluation of additional measures to enhance coldwater habitat that could be funded under License Condition 4(e), and to develop the Condition 4(d) report. Therefore, PG&E is requesting another extension of time until May 1, 2013.

If you have any questions, please call me at (415) 973-3642.

Sincerely,

Charles White, Senior License Coordinator
Hydro Licensing

Attachments

cc: Attached List

cc: Terri Simon-Jackson
Plumas National Forest
P.O. Box 11500
Quincy, CA 95971

Amy Lind
U.S. Forest Service
Sierra Nevada Research Center
1731 Research Park Dr.
Davis, CA 95618
Sharon Thrall
Plumas County Supervisor
P.O. Box 368
Chester, CA 96202

Mary Lisa Lynch
California Department of Fish and Game
1701 Nimbus Road, Suite A
Rancho Cordova, CA 95670

Peter Barnes
State Water Resources Control Board
P. O. Box 2000
Sacramento, CA 95812

Chris Shutes
CA Sportfishing Protection Alliance
1608 Francisco Street
Berkeley, CA 94703

Nate Rangel
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Coloma, CA 95613-0401

Bob Center
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U. S. Forest Service
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Deborah Giglio
U. S. Fish and Wildlife Service
2800 Cottage Way, Room W-2605
Sacramento, CA 95825

Leah Wills
Plumas County
520 Main Street, Rm. 302
Quincy, CA 95971

Laurie A. Soule
California Department of Fish and Game
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1701 Nimbus Road, Ste. A
Rancho Cordova, CA 95670

Dave Steindorf
American Whitewater
4 Baroni Drive
Chico, CA 95928

Stephen Bowes
National Park Service
1111 Jackson Street
Oakland, CA 94607

John Beuttler
CA Sportfishing Protection Alliance
1360 Neilson Street
Berkeley, CA 94702

Richard Roos-Collins
Water and Power Law Group
2140 Shattuck Avenue, Ste. 801
Berkeley CA 94704

Attachment A

Interim Temperature Control Measures

Rock Creek-Cresta Project
FERC No. 1962

Interim Temperature Control Measures

Background

The Federal Energy Regulatory Commission (FERC) issued to Pacific Gas and Electric Company (PG&E) a new license for the Rock Creek-Cresta Project, FERC No. 1962 (Project) on October 24, 2001. The License required the submission of the Additional Reasonable Control Measures report under Condition 4D (4D Report) within five years of the date when FERC approved the water temperature monitoring plan. FERC approved the water temperature plan in June 2002.

PG&E conducted an evaluation of measures to enhance coldwater habitat that could be funded under License Condition 4E. The primary measures modeled and evaluated were modifications to achieve the withdrawal of colder water from the upstream reservoirs on the Upper North Fork Feather River Project (UNFFR), FERC No. 2105. An informational progress report on water temperature monitoring, modeling and temperature control options was filed by PG&E on September 21, 2005. The UNFFR Project license expired on October 31, 2004 and is currently operating under an annual license. Following the guidelines and protocol of California Environmental Quality Act (CEQA), the current evaluation efforts are focused on the environmental review process in support of a 401 certification by the California State Water Resources Control Board (SWRCB).

PG&E's July 24, 2007 letter noted that the CEQA study effort was expected to produce supporting information for the evaluation. PG&E's July 31, 2008 letter noted the SWRCB had completed a level 1 and level 2 analysis and had progressed to a level 3 analysis, which is taking a more focused look at the most promising water temperature control options, which are in UNFFR project. The level 3 analysis was released on December 20, 2011.

The United States Forest Service (USFS) and the Rock Creek-Cresta Ecological Resources Committee (ERC) has recognized that the draft Environmental Impact Report (EIR) will greatly assist in the discussion of primary temperature control measures, as well as help with the analysis of any additional potential reasonable control measures. During the April 2011 ERC meeting, PG&E informed the ERC that they would prepare a letter to FERC requesting an extension to the Condition 4(d) report, in the anticipated release schedule of the draft EIR. With its May 11, 2011 letter, PG&E requested an extension of time to file the Addition Reasonable Control Measures Report to August 31, 2012, which was supported by the ERC.

FERC granted an extension to May 1, 2012, but indicated that any additional request for extension of time to file the Additional Reasonable Control Measures Report shall be accompanied by a proposal, developed in consultation with the ERC, to implement interim water temperature control measures. FERC also required that this filing include copies of the comments and recommendations of the ERC regarding the interim control measures and PG&E's description of how the proposed interim control measures accommodate the comments of the ERC. PG&E was also required to provide the ERC a minimum of 30 days to comment and to make recommendations before filing any request for an additional extension of time and/or proposed interim temperature control measures with the FERC. The following is PG&E's plan to address the interim temperature control measures to reduce water temperatures in the Rock Creek and Cresta reaches prior to the release of the draft UNFFR EIR.

Interim Control Measures

PG&E operates the Rock Creek and Cresta facilities in accordance with minimum instream flow requirements in License Condition 5. Additionally, as required by License Condition 4, PG&E monitors water temperatures in both the Rock Creek (PG&E Gage No. NF-57) and Cresta (PG&E Gage No. NF-56) reaches. If the daily average water temperature exceeds 20°C for two consecutive days, measured midnight to midnight for each 24 hour period, PG&E notifies the USFS and ERC of the temperature exceedence and informs the USFS and ERC of the actions being taken to decrease the water temperatures in an effort to maintain a daily average water temperature of 20°C or less.

Interim Measure 1

If the daily average water temperature in the Rock Creek or Cresta reach exceeds the 20°C criterion for two consecutive days, PG&E will maximize the release of the minimum instream flow requirement at each reservoir to the low-level outlet located approximately 30-feet below the invert of the radial gates. The change in the water release from the surface radial gate to the low-level outlet could potentially provide deeper, cooler water to the Cresta and Rock Creek reaches.

Interim Measure 2

PG&E will implement a program that will preferentially operate the Caribou 1 Powerhouse over the more efficient Caribou 2 Powerhouse once the temperature criterion is exceeded. Caribou 2 primarily withdraws surface water whereas Caribou 1 Powerhouse has the potential to access a limited amount of colder water from the deeper portions of Butt Valley Reservoir and deliver to the Rock Creek and Cresta reaches. In order to preserve the finite amount of colder water in Butt Valley Reservoir, PG&E will attempt to maintain Butt Valley Reservoir at maximum pool and minimize the operation of Caribou 1 until July 15 or the first occurrence of average daily temperatures in either the Rock Creek Reach (NF-57) or Cresta reach (NF-56) exceeding 20°C for two days, whichever occurs sooner. During this special Caribou 1 operation[1], Caribou 2 will reduce its operation as much as is reasonably possible to

[1] The above action is not intended to restrict the operation of either Caribou 1 or Caribou 2 in meeting system power needs during system alerts, warnings or stage emergencies. Also, Caribou 1 is routinely used for meeting peak loads for several hours on days with high energy demand, which may reduce, over time, the amount of cold water available in Butt Valley Reservoir.

minimize the mixing with surface water. This operation will be for a period of 5 days as effective colder water withdrawal from Caribou 1 diminishes after this period.

Interim Measure 3

In the report "*North Fork Feather River Study Data and Informational Report on Water Temperature Monitoring and Additional Reasonable Water Temperature Control Measures*" filed with FERC on September 19, 2005, PG&E determined that the current configuration and operation of the Bucks Project provided very favorable water temperature benefits to the NFFR. PG&E will continue to operate the Bucks Creek Powerhouse in a manner that will help reduce daily average water temperatures both in the lower Rock Creek Reach (between Bucks Creek and Rock Creek powerhouses) and the Cresta Reach. Bucks Creek Powerhouse discharges to the NFFR approximately 1 mile upstream of Rock Creek Powerhouse and has significantly cooler water, which will benefit the lower Rock Creek Reach (about 12% of the total Rock Creek reach) and the Cresta reach.

Interim Measure 4

During critically dry years, after implementing Interim Measures 1 through 3 and when daily average temperature at NF-57 or NF-56 are above 20°C, the minimum instream flow from the Rock Creek (150 cfs) and Cresta (140 cfs) dams will be increased to 200 cfs, or to any flow in between 150/140 cfs to 200 cfs, to the extent necessary to contribute to the maintenance of mean daily temperatures of 20°C or less in the respective reach. The increase will be in daily increments of approximately 20 cfs until which time the daily average temperature is less than or equal to 20°C or the flow release is 200 cfs

Similarly, this increased flow shall be reduced back to the minimum instream flow, when not required to maintain mean daily temperatures of 20°C. Any flow adjustments will be made in the early morning to allow enough time to reflect any temperature change at NF-57 and NF-56 that peaks in the late afternoon.

Interim Measure 5

PG&E, the USFS, and the ERC will finalize a Letter of Intent (LOI) to participate in ongoing efforts to address fish and amphibian passage issues in tributaries to the North Fork Feather River. This LOI could provide access to cold-water refugia and potentially increase the overall aquatic productivity in the NFFR. PG&E, the USFS, and the ERC recognize that access for aquatic biota to NFFR tributaries is an issue of great importance not only within the Project waters, but for the health of the entire watershed.

Reporting

PG&E will determine the effectiveness of the interim control measures and the results will be reported in the Rock Creek – Cresta Annual Report filed with FERC each year.

Attachment B

Agency Correspondence

White, Charles

From: Smith, Dennis E -FS <dennissmith@fs.fed.us>
Sent: Friday, April 27, 2012 2:43 PM
To: White, Charles
Cc: SimonJackson, Terri -FS; Lind, Amy -FS
Subject: RE: Letter to FERC, Interim Control Measures, and LOI

Charlie,

The USDA Forest Service has reviewed the DRAFT Rock Creek–Cresta Project (FERC NO. 1962) Interim Temperature Control Measures Draft document. We agree that the review of the Upper North Fork Feather River Project (FERC No. 2105) EIR is necessary in order to conduct the appropriate evaluation of additional measures to enhance coldwater habitat that could be funded under License Condition 4(e), and to develop the Condition 4(d) report. For that reason the USDA Forest Service agrees with PG&E's request for an additional extension of time until May 1, 2013 to file these Condition 4(e) measures and the 4(d) report with FERC.

With this agreement for an extension of time the USDA Forest Service requests to be notified within 24 hours of excursions in temperature that necessitate implementation of any of the five interim measures and what specific interim measure is being taken. We also would like notification within 48 hours after an interim measure is taken as to its effectiveness and if the measure taken is not effective, what addition interim control measures will be taken to return stream temperatures to below 20ºC.

If you have any questions about the specifics of our support for an extension of time, don't hesitate to contact me.

R/
Dennis

Dennis Smith
USDA Forest Service
Pacific Southwest Region
Regional Hydropower Assistance Team Project Manager
1323 Club Drive
Vallejo, CA 94592
dennissmith@fs.fed.us
707-562-9176 Office
916-849-8039 Cell
707-562- 9055 Fax

From: White, Charles [mailto:COW1@pge.com]
Sent: Friday, April 27, 2012 1:38 PM
To: Smith, Dennis E -FS
Subject: Letter to FERC, Interim Control Measures, and LOI

Dennis,

Here is the submittal package that I am planning to send to FERC. All the other active members of the ERC have indicated their concurrence with the proposed Interim Control Measures.

Thank you for looking at this.

Charles White
Pacific Gas and Electric Company
245 Market Street, 1120B, San Francisco, CA 94105
Mailing: MC N11C, PO Box 770000, San Francisco, CA 94177
(415) 973-3642 Office
(925) 487-5270 Cell
cow1@pge.com

White, Charles

From: leah wills <leah2u@frontiernet.net>
Sent: Wednesday, April 25, 2012 5:02 PM
To: White, Charles
Cc: Sherrie Thrall; Randy Wilson; Albietz, Jessica
Subject: Re: Draft Interim Temperature Control Measures

Hi Charlie,

Good luck with your new job. It has been great to work with you.

Plumas County supports the Interim Control measures as proposed with the following suggested edits. Plumas would like to retain the cold water pool in But Valley reservoir as long as possible to lessen the cumulative heat strain on the trophy cold water trout fishery in the reservoir. So please defer the preferential use of Caribou 1 as long as possible in the heat storm season this year. Also, could you identify how the ERC will be notified of the interim water measures/actions that you do you take this year? And finally, the ERC has identified that moving ahead with the signing of the LOI is part of this summer/fall interim coldwater trout habitat measures.

The habitat/temperature/flows nexus is something the ERC will be working on for the rest of this year, although you may miss it.
Oh, too bad for you.

The approval of the LOI is scheduled on the May 15th, 2012 Plumas County Board of Supervisor's agenda.

Plumas County would like to see the signing of the LOI added to the Interim Measures document if you think the LOI is not too far "off topic" with FERC.

Best, Leah
On Apr 2, 2012, at 2:28 PM, White, Charles wrote:

ERC Members,

Attached is the draft Interim Temperature Control Measures recommendations. These are recommendations that we discussed at the February and March ERC meetings. I would like to get your comments April 26th.

This is also posted on the RCC ERC website.

Charles White
Pacific Gas and Electric Company
245 Market Street, 1120B, San Francisco, CA 94105
Mailing: MC N11C, PO Box 770000, San Francisco, CA 94177
(415) 973-3642 Office
(925) 487-5270 Cell
cow1@pge.com

<Interim Temperature Control Measures (ERC Review)_JA1.docx>

White, Charles

From: Chris Shutes <blancapaloma@msn.com>
Sent: Wednesday, April 18, 2012 11:58 AM
To: White, Charles; Albietz, Jessica
Cc: Peter Barnes; Laurie Soule; Herman, Andie; Amy Lind; Running, Stuart; Dave Steindorf; Leah Wills
Subject: Interim temperature report

Charlie,

I approve the draft "Interim Temperature Control Measures" for the Rock Creek - Cresta Project, as outlined in the April 5, 2012 review draft.

More permanent potential measures to improve summer water temperatures in the North Fork Feather River between Lake Almanor and Lake Oroville will become more evident with the issuance by the State Water Resources Control Board of its EIR for the 401 Water Quality Certification for the Upper North Fork Feather Project. CSPA looks forward to working with other stakeholders in reviewing the EIR, and developing permanent measures to improve summer water temperatures in the North Fork Feather River, pursuant to the 401 process for the Upper North Fork Feather Project.

Chris Shutes
FERC Projects Director
California Sportfishing Protection Alliance

White, Charles

From: Laurie Soule <LSOULE@dfg.ca.gov>
Sent: Wednesday, April 25, 2012 2:11 PM
To: White, Charles
Subject: Re: Draft Interim Temperature Control Measures

DFG concurs with the draft Interim Temperature Control recommendations. Thank you.

Laurie A. Soule
Staff Environmental Scientist
California Department of Fish and Game
North Central Region
1701 Nimbus Road, Ste. A
Rancho Cordova, CA 95670
916-358-2847

>>> On 4/2/2012 at 2:28 PM, "White, Charles" <COW1@pge.com> wrote:

ERC Members,

Attached is the draft Interim Temperature Control Measures recommendations. These are recommendations that we discussed at the February and March ERC meetings. I would like to get your comments April 26th.

This is also posted on the RCC ERC website.

Charles White
Pacific Gas and Electric Company
245 Market Street, 1120B, San Francisco, CA 94105
Mailing: MC N11C, PO Box 770000, San Francisco, CA 94177
(415) 973-3642 Office
(925) 487-5270 Cell
cow1@pge.com

White, Charles

From: Peter Barnes <PBarnes@waterboards.ca.gov>
Sent: Wednesday, April 25, 2012 11:52 AM
To: White, Charles
Subject: Re: Draft Interim Temperature Control Measures

Charlie,

The proposed measures look good. I understand that the UNFFR Draft EIR will help inform future decisions and am working diligently towards its completion.

Sincerely,

Peter Barnes
Engineering Geologist
Division of Water Rights
State Water Resources Control Board
Phone: (916) 445-9989
Email: pbarnes@waterboards.ca.gov
>>> "White, Charles" <COW1@pge.com> 4/2/2012 2:28 PM >>>
ERC Members,

Attached is the draft Interim Temperature Control Measures recommendations. These are recommendations that we discussed at the February and March ERC meetings. I would like to get your comments April 26th.

This is also posted on the RCC ERC website.

Charles White
Pacific Gas and Electric Company
245 Market Street, 1120B, San Francisco, CA 94105
Mailing: MC N11C, PO Box 770000, San Francisco, CA 94177
(415) 973-3642 Office
(925) 487-5270 Cell
cow1@pge.com

White, Charles

From: Dave Steindorf <dave@americanwhitewater.org>
Sent: Thursday, April 26, 2012 4:33 PM
To: White, Charles
Subject: Re: Draft Interim Temperature Control Measures

Charlie,
This report has my approval to go to FERC.
Dave

Dave Steindorf
California Stewardship Director
American Whitewater
4 Baroni Drive
Chico, CA 95928
Office 530.343.1871
Cell 530.518.2729

Join or donate today!
www.americanwhitewater.org

On Apr 2, 2012, at 2:28 PM, White, Charles wrote:

ERC Members,

Attached is the draft Interim Temperature Control Measures recommendations. These are recommendations that we discussed at the February and March ERC meetings. I would like to get your comments April 26th.

This is also posted on the RCC ERC website.

Charles White
Pacific Gas and Electric Company
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(925) 487-5270 Cell
cow1@pge.com

<Interim Temperature Control Measures (ERC Review)_JA1.docx>

ATTACHMENT B

TEMPERATURE RESPONSES TO CARIBOU 1 RELEASES (MEASURE 2)

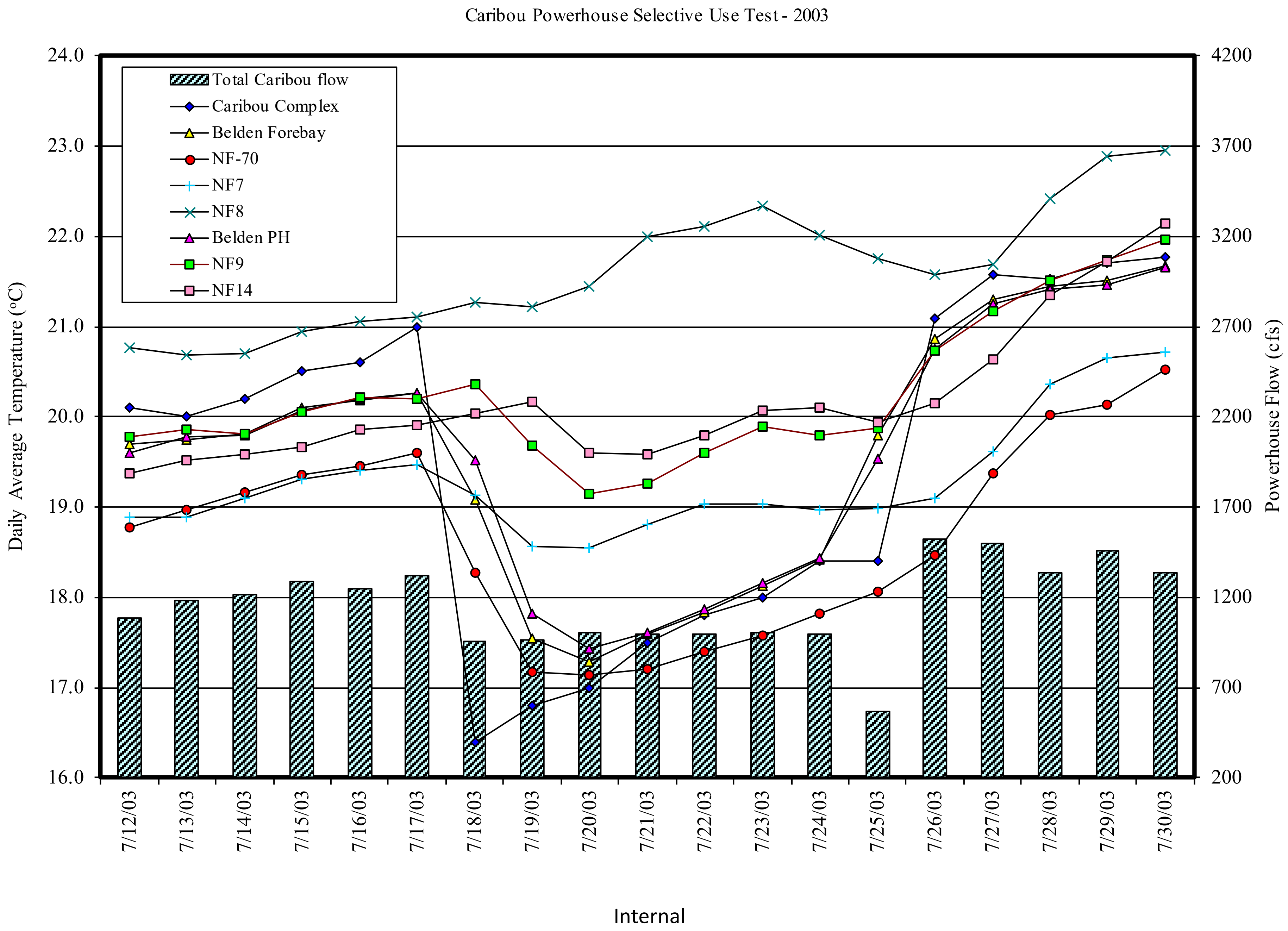

Caribou Powerhouse Selective Use Test - 2003
Total Caribou flow
Caribou Complex
Belden Forebay
NF-70
NF7
NF8
Belden PH
NF9
NF14
Daily Average Temperature (°C)
Powerhouse Flow (cfs)
24.0
23.0
22.0
21.0
20.0
19.0
18.0
17.0
16.0
4200
3700
3200
2700
2200
1700
1200
700
200
7/12/03
7/13/03
7/14/03
7/15/03
7/16/03
7/17/03
7/18/03
7/19/03
7/20/03
7/21/03
7/22/03
7/23/03
7/24/03
7/25/03
7/26/03
7/27/03
7/28/03
7/29/03
7/30/03
Internal

Figure A2-1

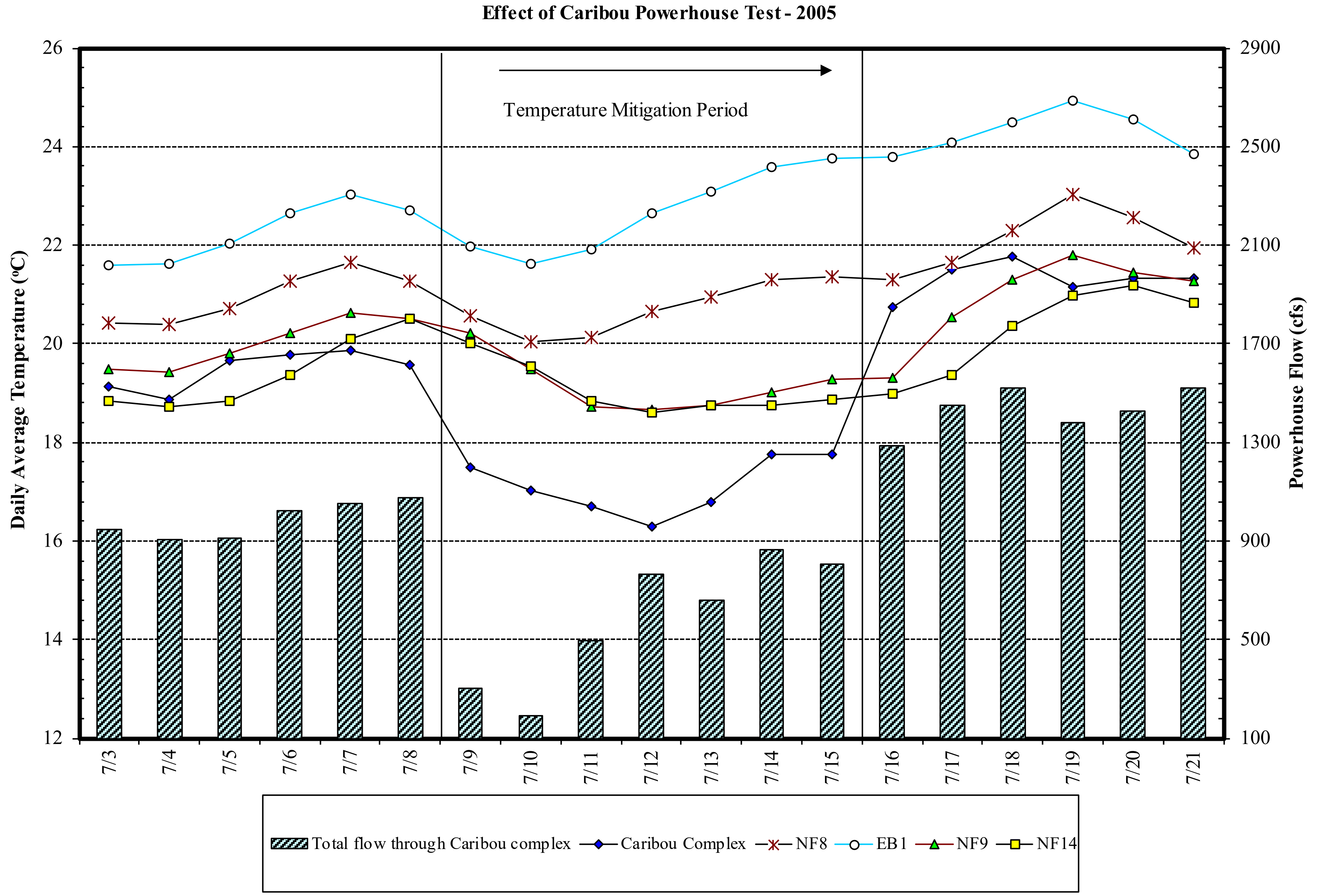


Figure A2-2

Internal

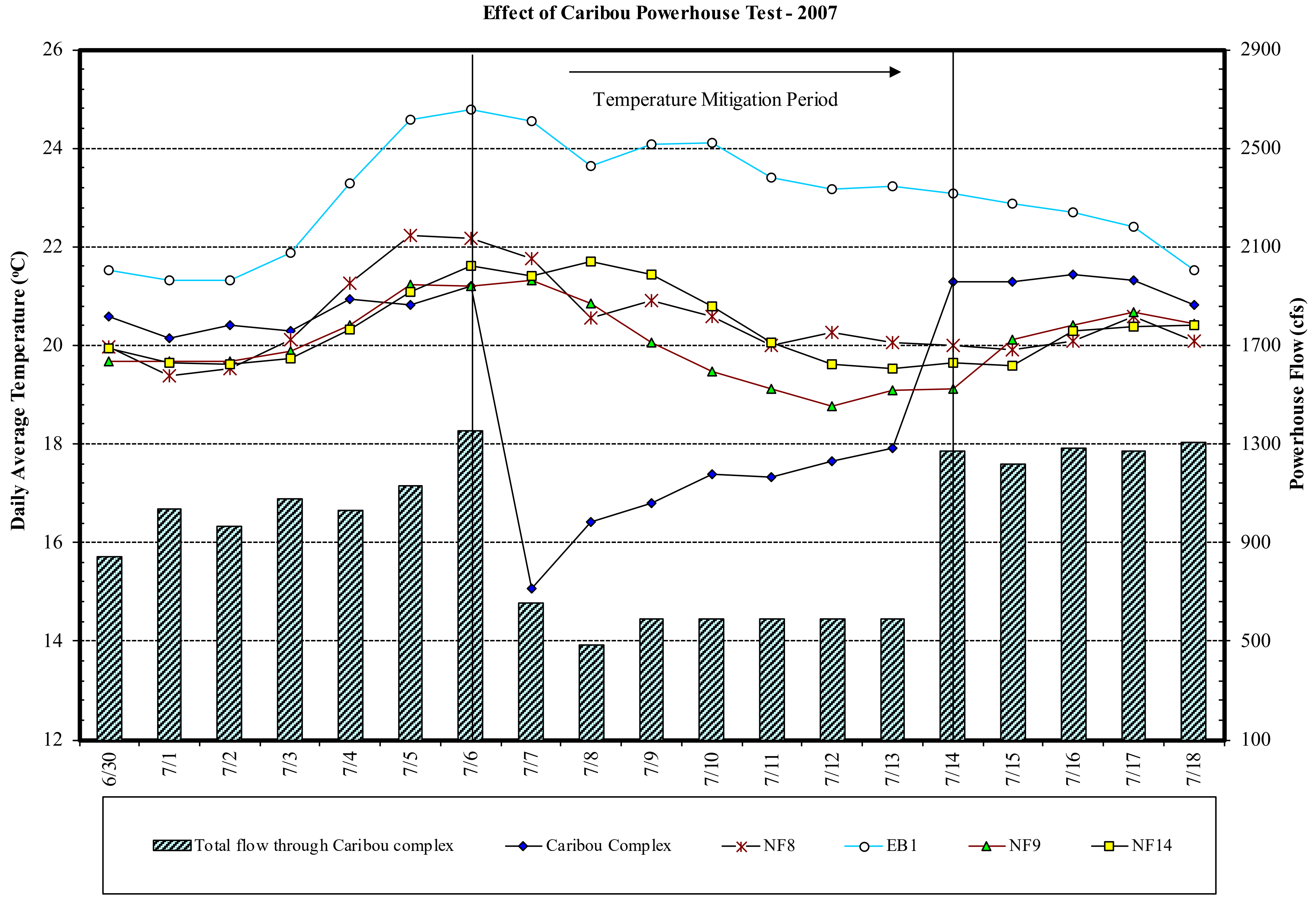


Figure A2-3

Internal

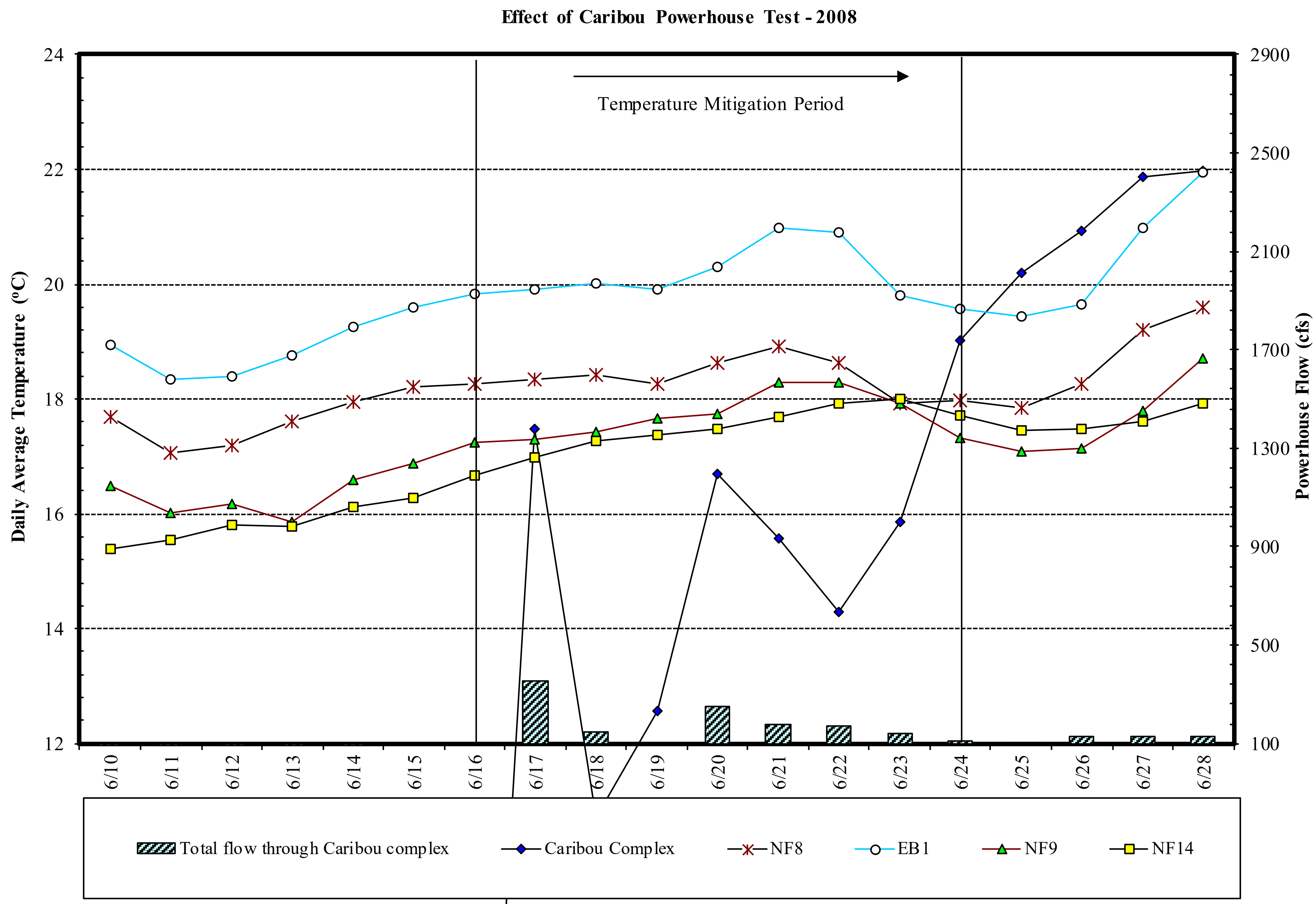


Figure A2-4

Internal

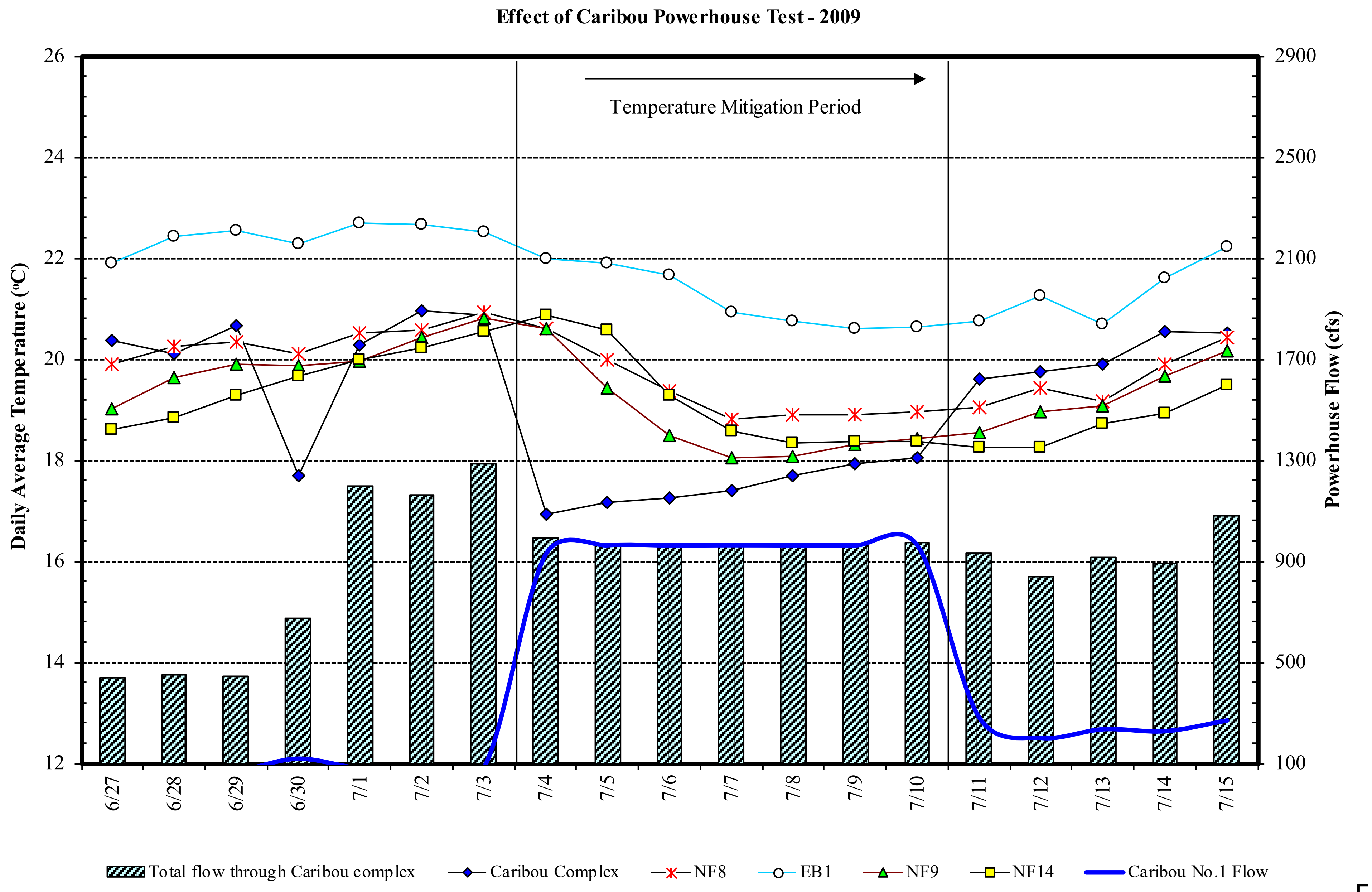
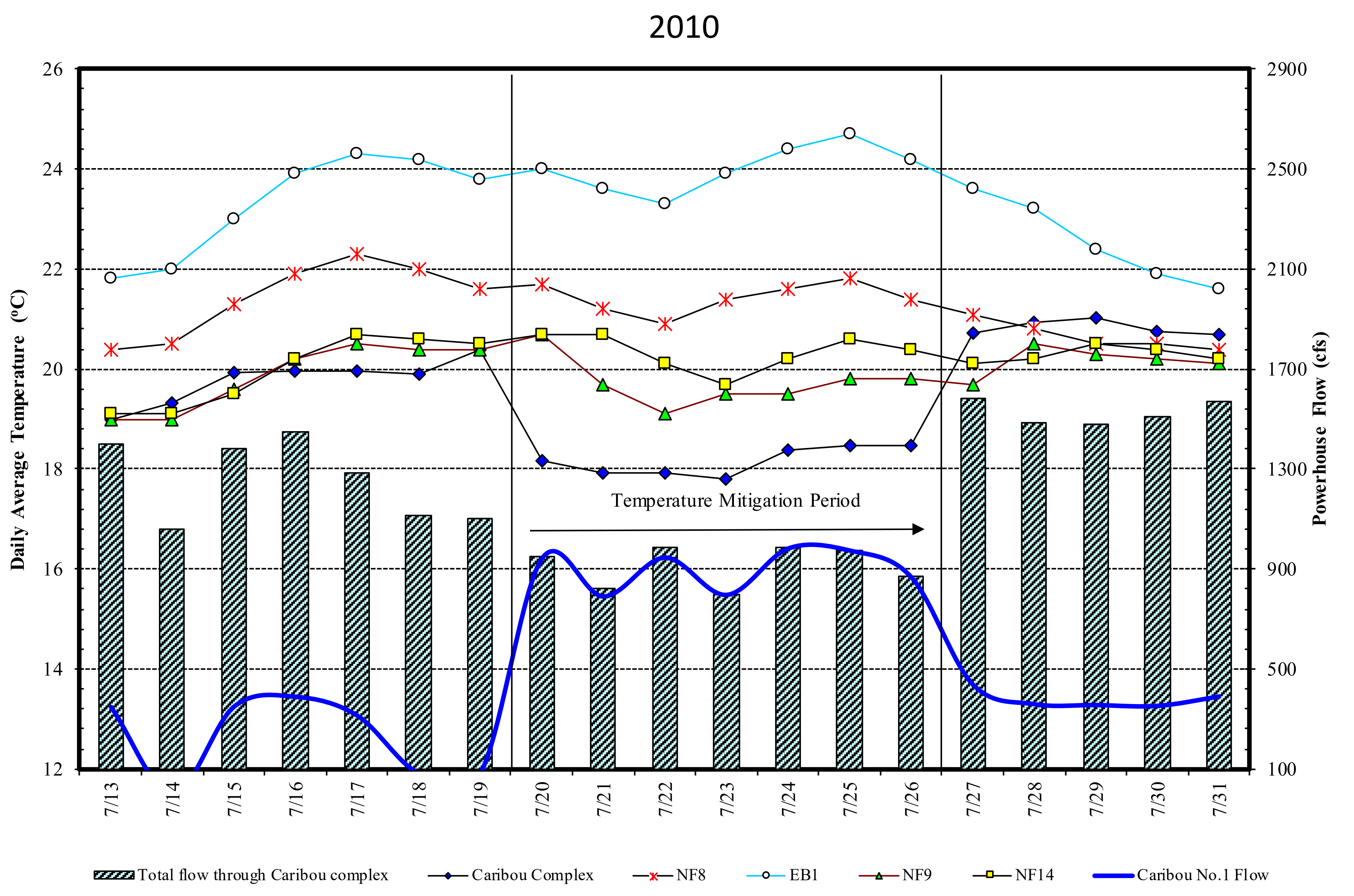

Effect of Caribou Powerhouse Test - 2009
Temperature Mitigation Period
Daily Average Temperature (ºC)
Powerhouse Flow (cfs)
26
24
22
20
18
16
14
12
2900
2500
2100
1700
1300
900
500
100
6/27
6/28
6/29
6/30
7/1
7/2
7/3
7/4
7/5
7/6
7/7
7/8
7/9
7/10
7/11
7/12
7/13
7/14
7/15
Total flow through Caribou complex
Caribou Complex
NF8
EB1
NF9
NF14
Caribou No.1 Flow

Figure A2-5



2010
Daily Average Temperature (ºC)
Powerhouse Flow (cfs)
26
24
22
20
18
16
14
12
2900
2500
2100
1700
1300
900
500
100
Temperature Mitigation Period
7/13
7/14
7/15
7/16
7/17
7/18
7/19
7/20
7/21
7/22
7/23
7/24
7/25
7/26
7/27
7/28
7/29
7/30
7/31
Total flow through Caribou complex
Caribou Complex
NF8
EB1
NF9
NF14
Caribou No.1 Flow

Figure A2-6

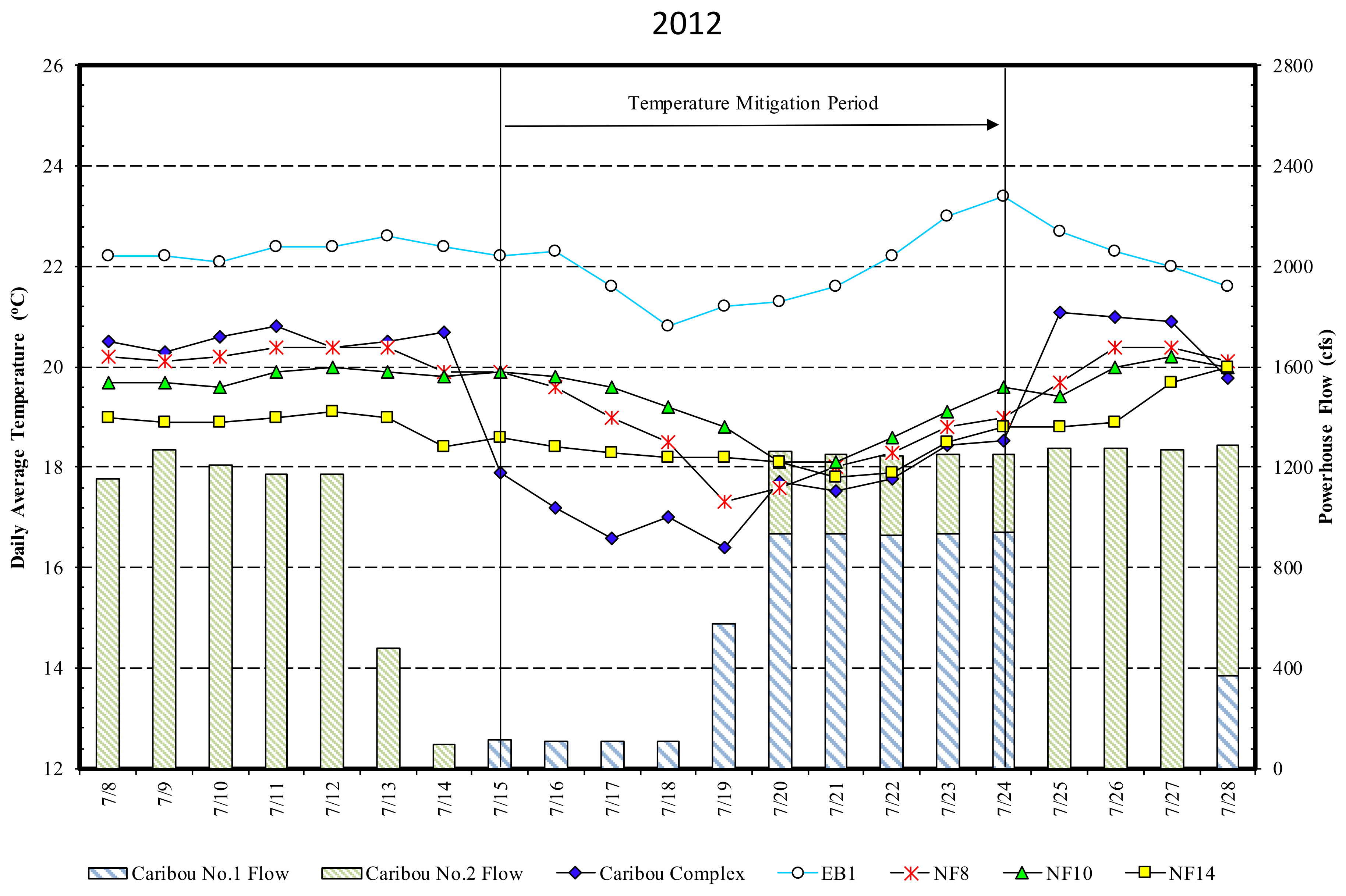
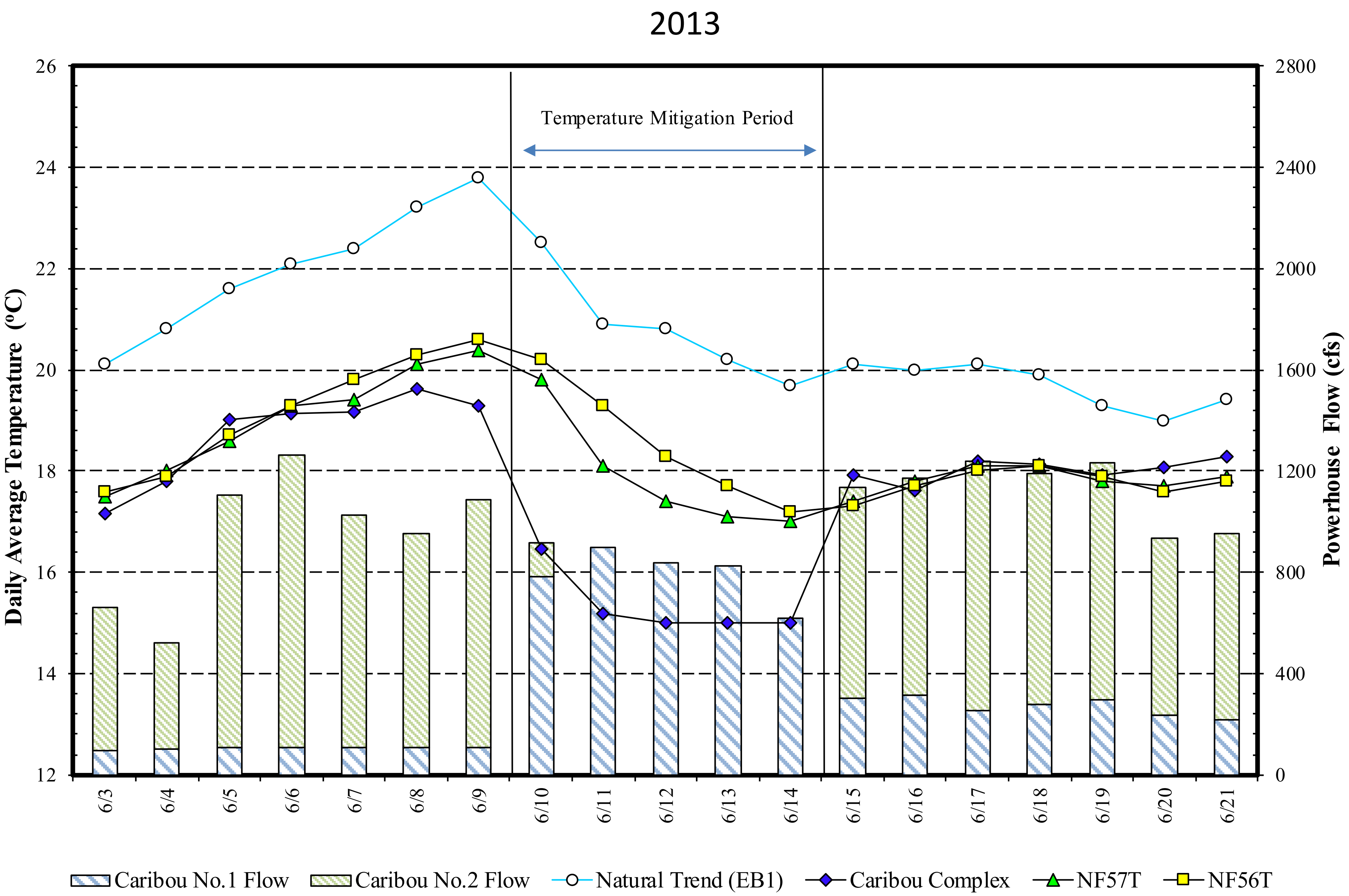

2012
Temperature Mitigation Period
Daily Average Temperature (ºC)
Powerhouse Flow (cfs)
26
24
22
20
18
16
14
12
2800
2400
2000
1600
1200
800
400
0
7/8
7/9
7/10
7/11
7/12
7/13
7/14
7/15
7/16
7/17
7/18
7/19
7/20
7/21
7/22
7/23
7/24
7/25
7/26
7/27
7/28
Caribou No.1 Flow
Caribou No.2 Flow
Caribou Complex
EB1
NF8
NF10
NF14

Figure A2-7



2013
Temperature Mitigation Period
Daily Average Temperature (ºC)
Powerhouse Flow (cfs)
26
24
22
20
18
16
14
12
2800
2400
2000
1600
1200
800
400
0
6/3
6/4
6/5
6/6
6/7
6/8
6/9
6/10
6/11
6/12
6/13
6/14
6/15
6/16
6/17
6/18
6/19
6/20
6/21
Caribou No.1 Flow
Caribou No.2 Flow
Natural Trend (EB1)
Caribou Complex
NF57T
NF56T

Figure A2-8

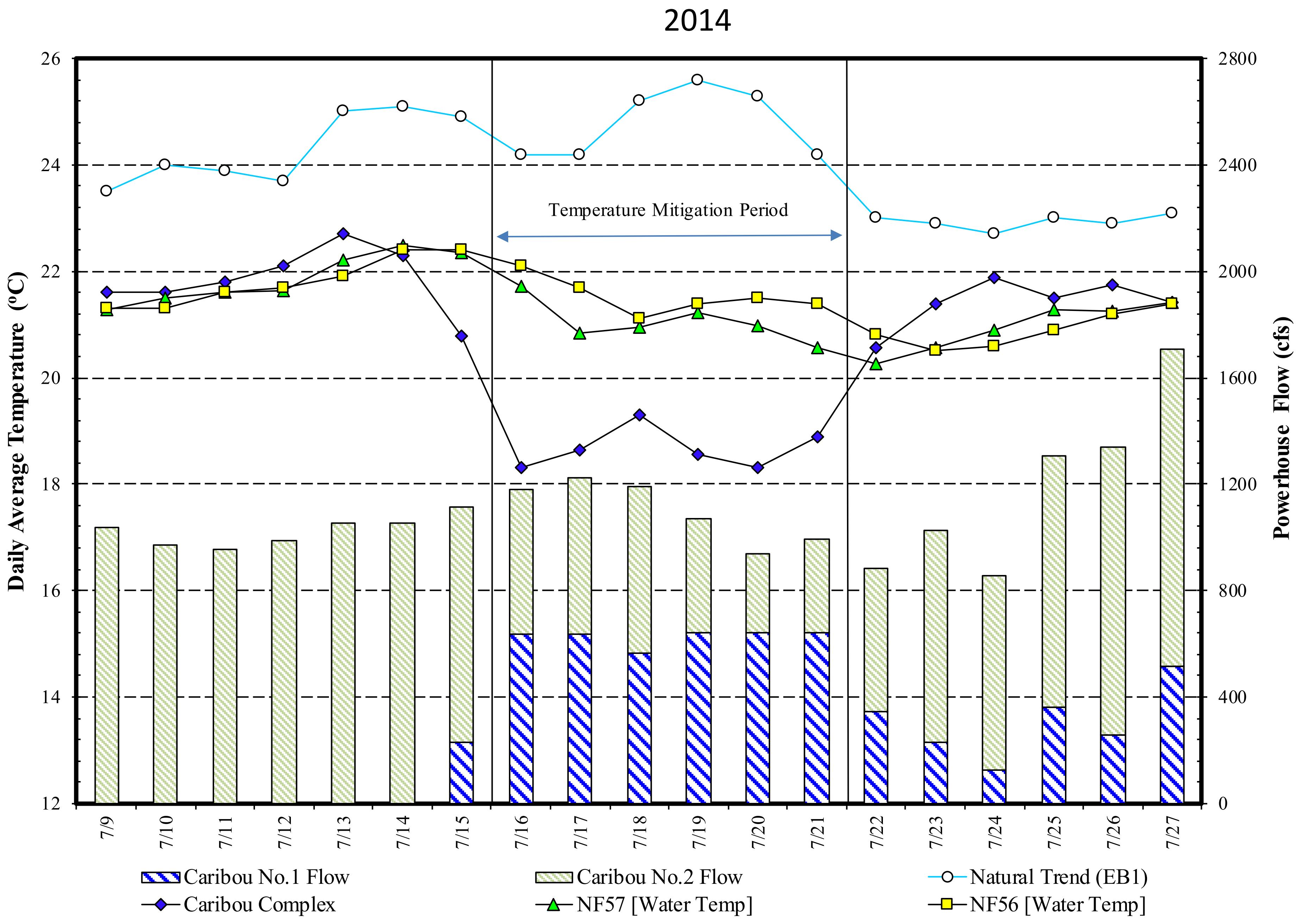


Figure A2-9

Internal

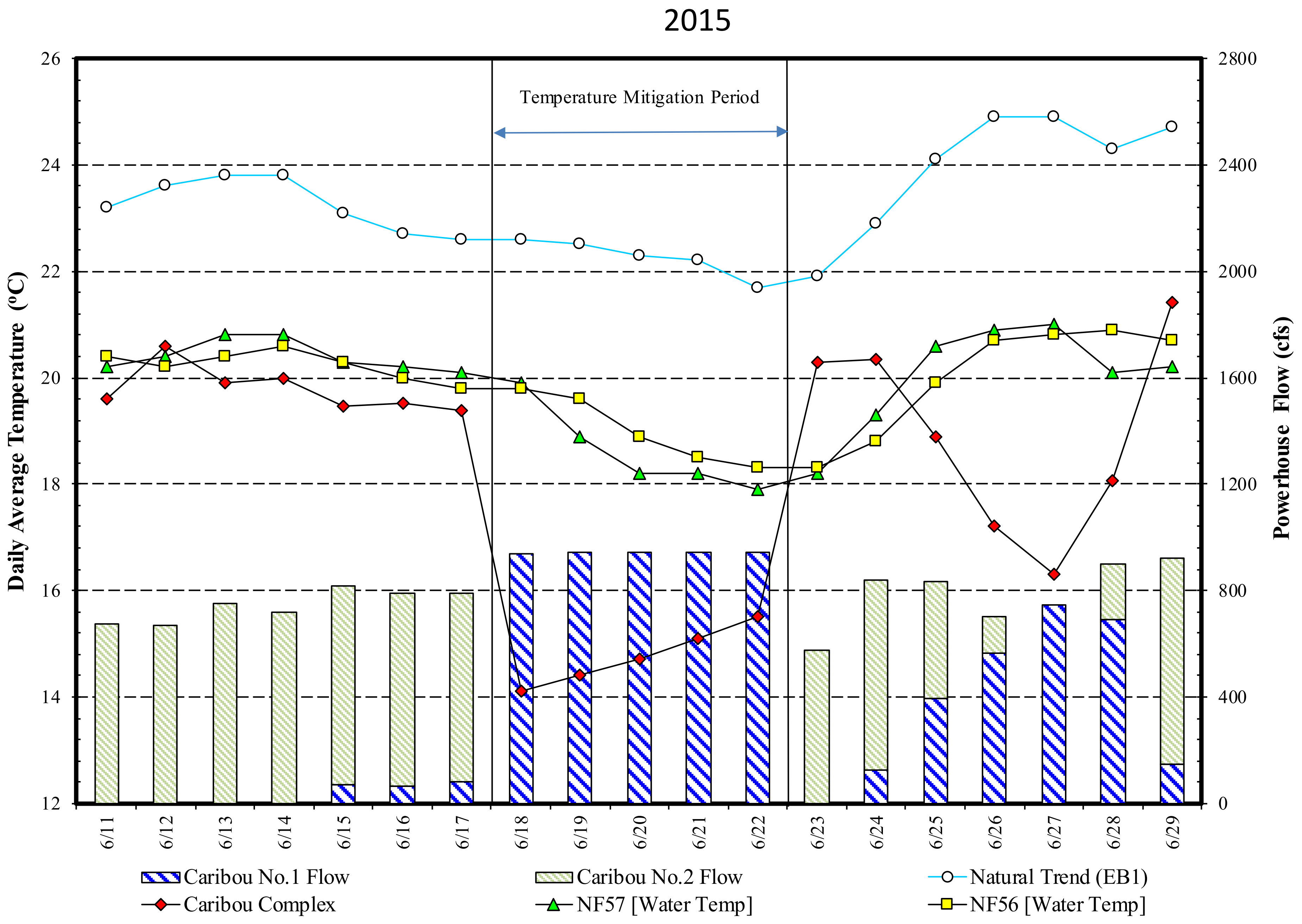

2015
Temperature Mitigation Period
Daily Average Temperature (ºC)
Powerhouse Flow (cfs)
26
24
22
20
18
16
14
12
2800
2400
2000
1600
1200
800
400
0
6/11
6/12
6/13
6/14
6/15
6/16
6/17
6/18
6/19
6/20
6/21
6/22
6/23
6/24
6/25
6/26
6/27
6/28
6/29
Caribou No.1 Flow
Caribou No.2 Flow
Natural Trend (EB1)
Caribou Complex
NF57 [Water Temp]
NF56 [Water Temp]

Figure A2-10

2016

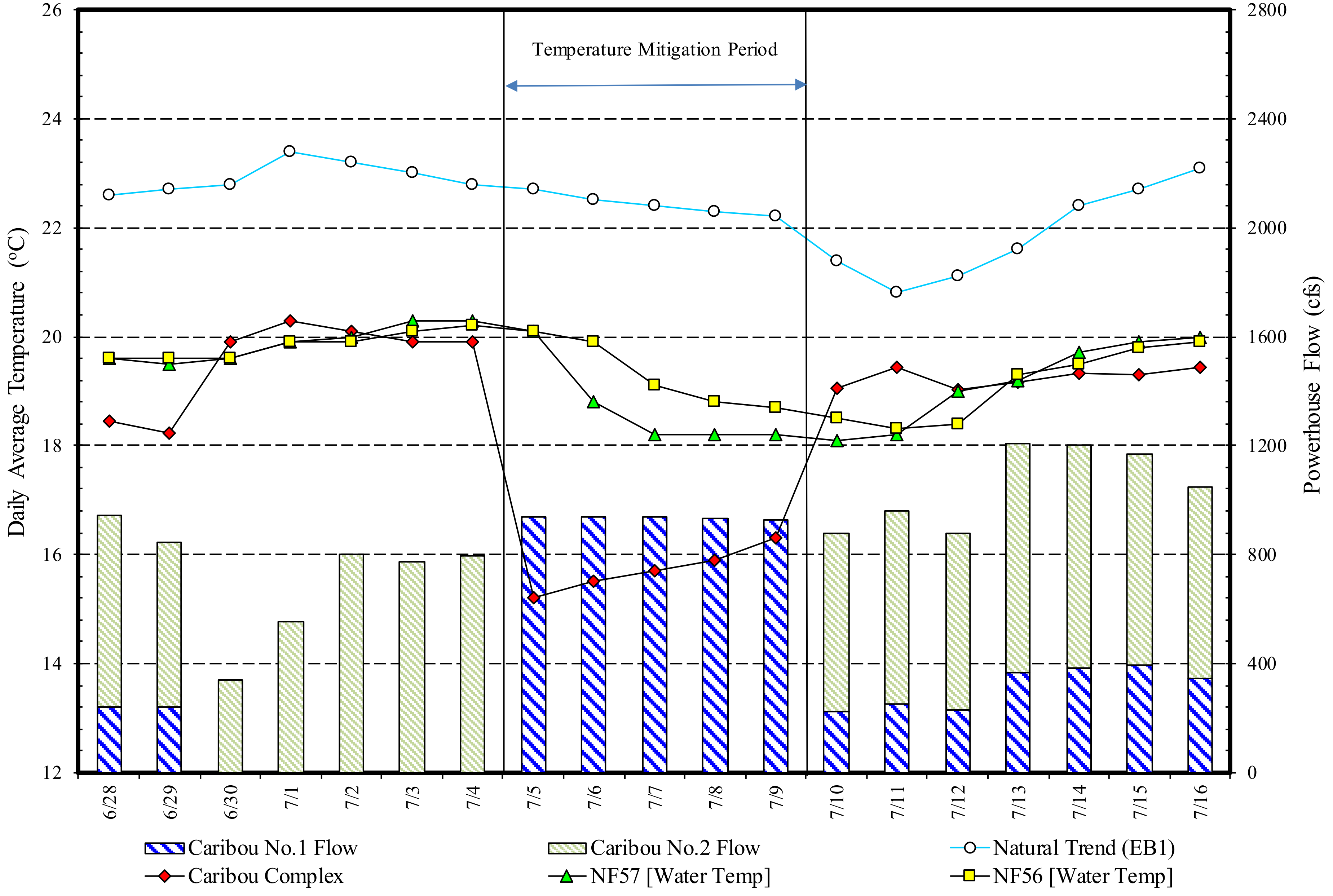


Figure A2-11

Internal

2017

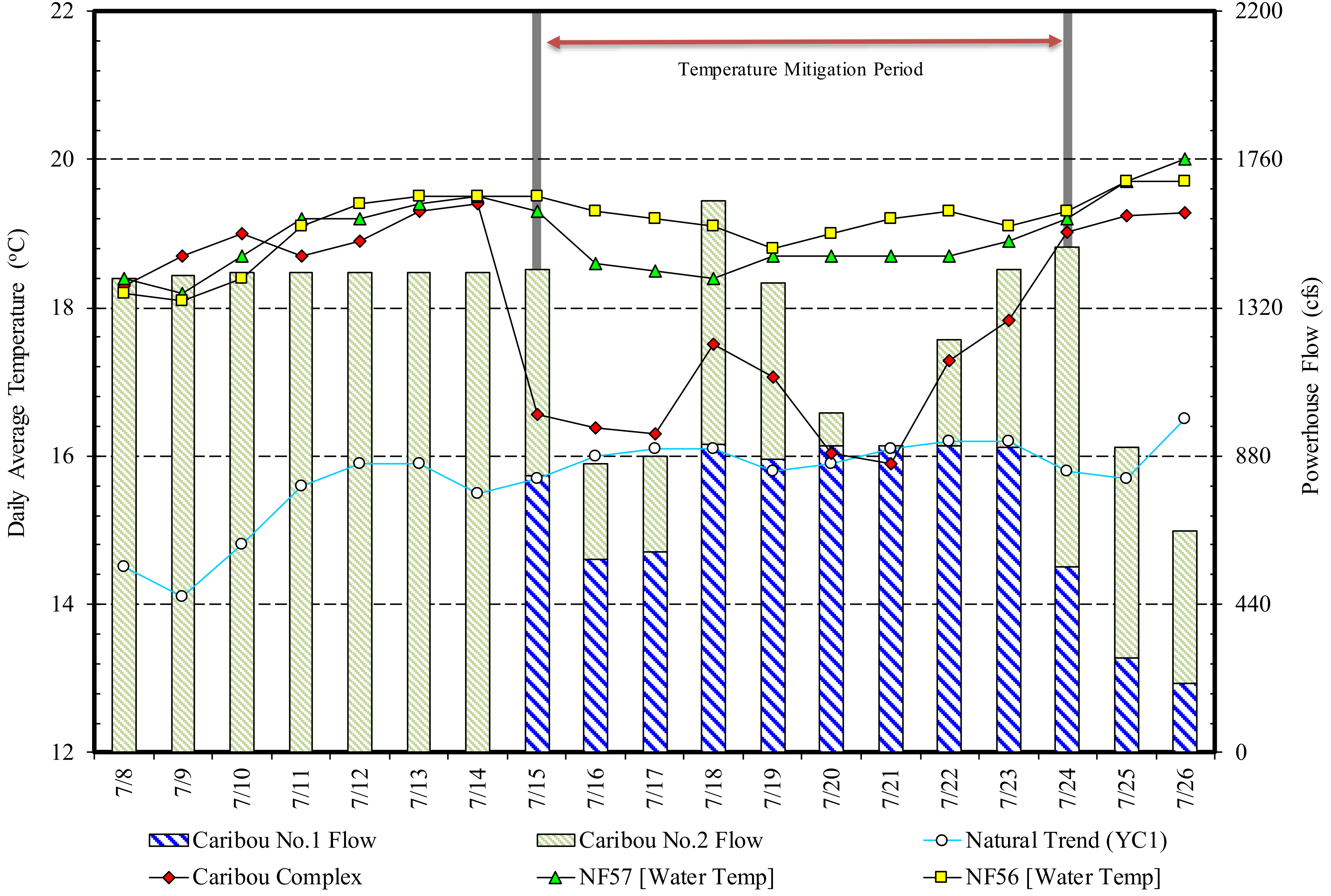


Figure A2-12

2018

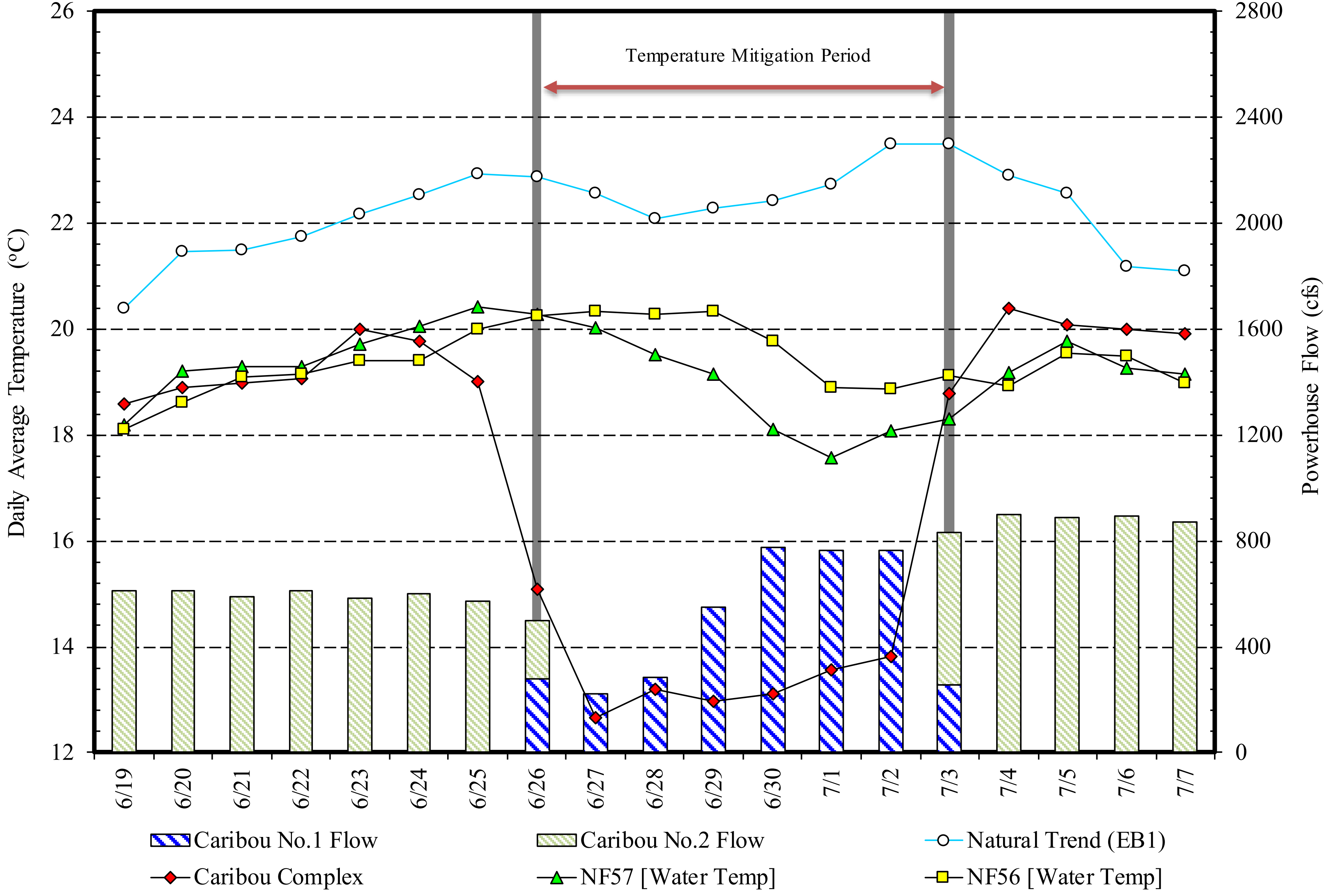


Figure A2-13

2019

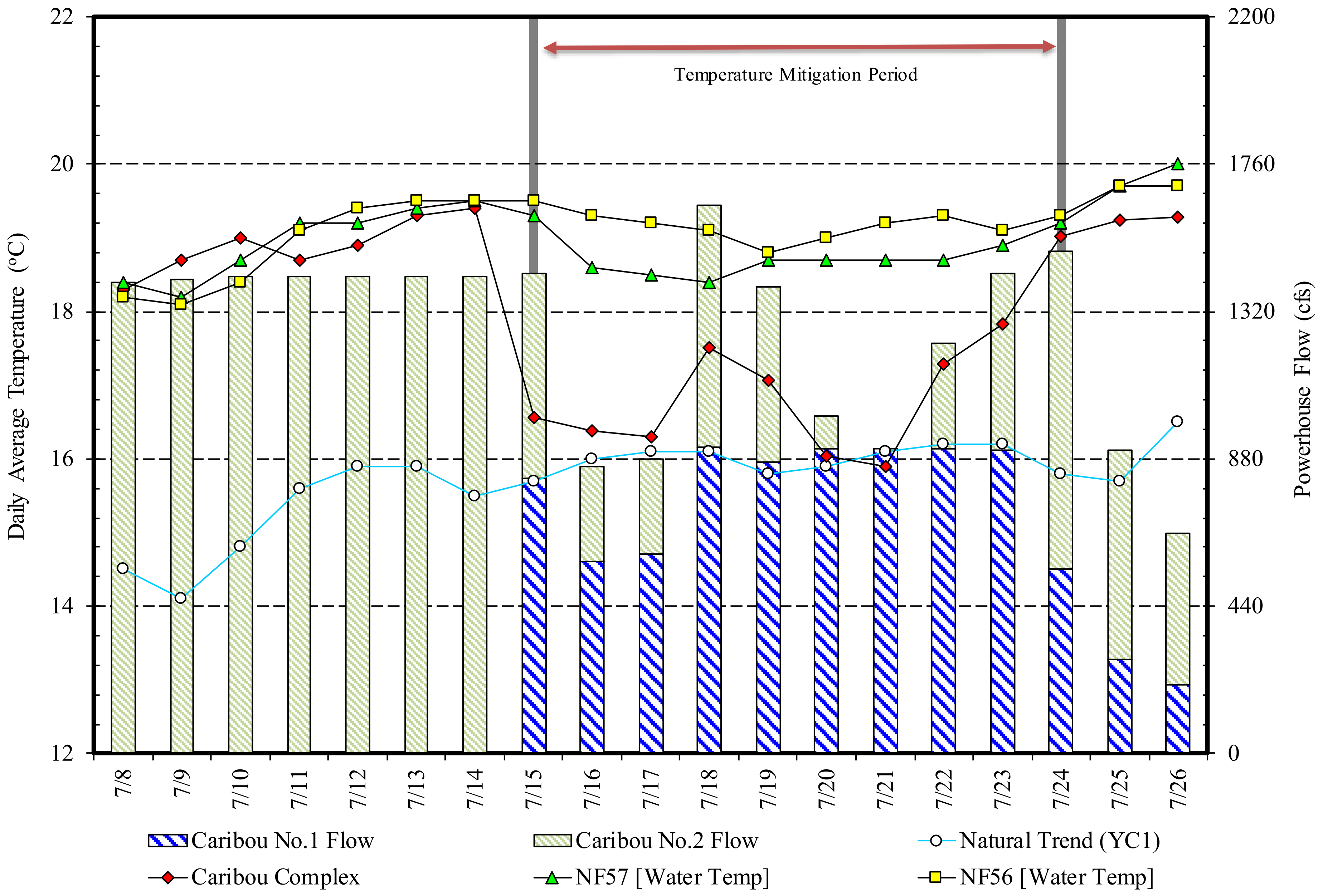


Figure A2-14

Internal

2020

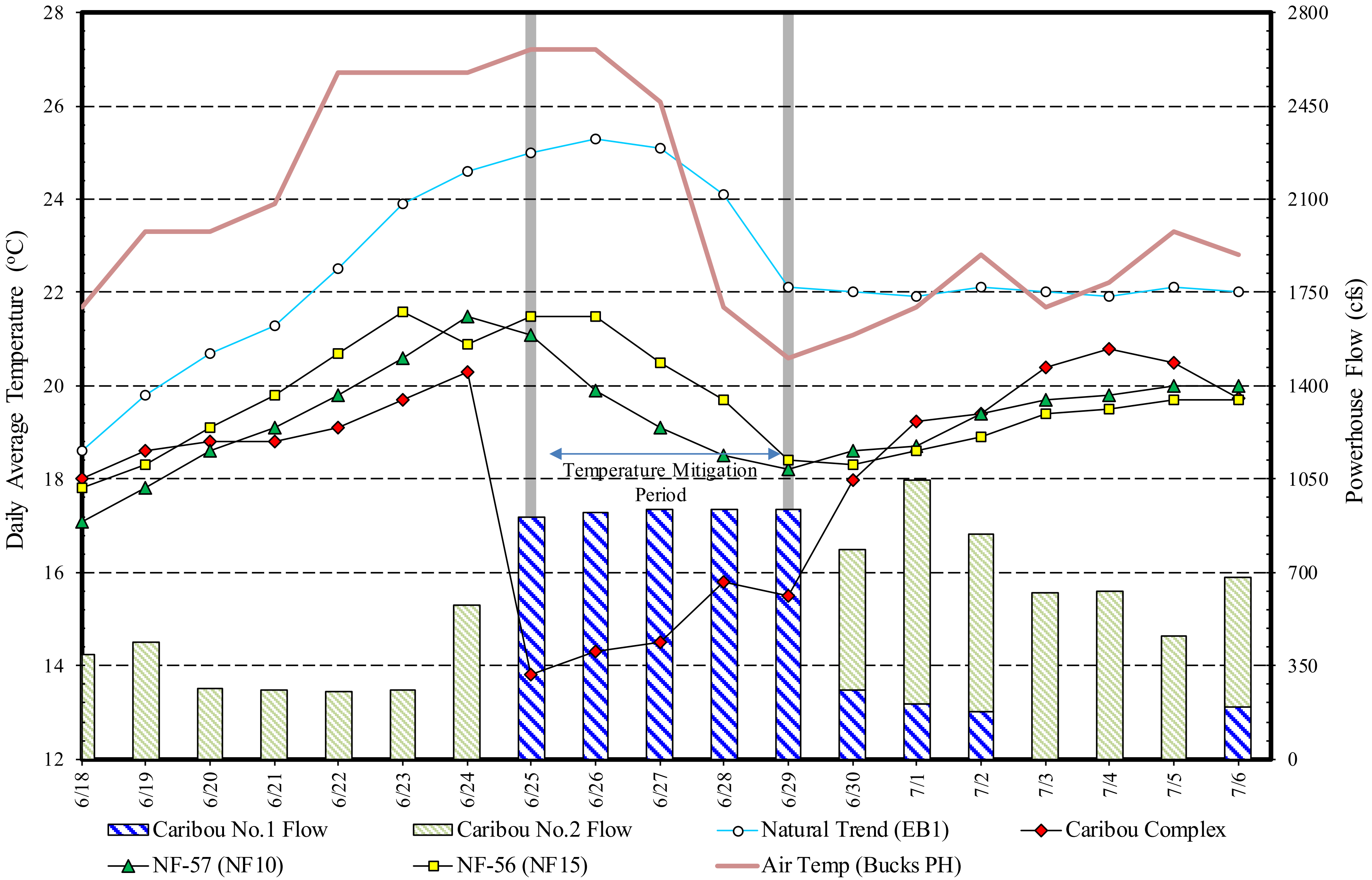


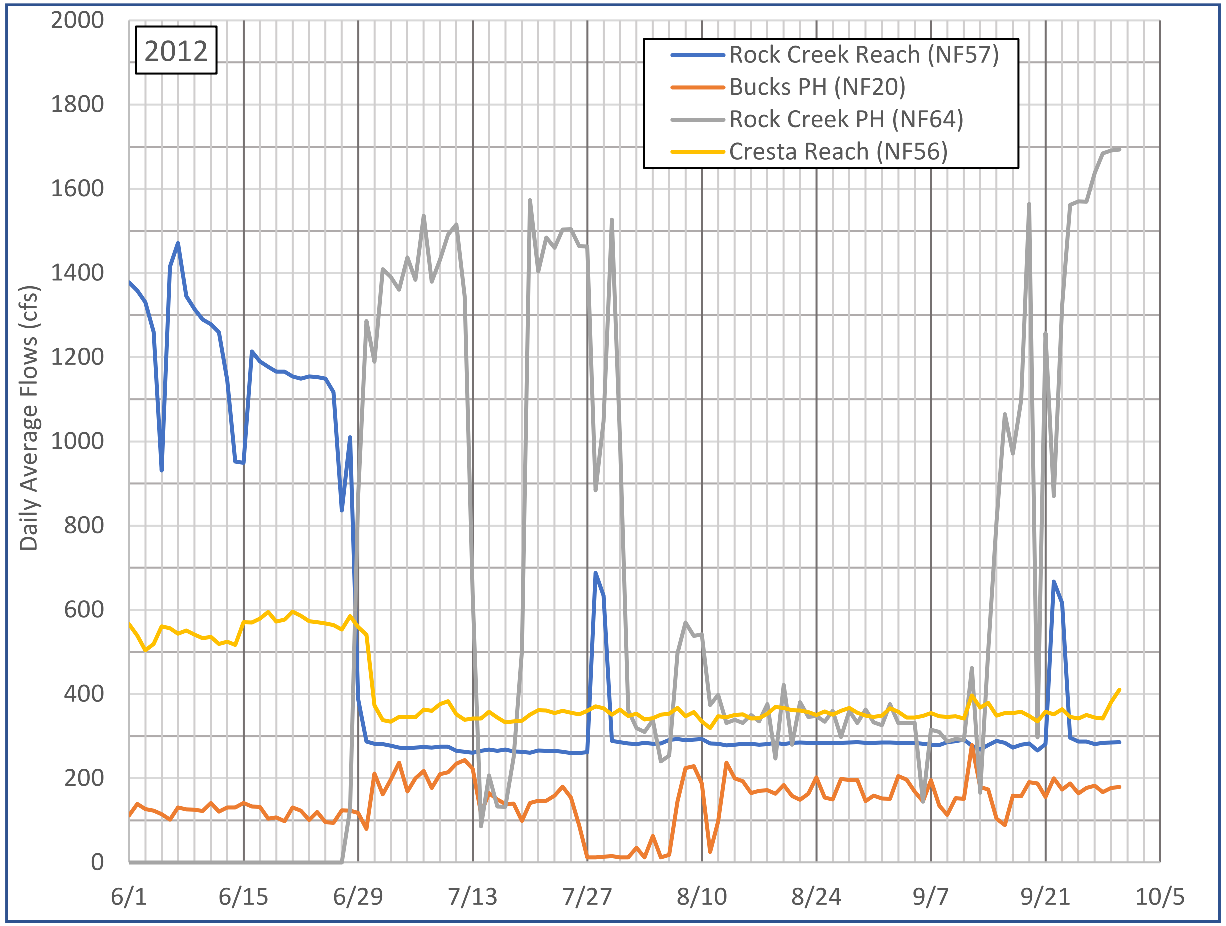
Figure A2-15

Internal

ATTACHMENT C

TEMPERATURE RESPONSES RELATED TO THE BUCKS POWERHOUSE FLOWS (MEASURE 3)

Flows



Water Temperature

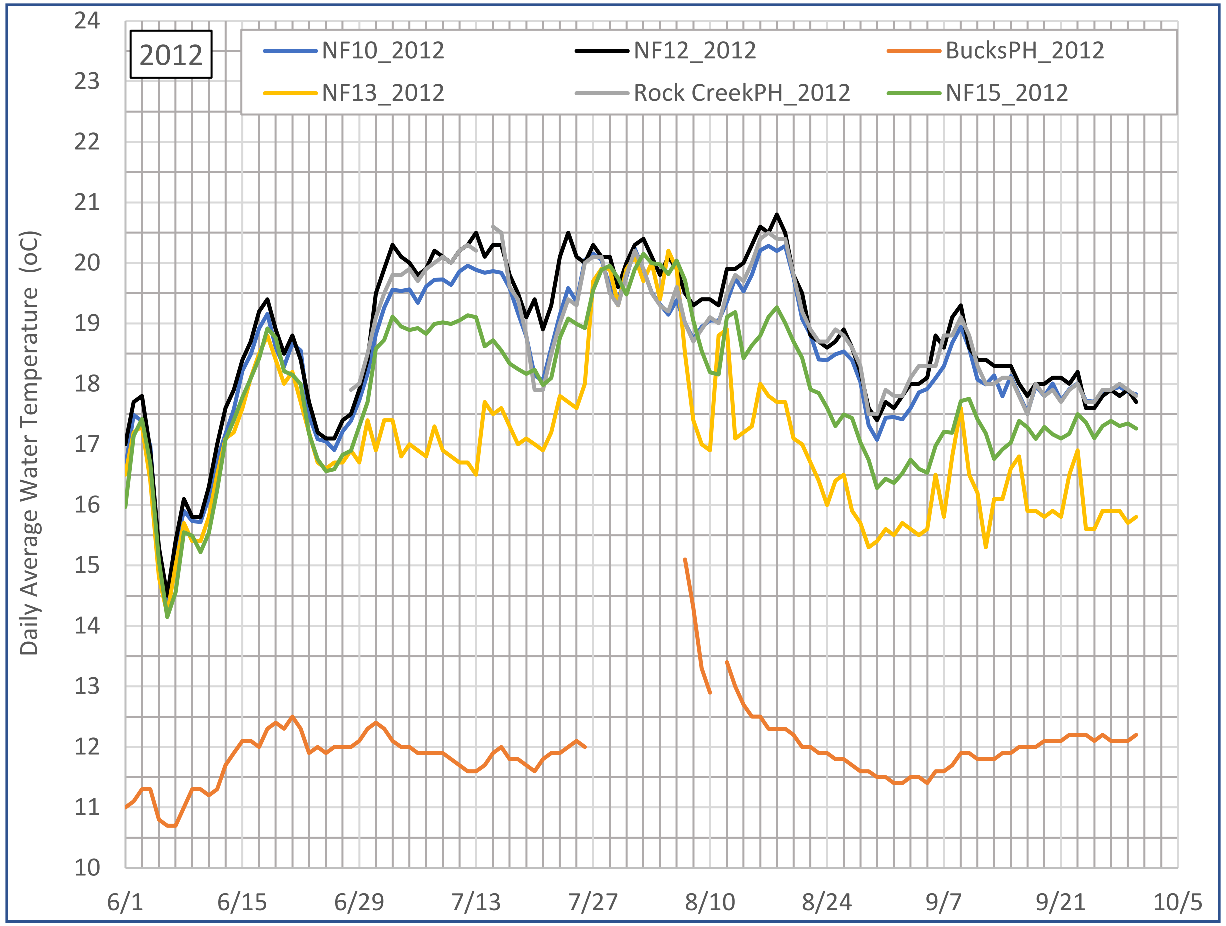
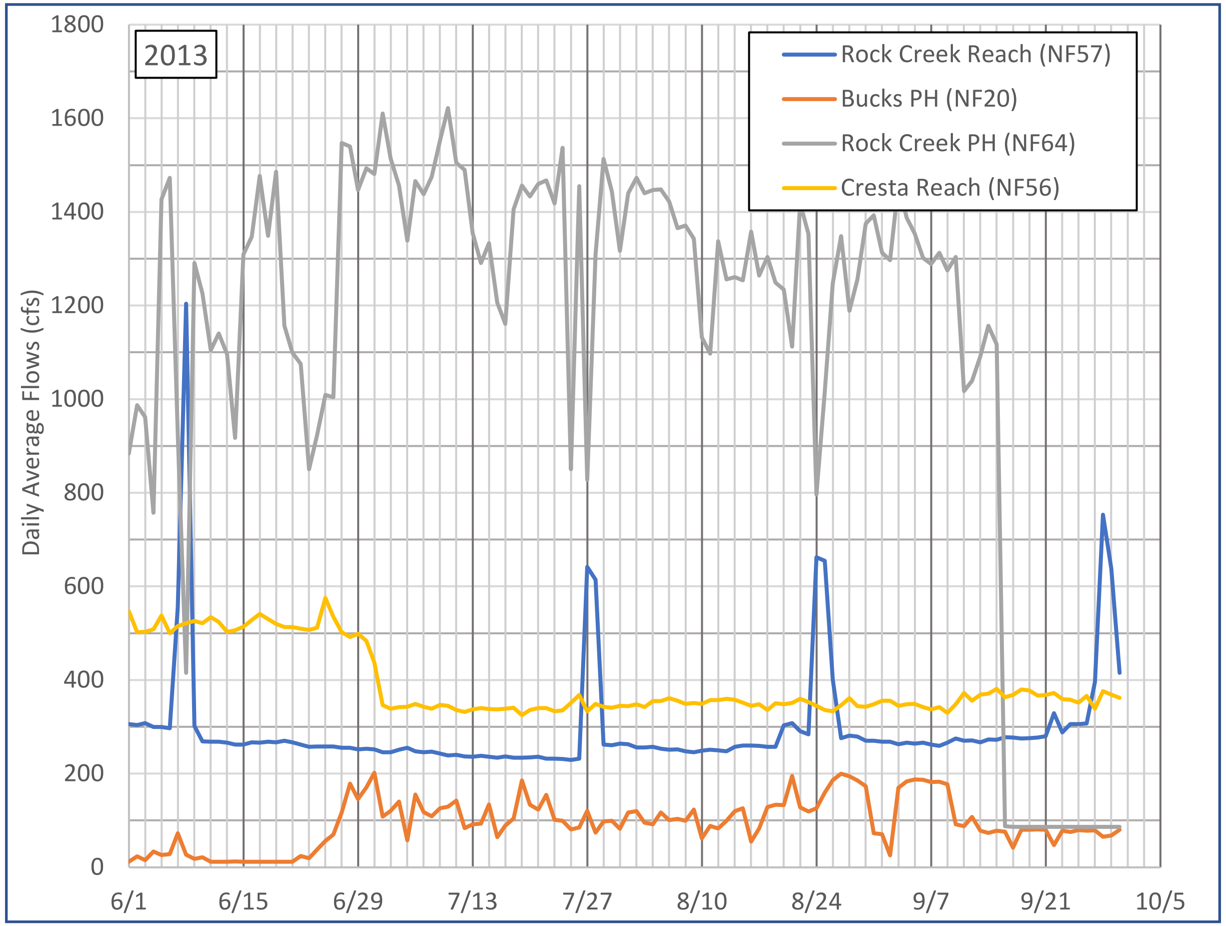


Figure A3-1

Flows



Water Temperature

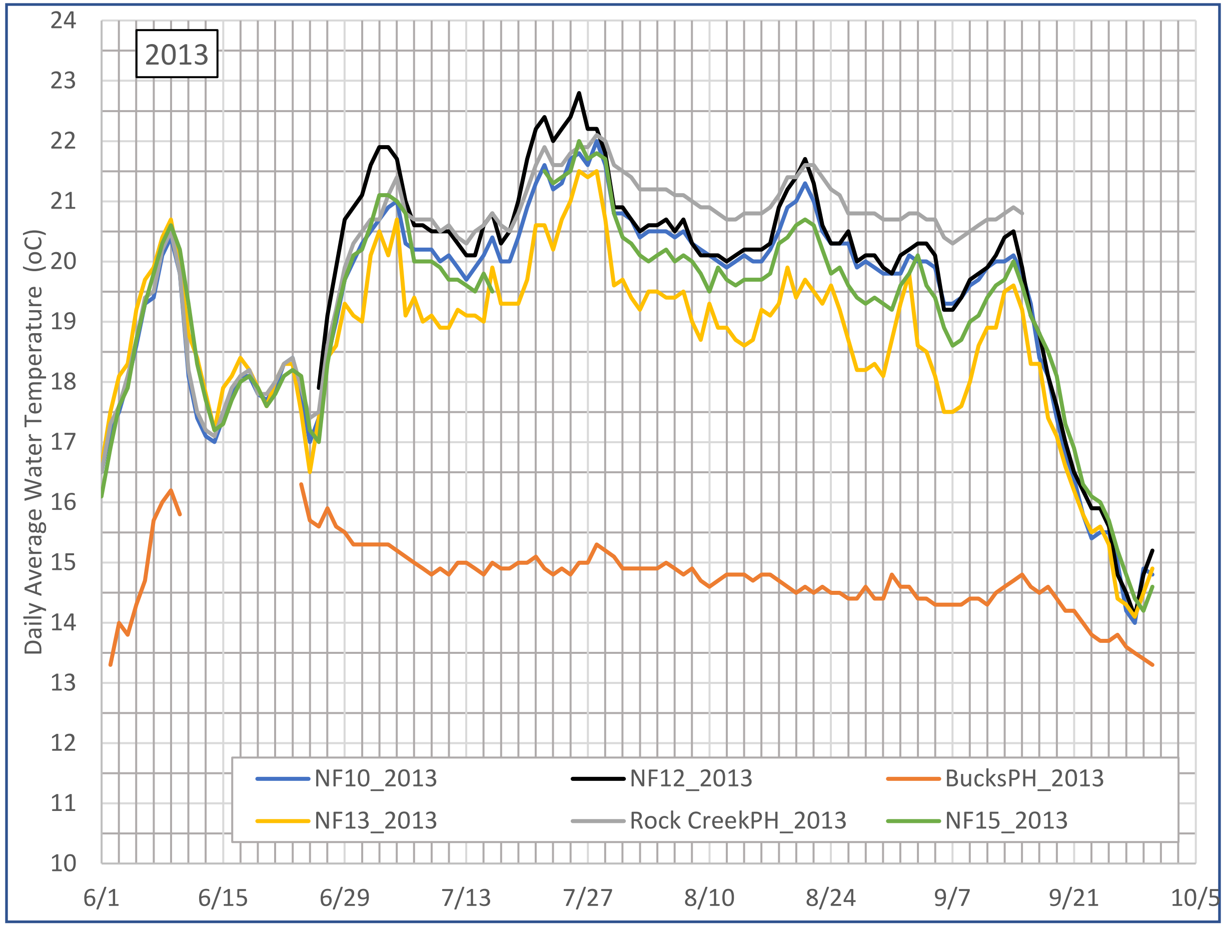
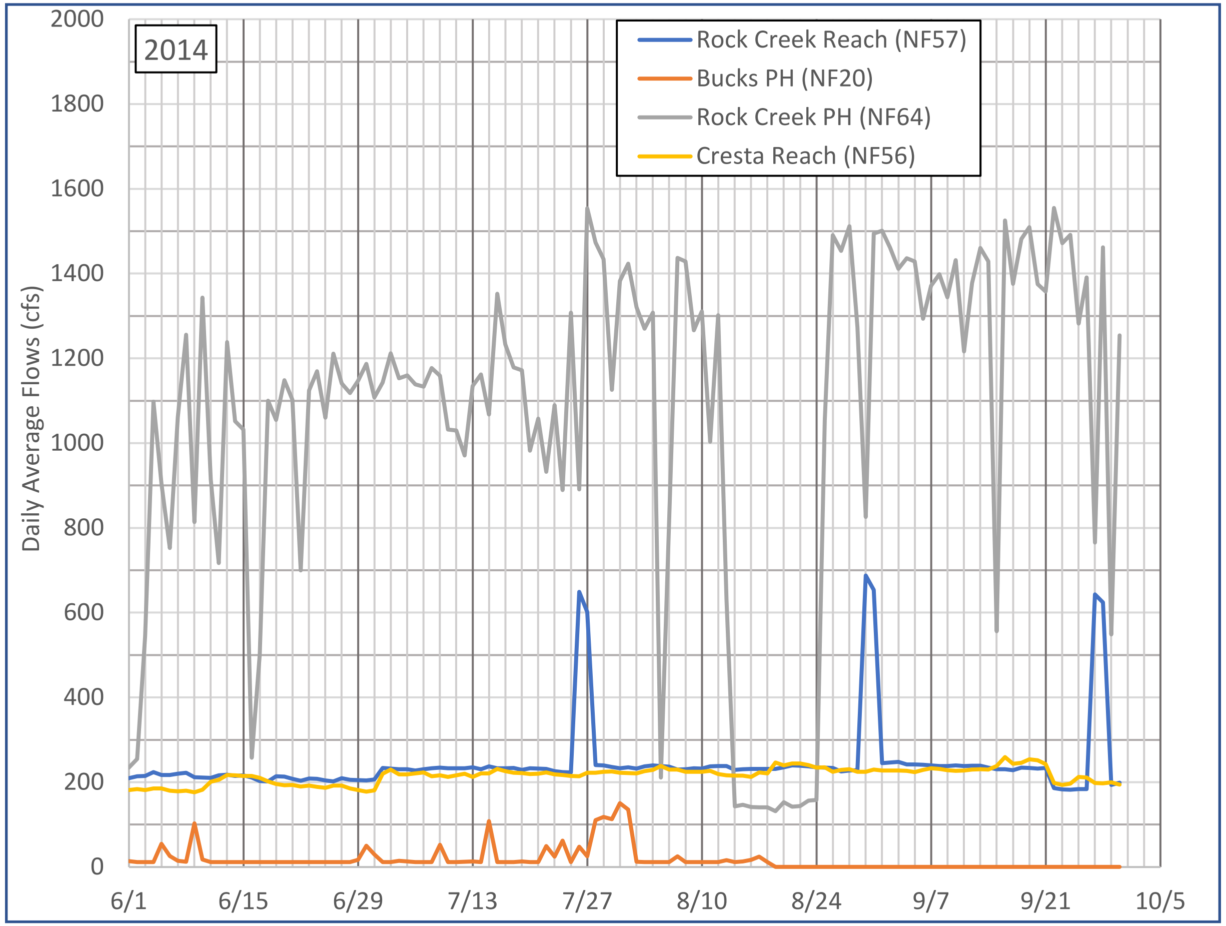


Figure A3-2

Flows



Water Temperature

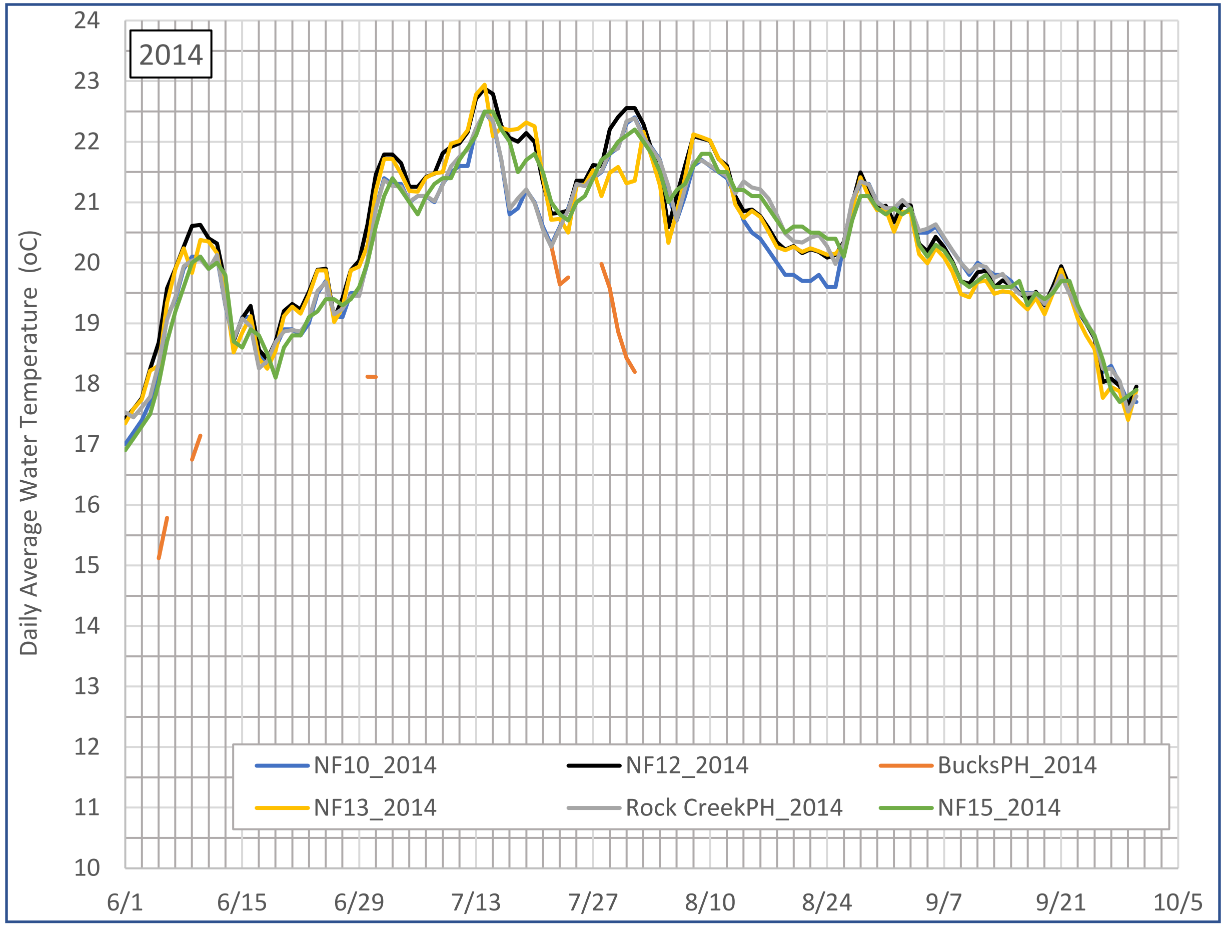
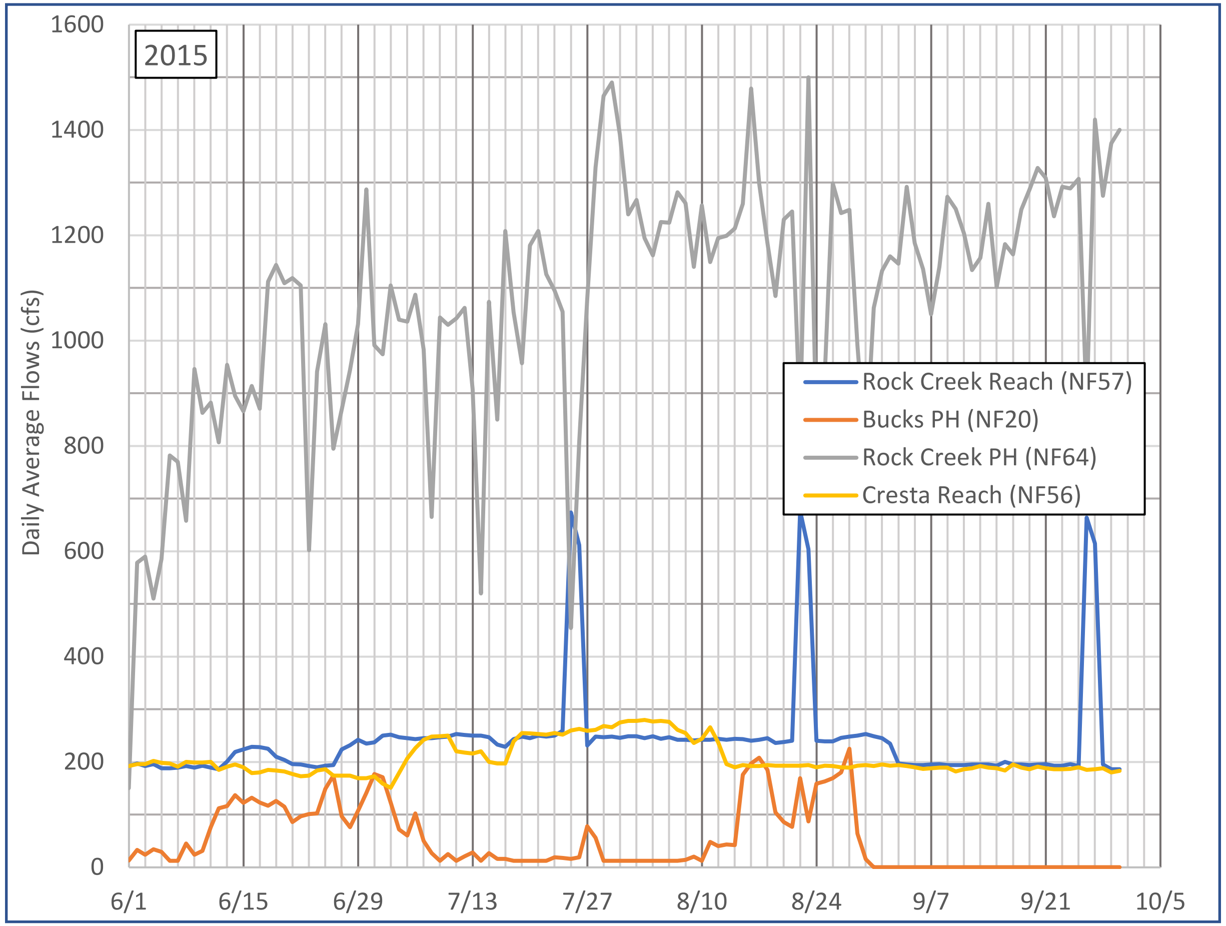


Figure A3-3

Flows



Water Temperature

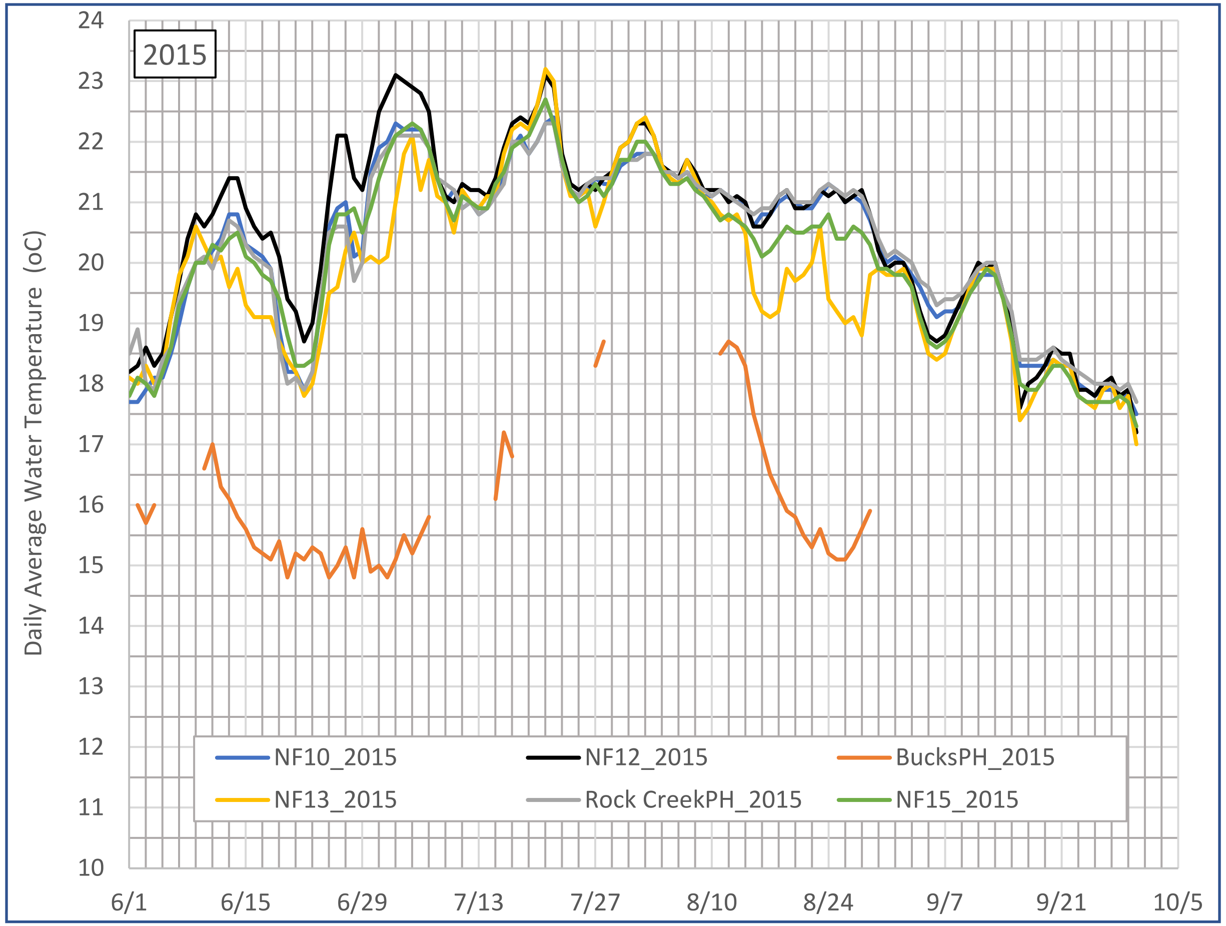
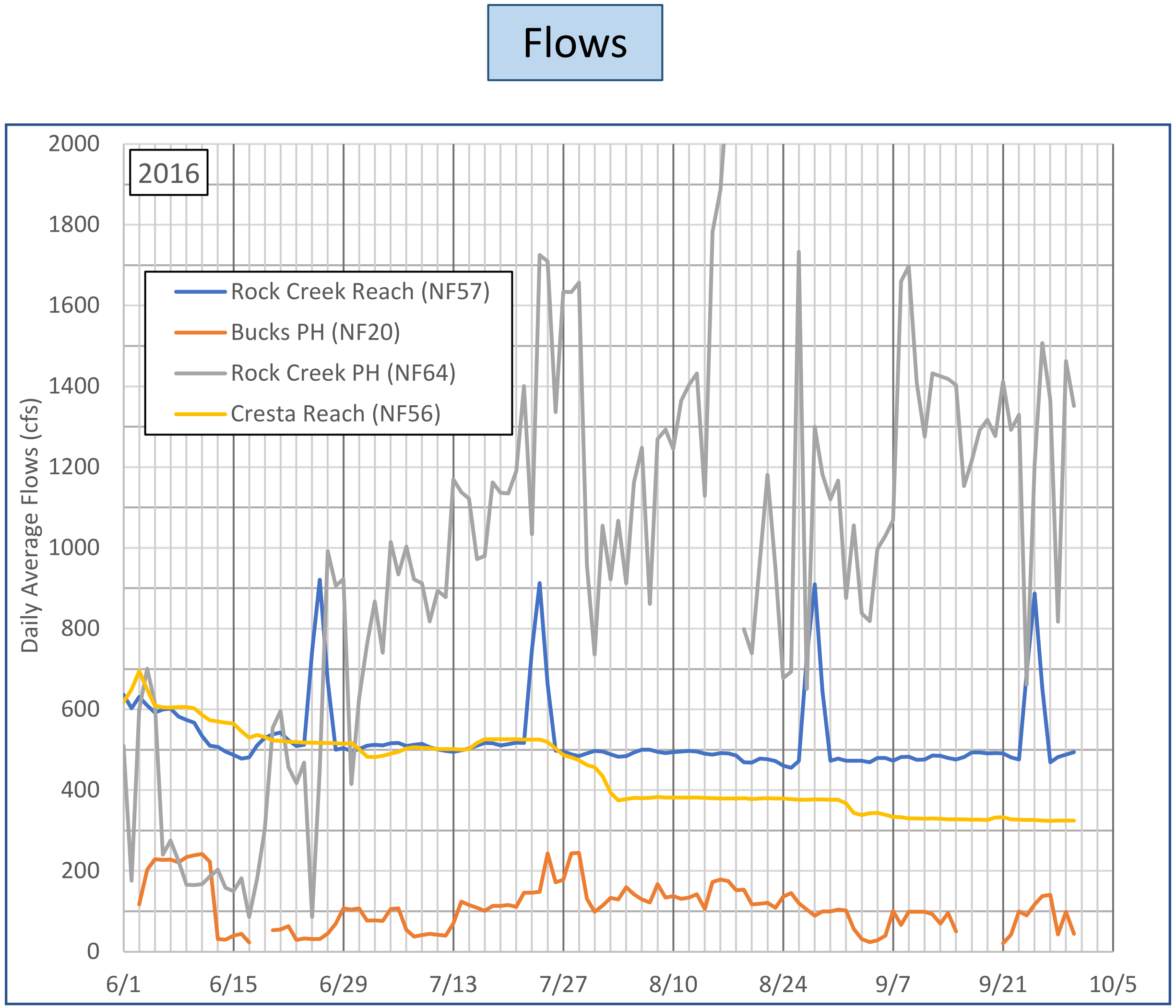


Figure A3-4


Flows
2016
Rock Creek Reach (NF57)
Bucks PH (NF20)
Rock Creek PH (NF64)
Cresta Reach (NF56)
Daily Average Flows (cfs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5

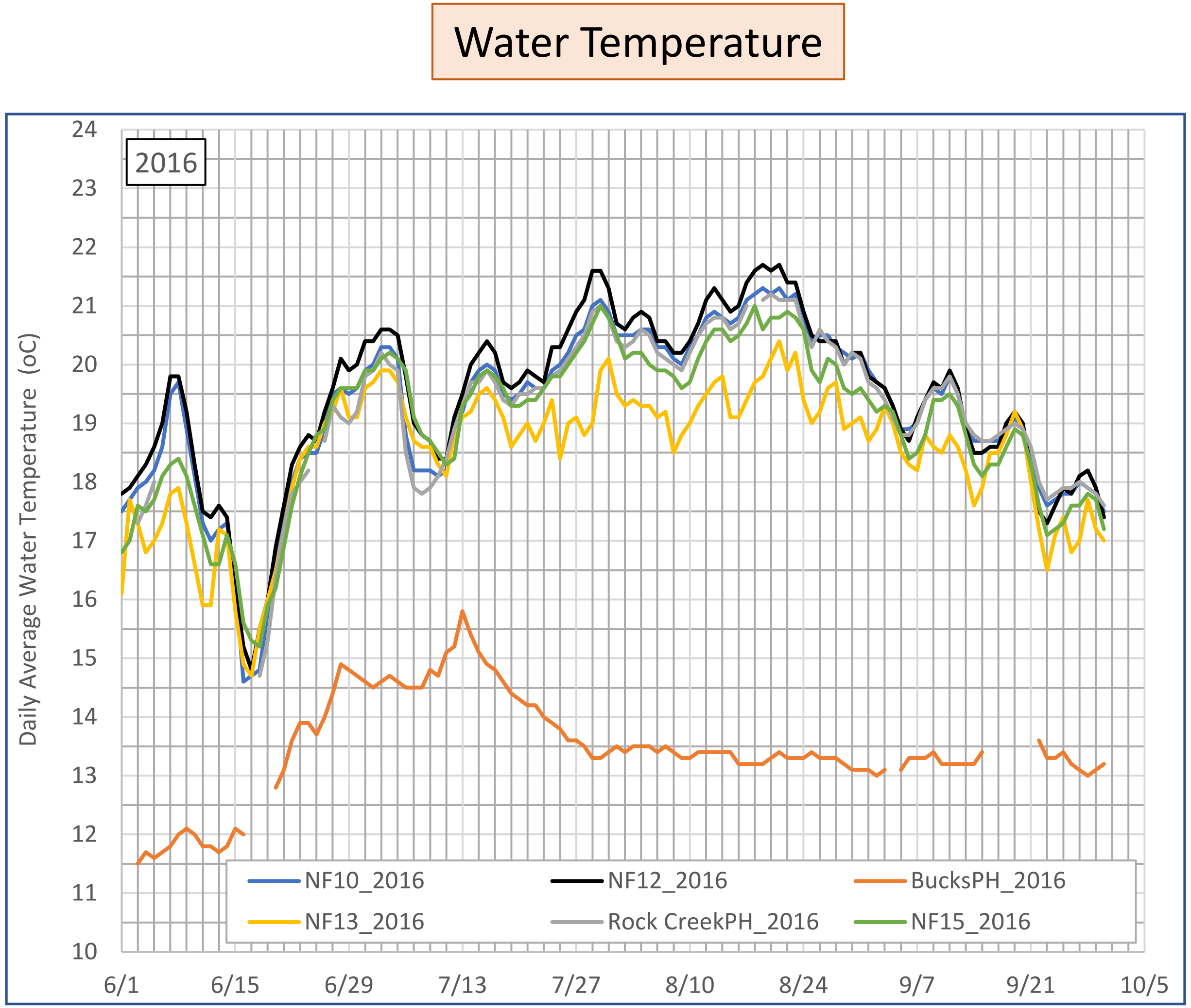
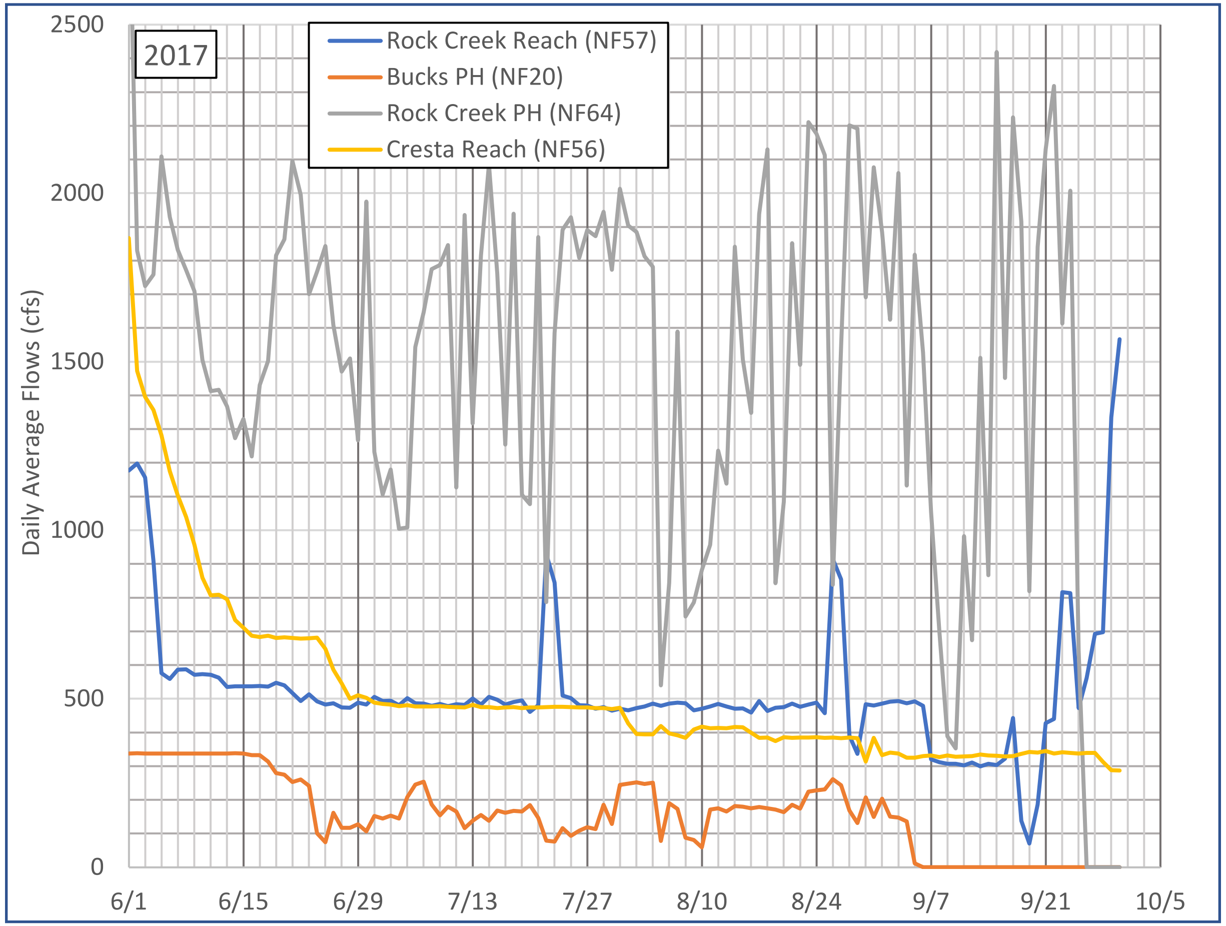

Water Temperature
2016
Daily Average Water Temperature (oC)
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
NF10_2016
NF12_2016
BucksPH_2016
NF13_2016
Rock CreekPH_2016
NF15_2016

Figure A3-5

Flows



Water Temperature

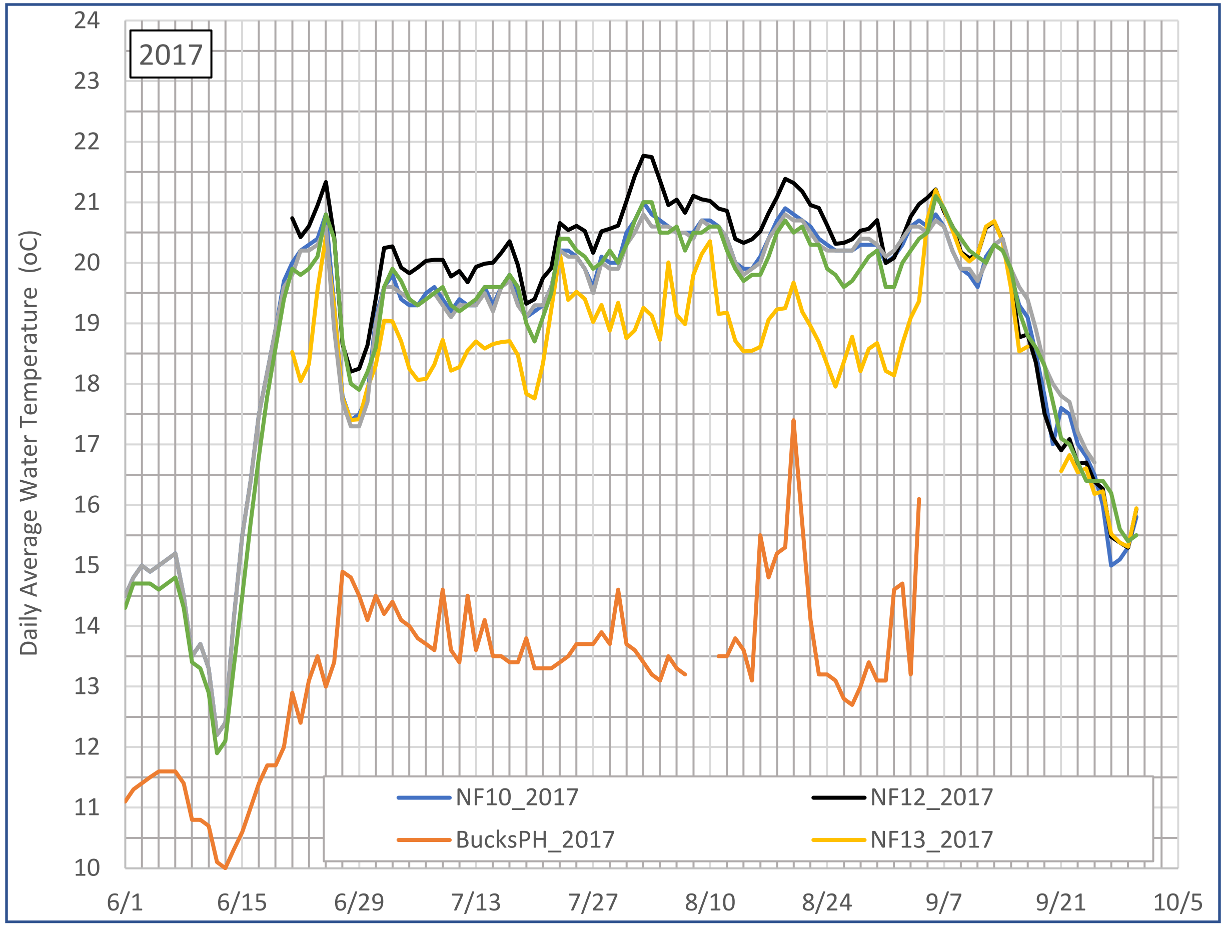
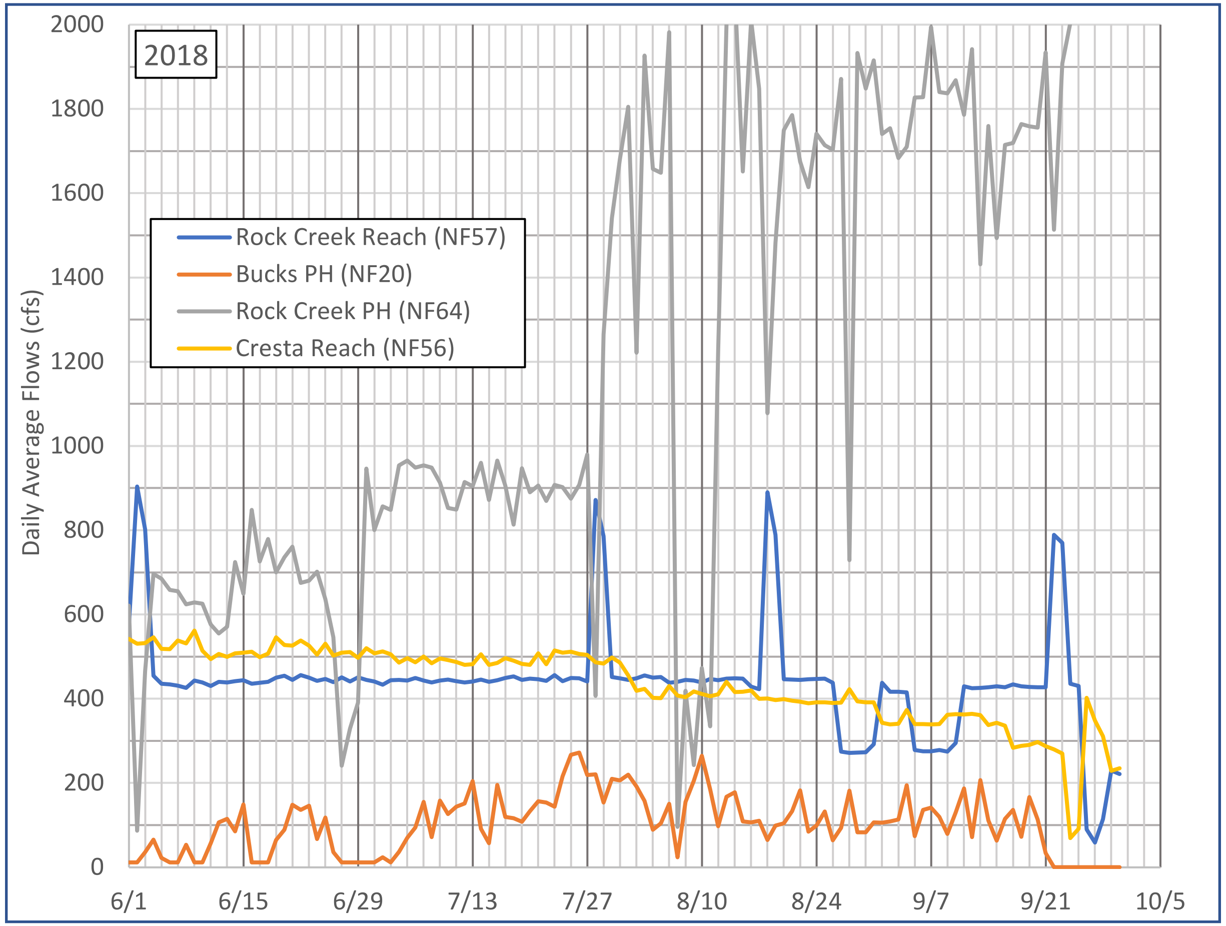


Figure A3-6

Flows



Water Temperature

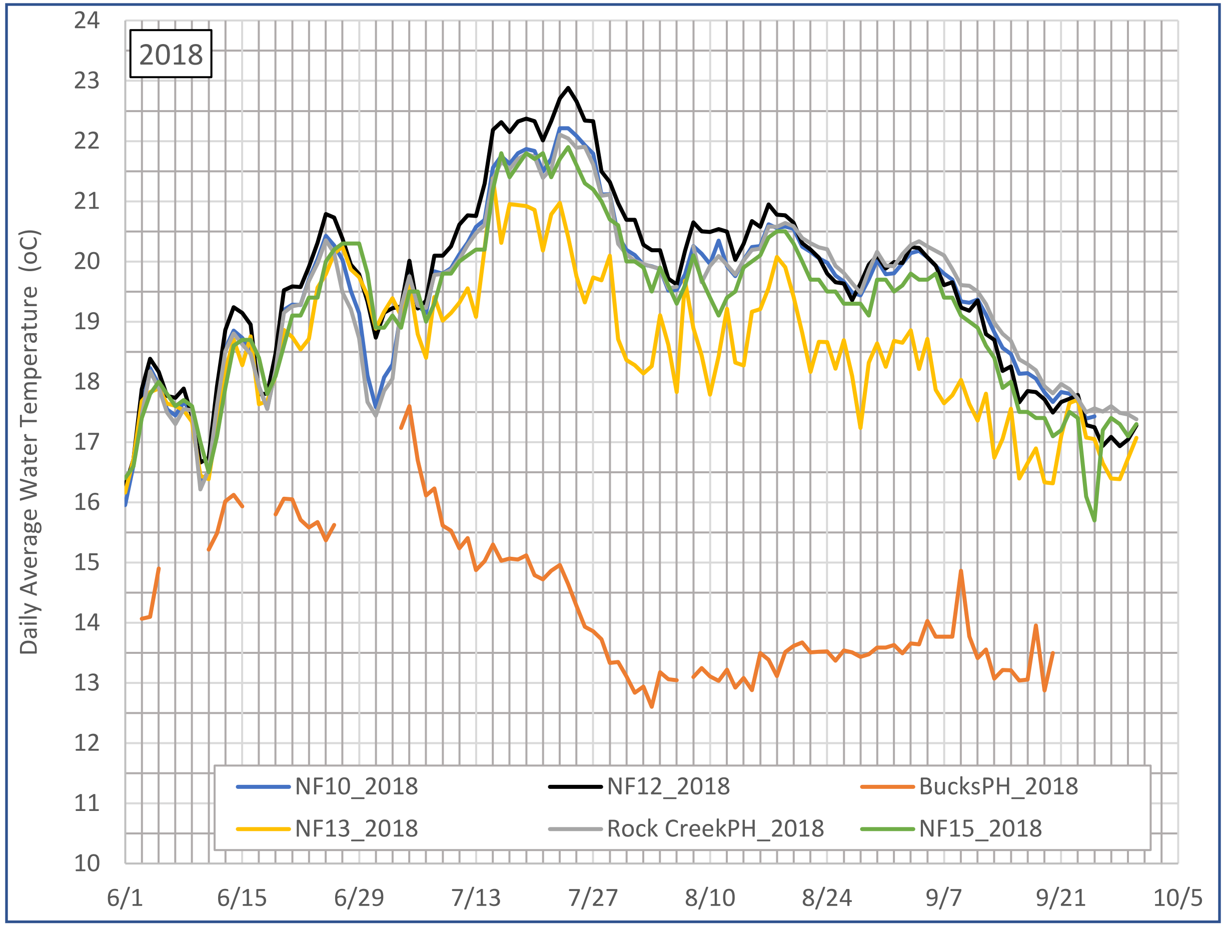
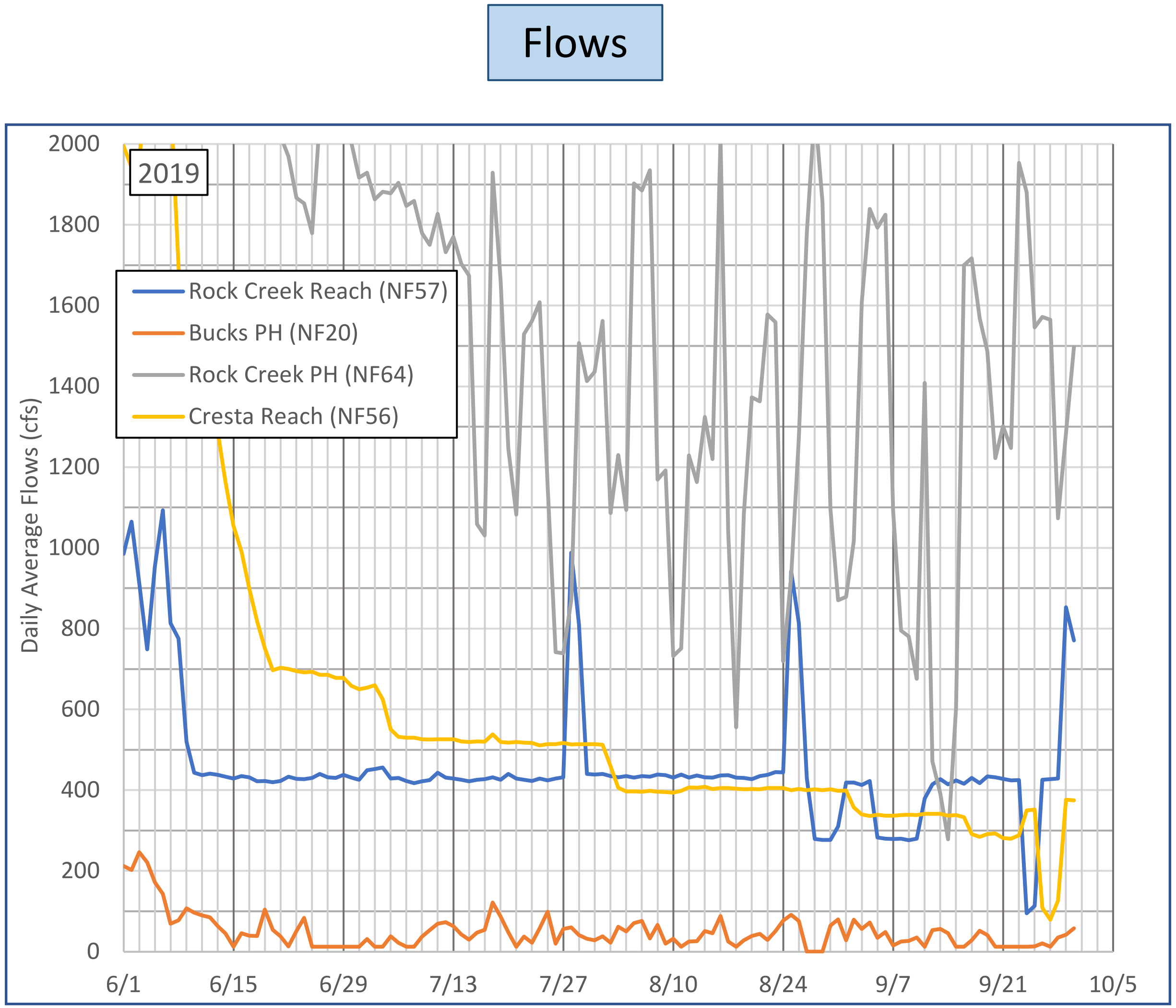
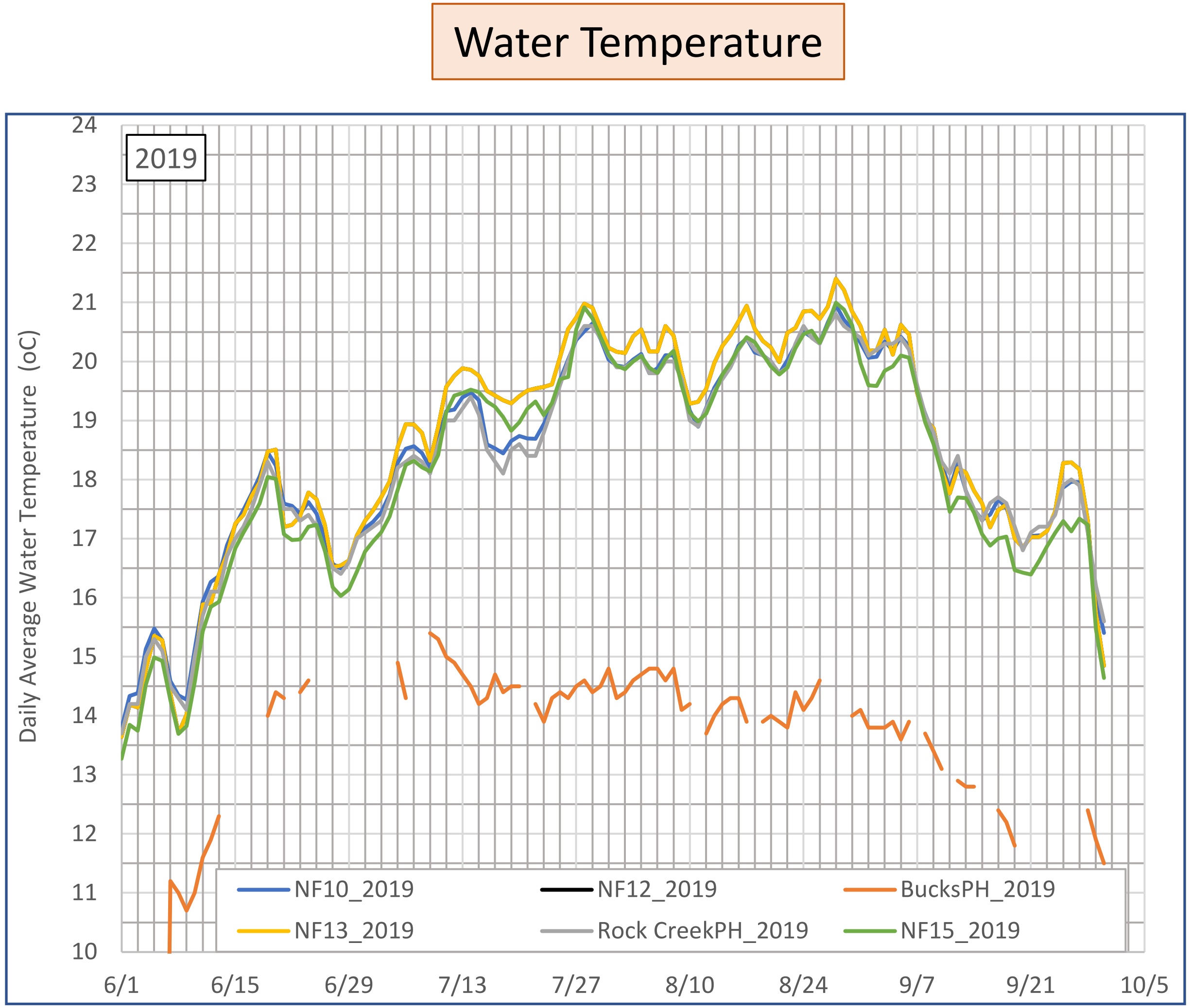


Figure A3-7

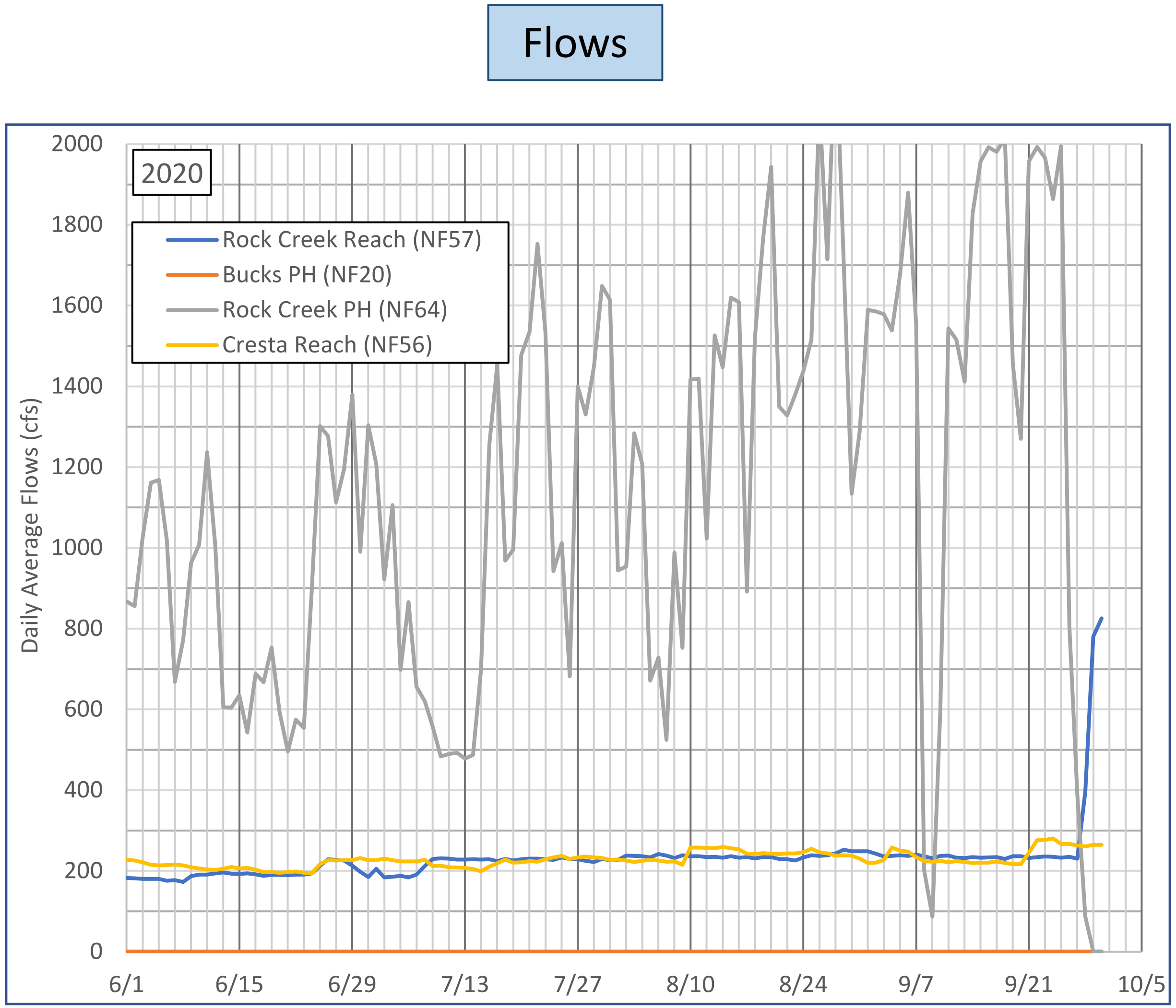


Flows
2019
Rock Creek Reach (NF57)
Bucks PH (NF20)
Rock Creek PH (NF64)
Cresta Reach (NF56)
Daily Average Flows (cfs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5



Water Temperature
2019
Daily Average Water Temperature (oC)
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
NF10_2019
NF12_2019
BucksPH_2019
NF13_2019
Rock CreekPH_2019
NF15_2019
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5

Figure A3-8


Flows
2020
Rock Creek Reach (NF57)
Bucks PH (NF20)
Rock Creek PH (NF64)
Cresta Reach (NF56)
Daily Average Flows (cfs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5

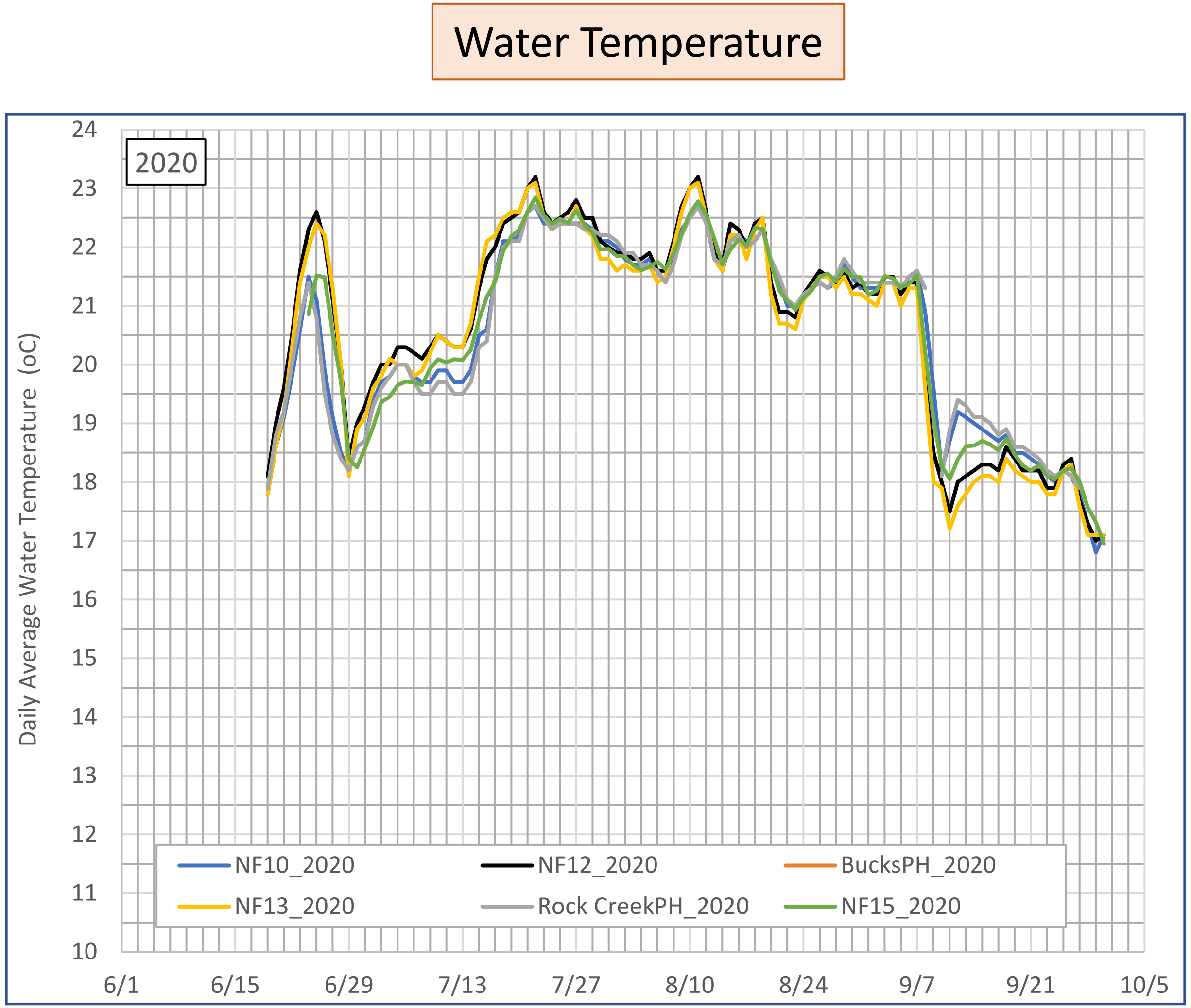
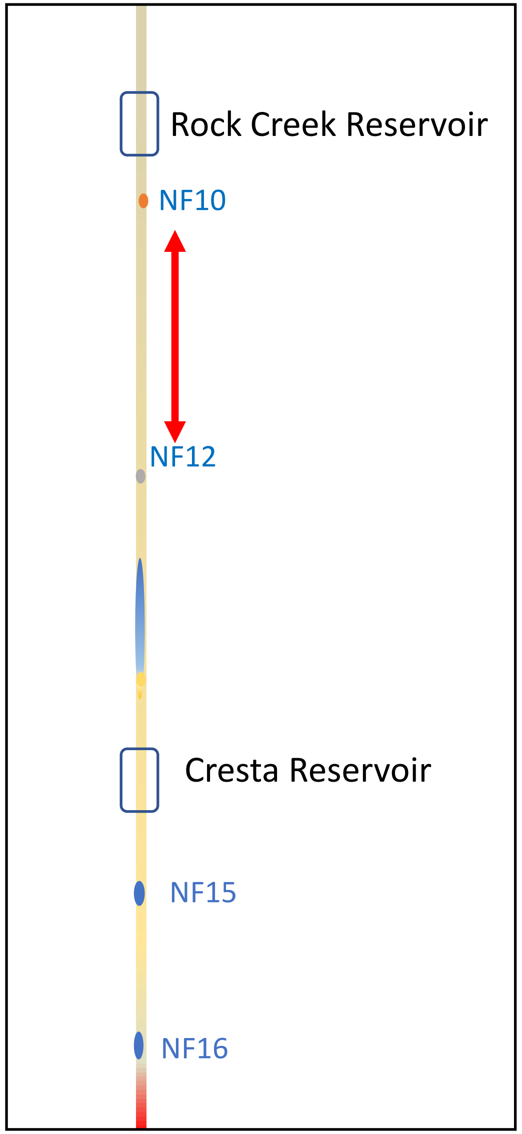

Water Temperature
2020
Daily Average Water Temperature (oC)
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
NF10_2020
NF12_2020
BucksPH_2020
NF13_2020
Rock CreekPH_2020
NF15_2020
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5

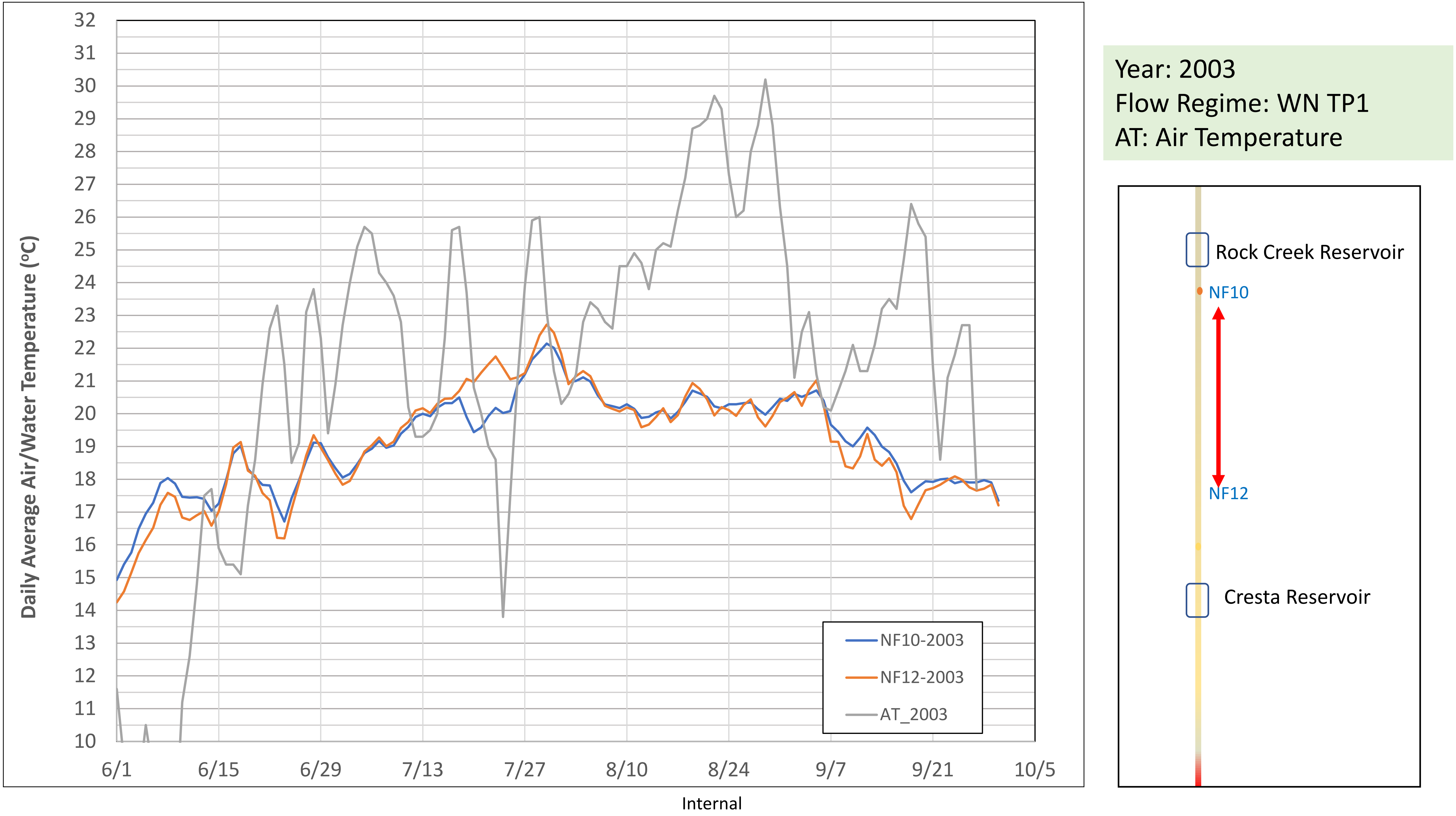
Figure A3-9

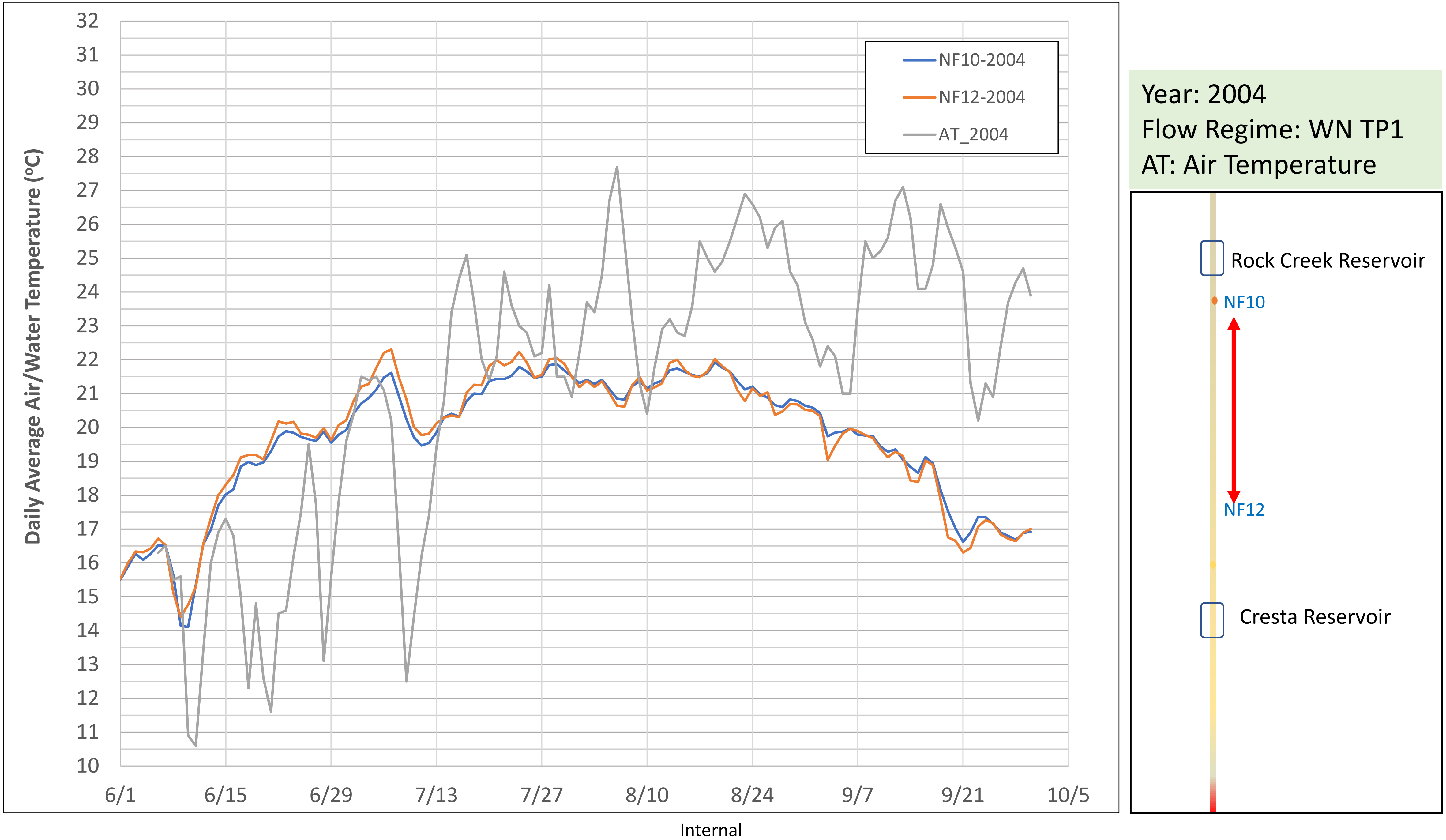
ATTACHMENT D

TEMPERATURE RESPONSES RELATED TO THE CHANGES IN MINIMUM INSTREAM FLOW RATES (MEASURE 4)

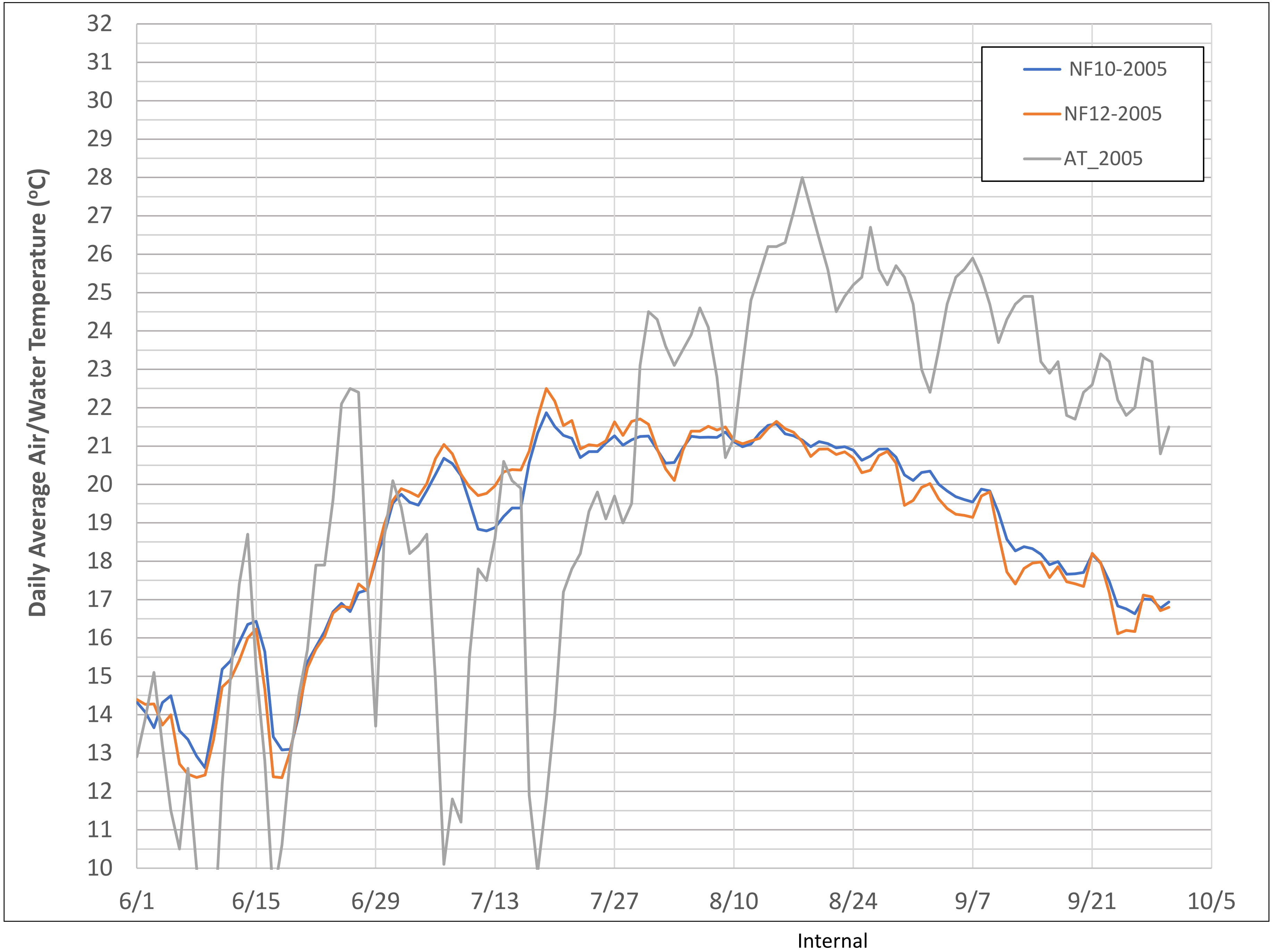
Water Temperature Difference between downstream and upstream of Rock Creek Reach during three flow groupings (i.e., **CD**, **WN TP1, WN TP3)**



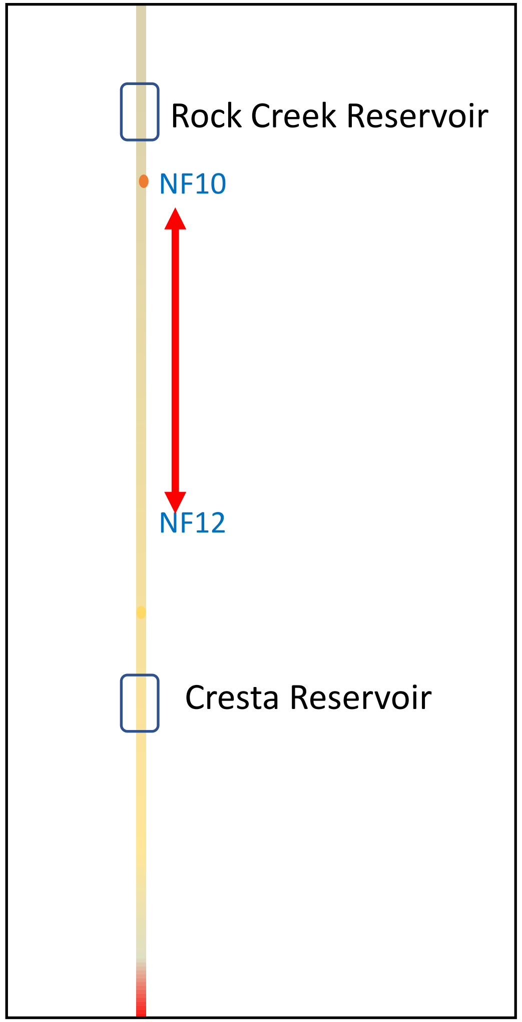

Daily Average Air/Water Temperature (°C)
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
Internal
NF10-2003
NF12-2003
AT_2003
Year: 2003
Flow Regime: WN TP1
AT: Air Temperature
Rock Creek Reservoir
NF10
NF12
Cresta Reservoir

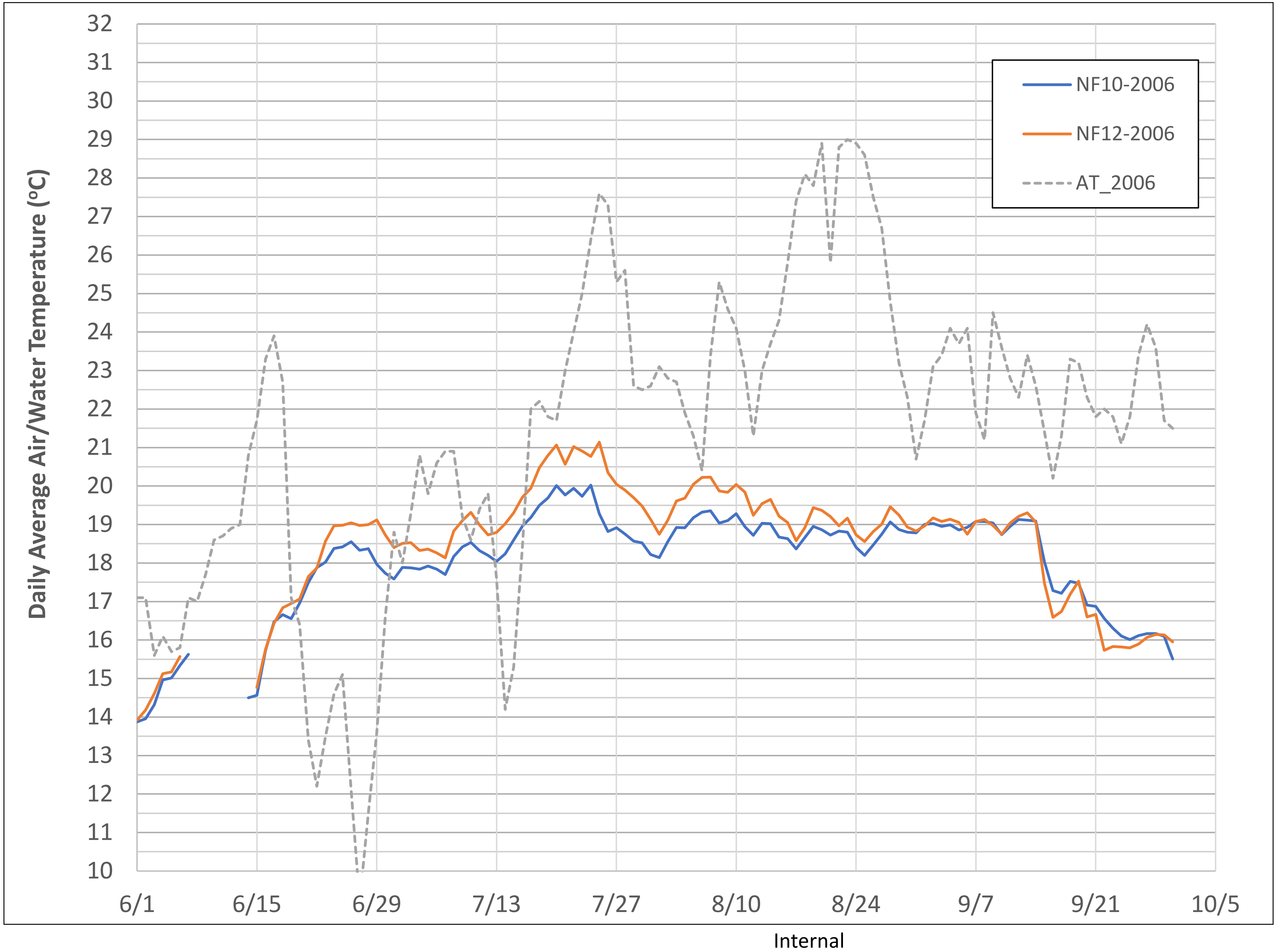


NF10-2004
NF12-2004
AT_2004
Daily Average Air/Water Temperature (ºC)
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
Internal
Year: 2004
Flow Regime: WN TP1
AT: Air Temperature
Rock Creek Reservoir
NF10
NF12
Cresta Reservoir

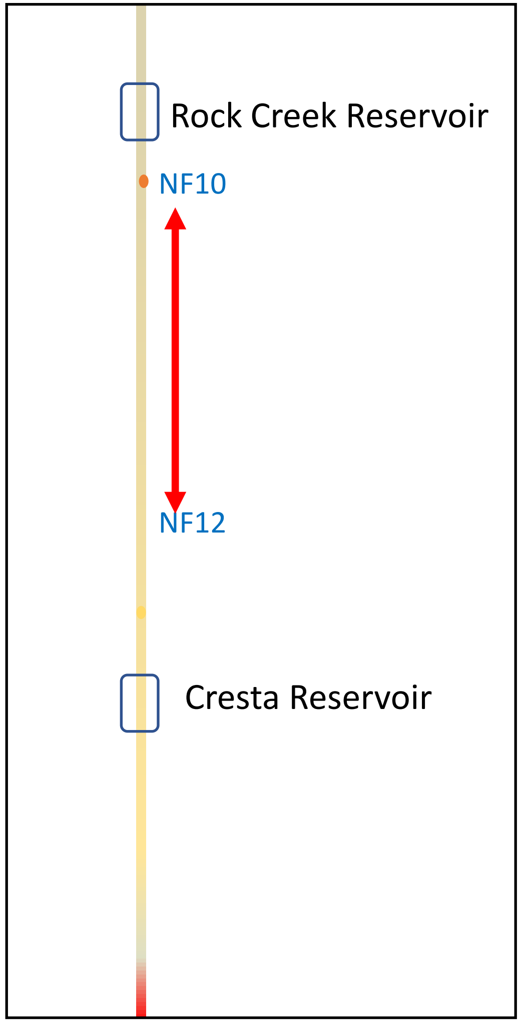


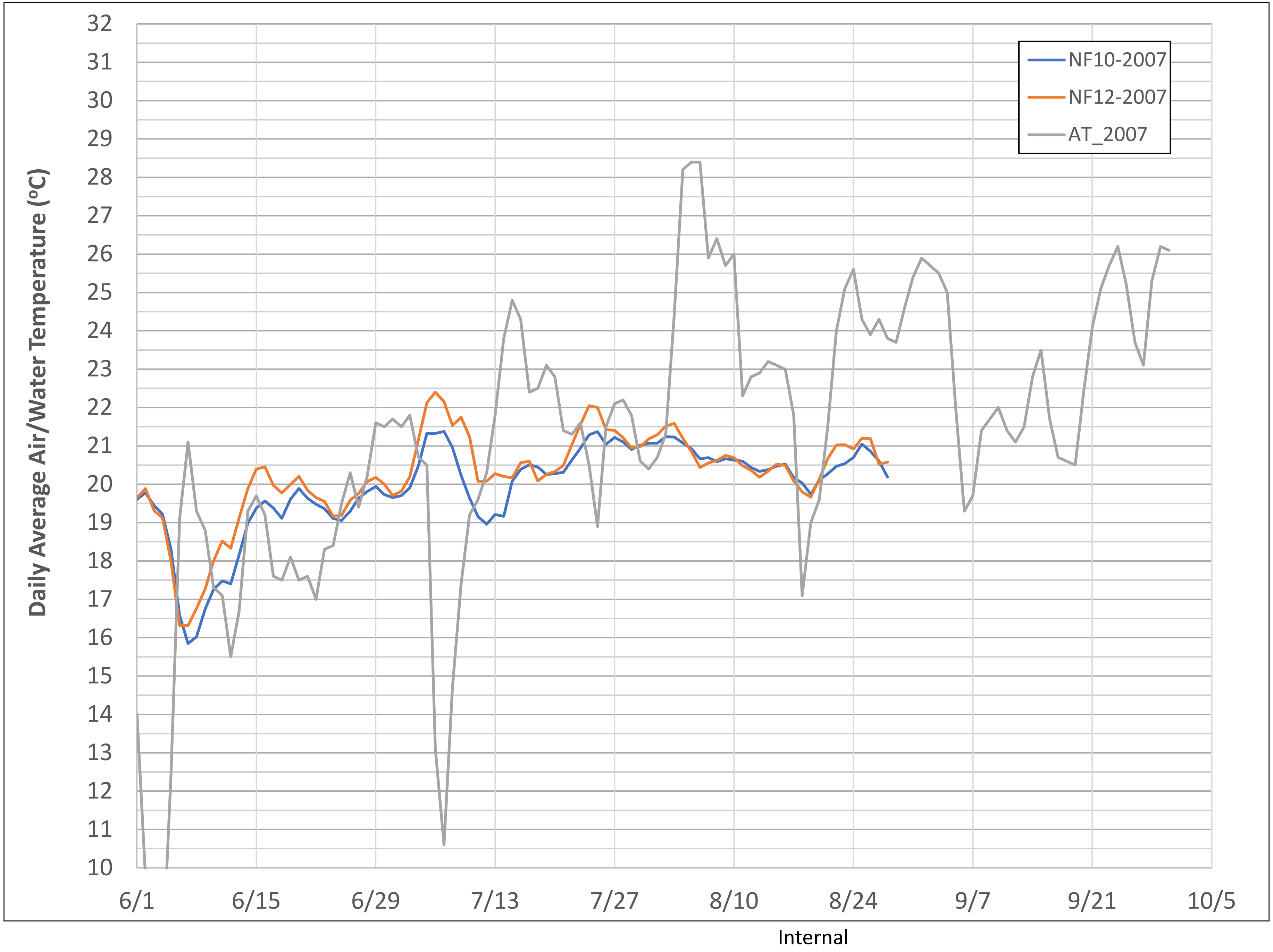
Year: 2005
Flow Regime: WN TP1
AT: Air Temperature



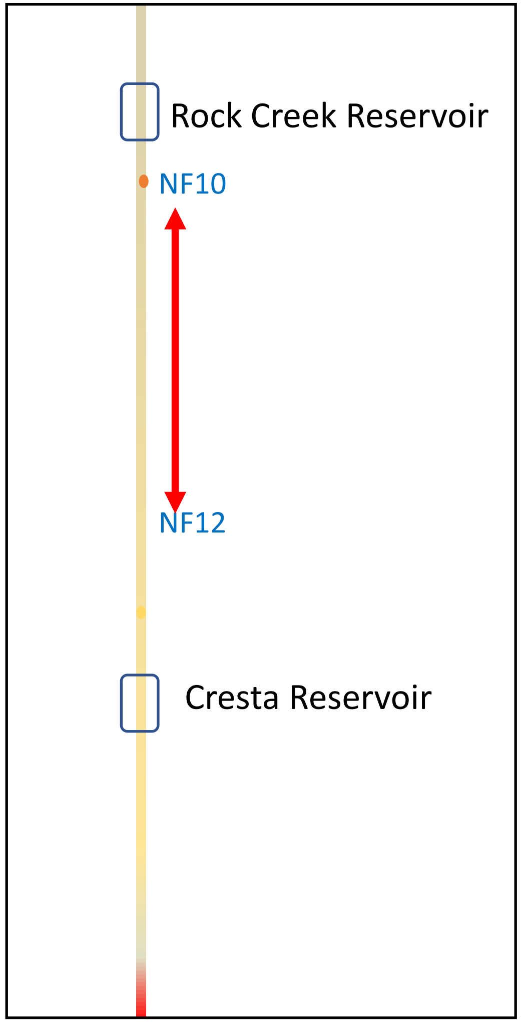


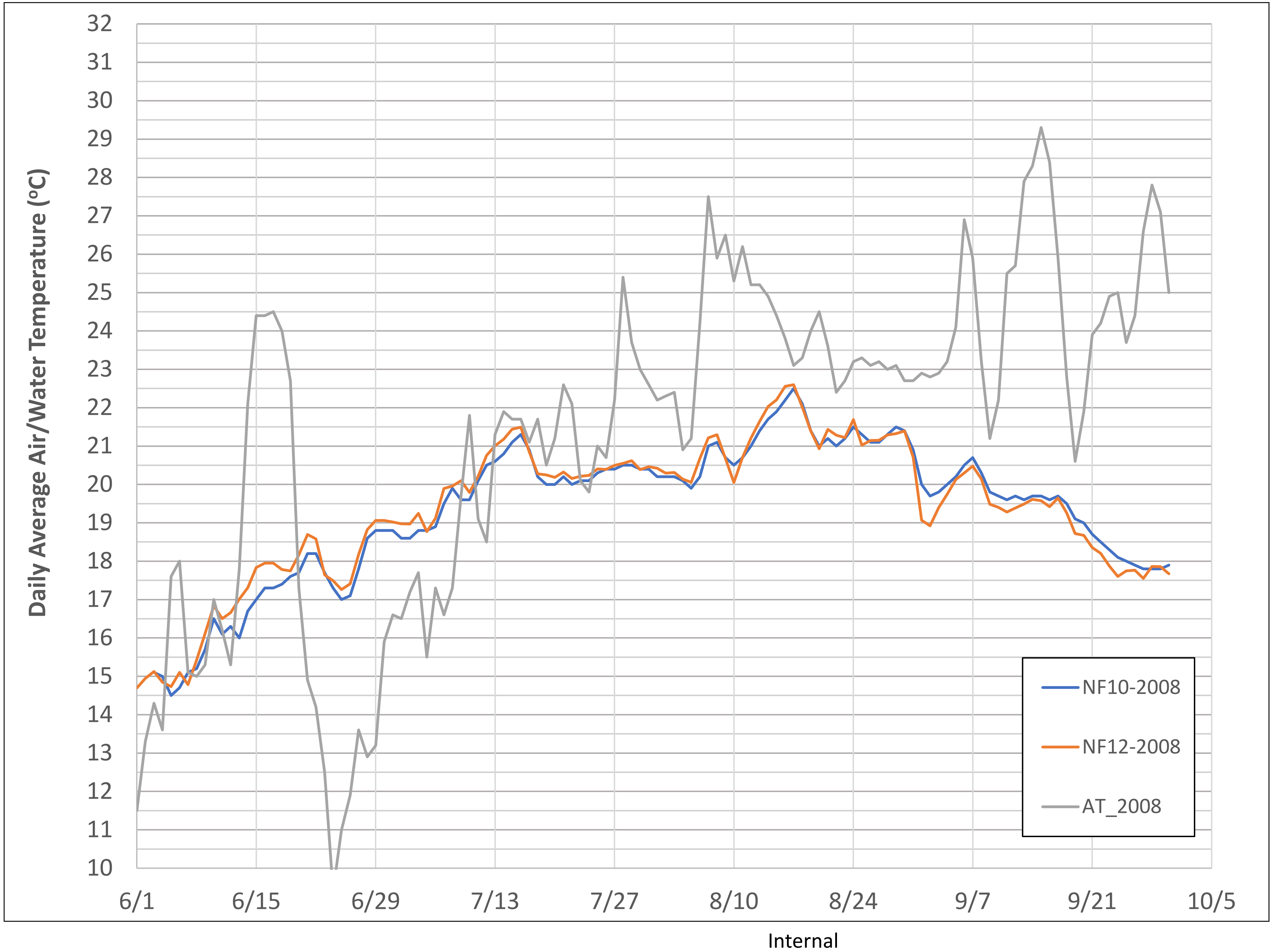
Year: 2006
Flow Regime: WN TP1
AT: Air Temperature



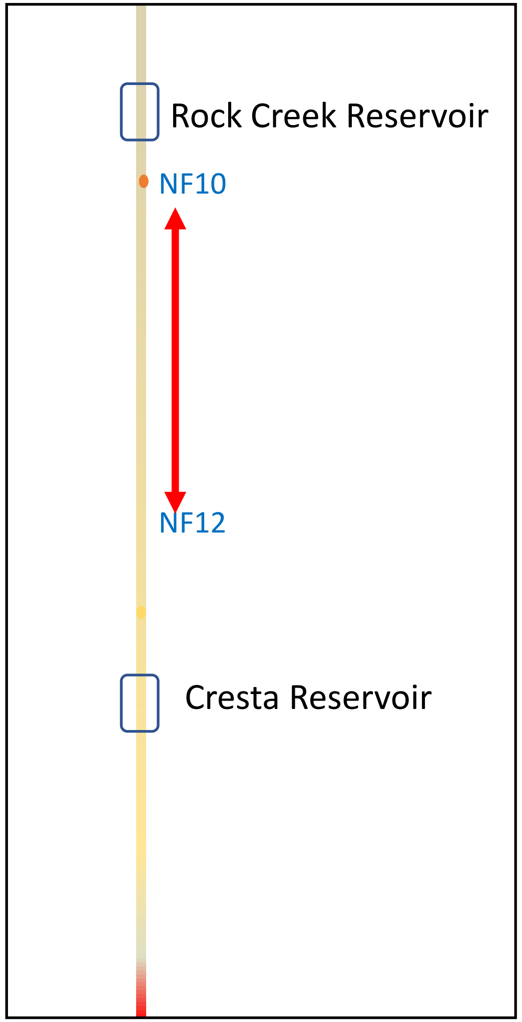


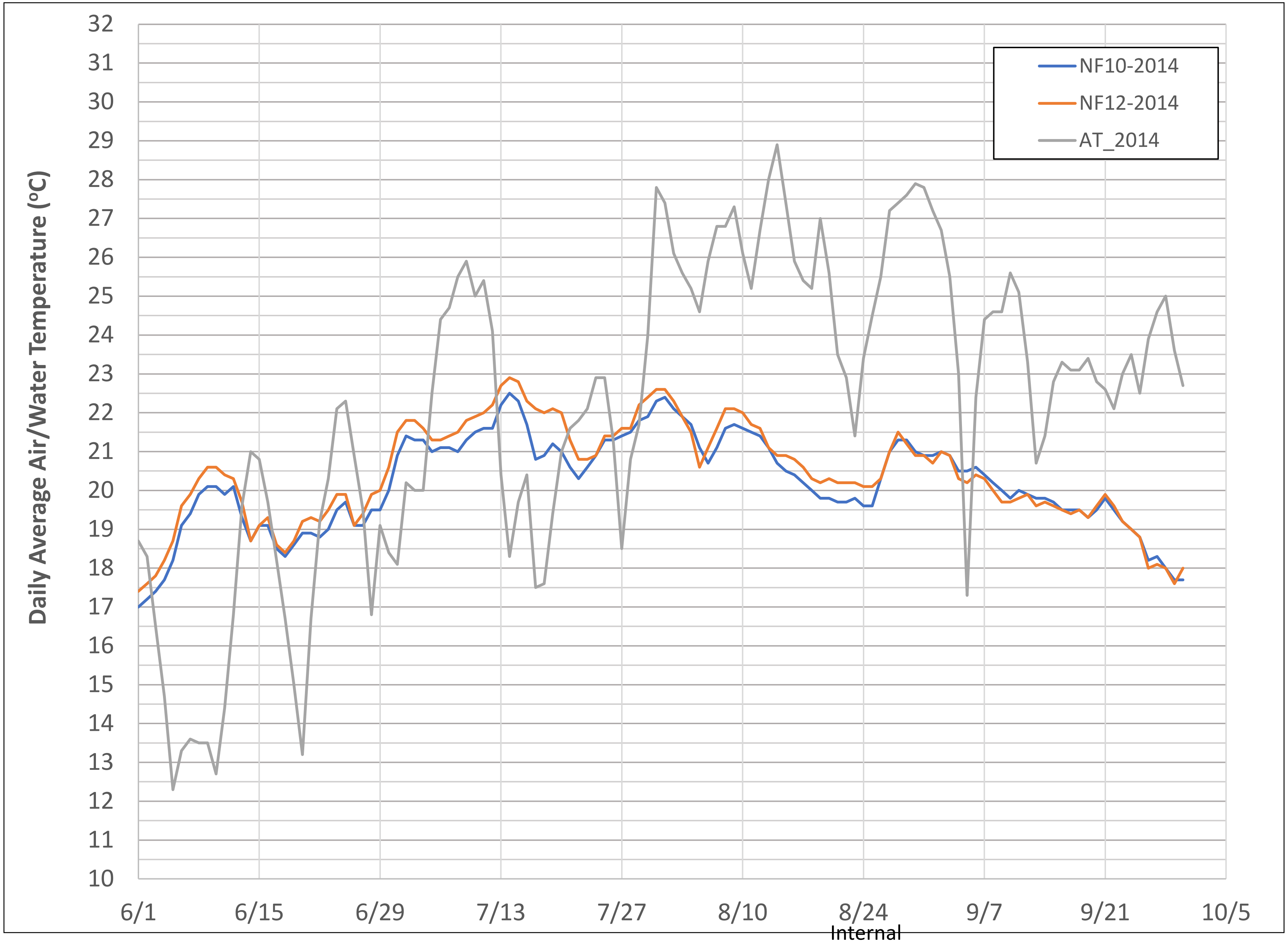
Year: 2007
Flow Regime: CD
AT: Air Temperature



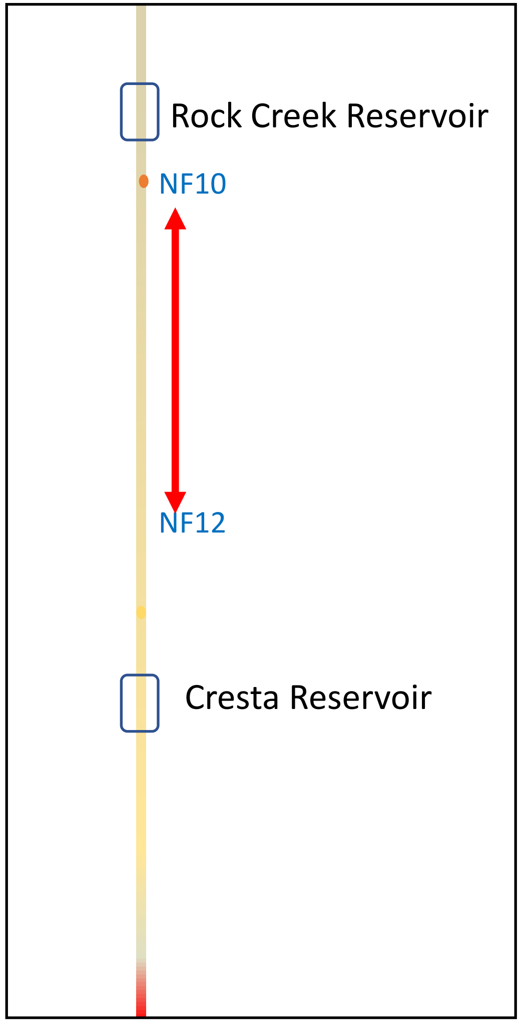


Year: 2008
Flow Regime: CD
AT: Air Temperature

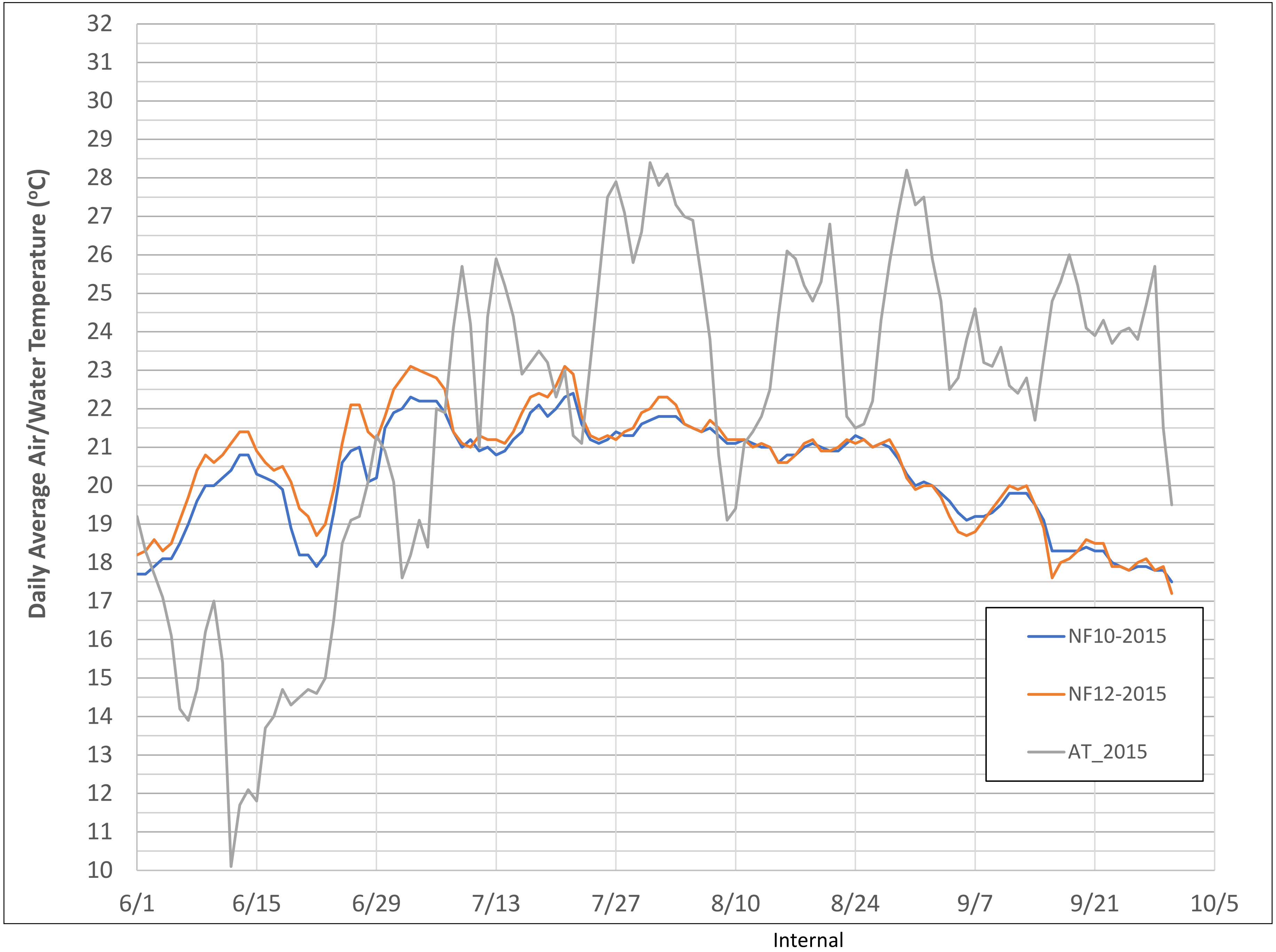




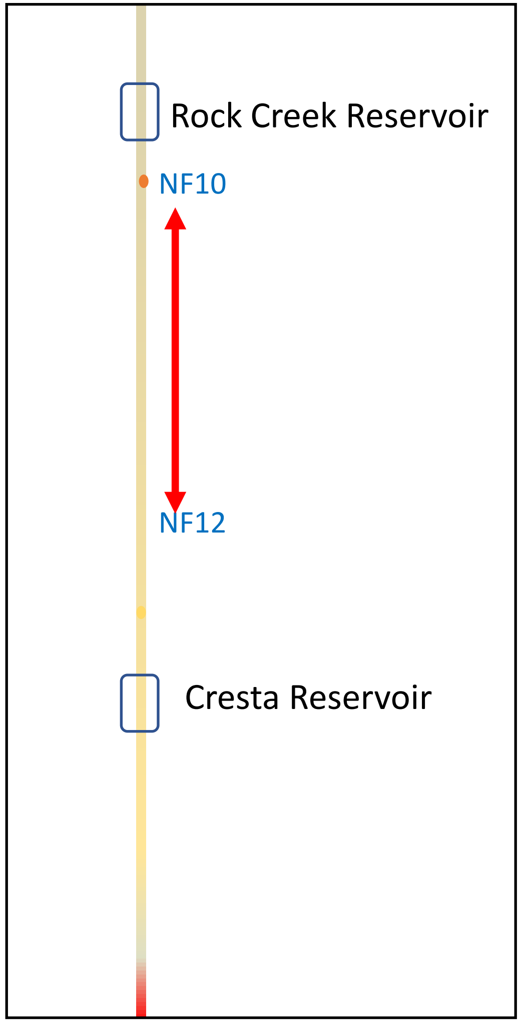
Year: 2014
Flow Regime: CD
AT: Air Temperature

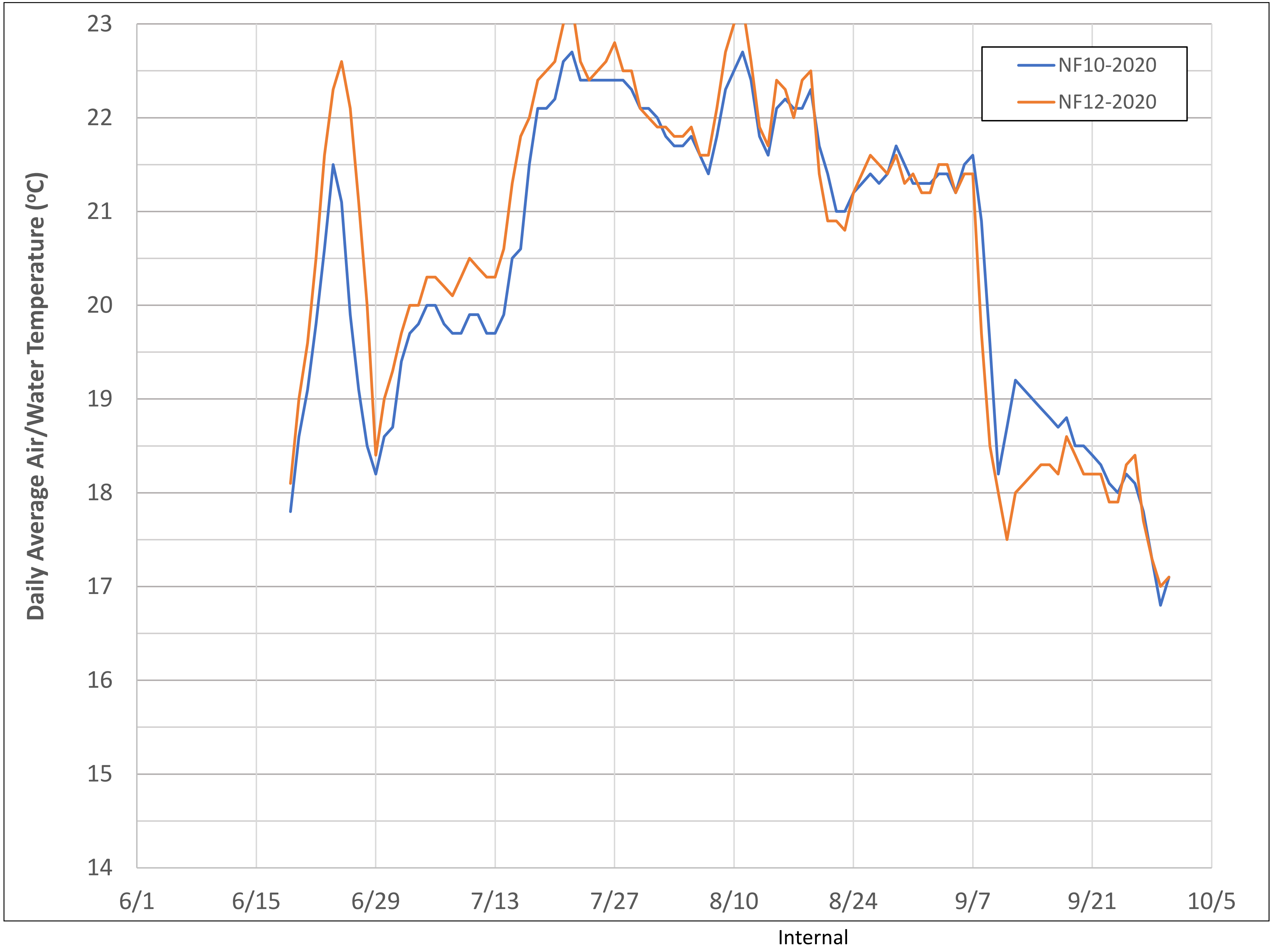


Internal

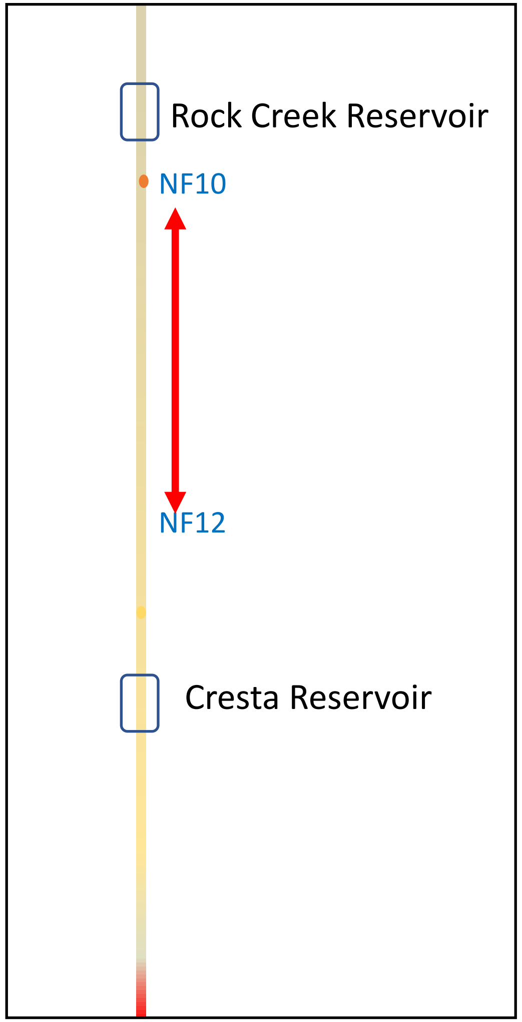


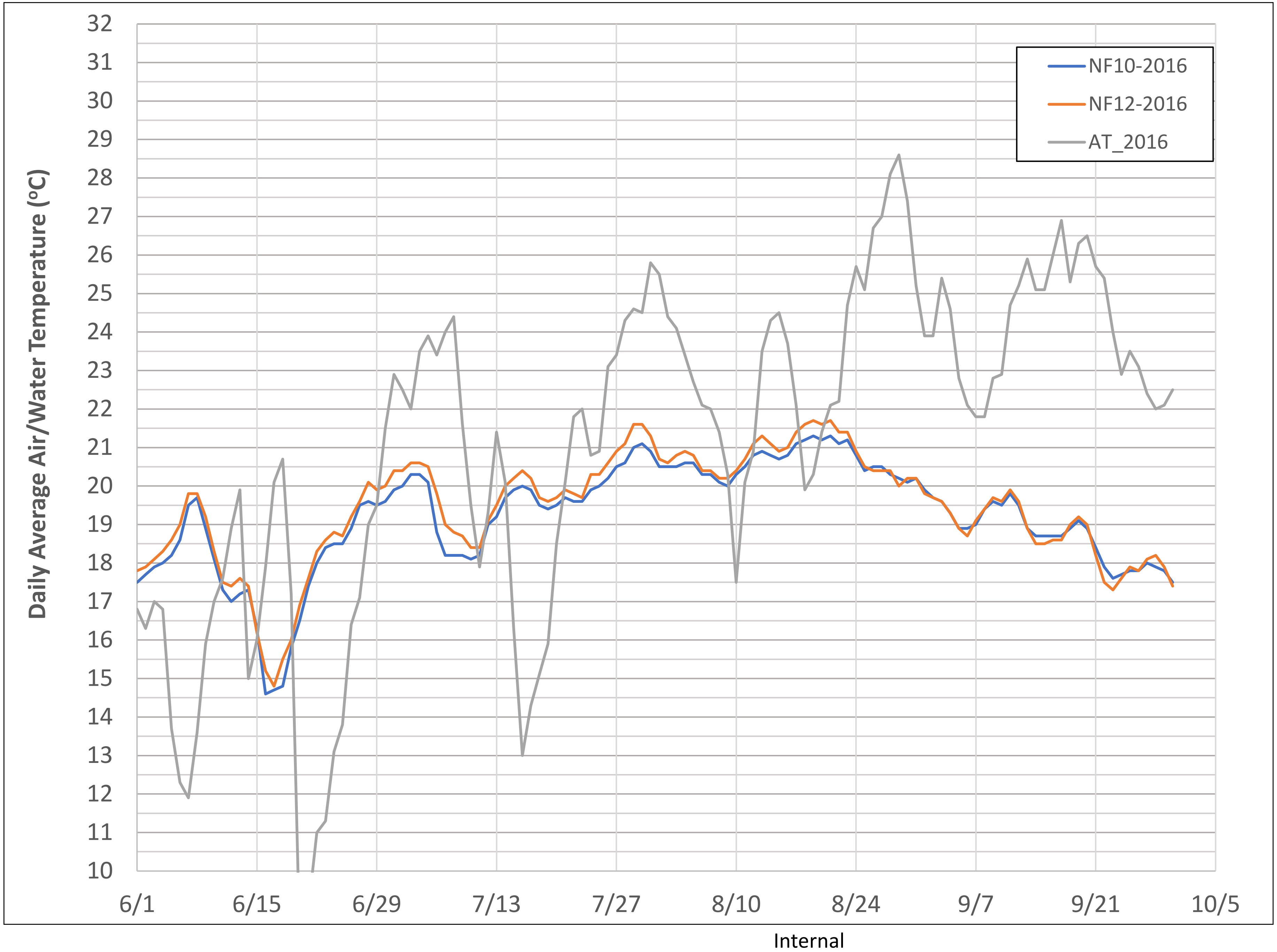
Year: 2015
Flow Regime: CD
AT: Air Temperature



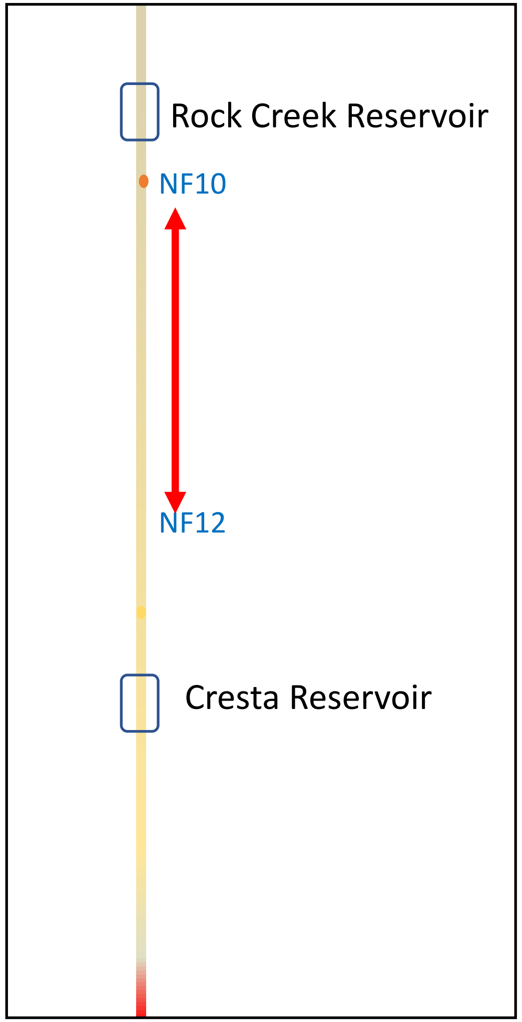


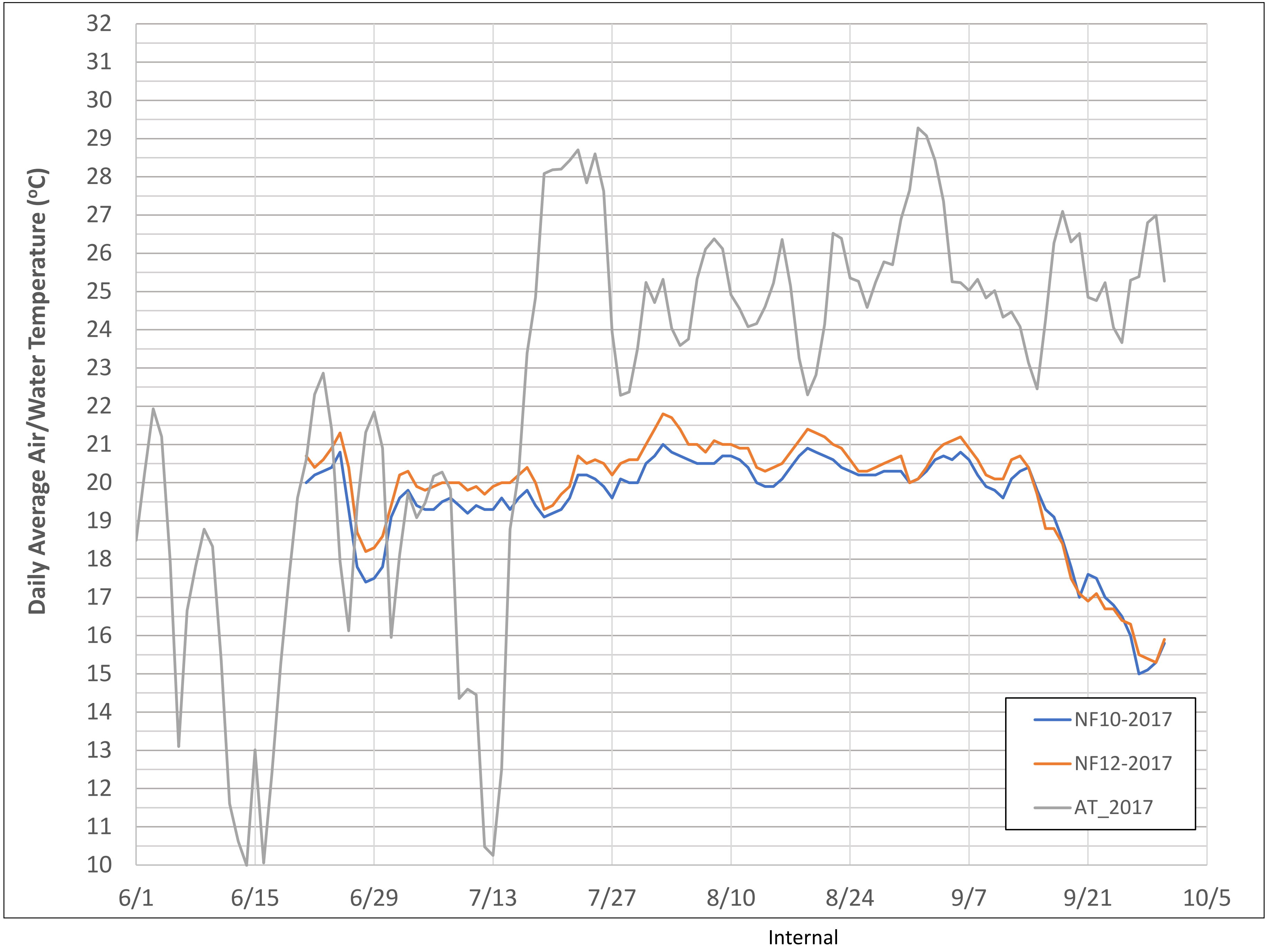
Year: 2020
Flow Regime: CD
AT: Air Temperature



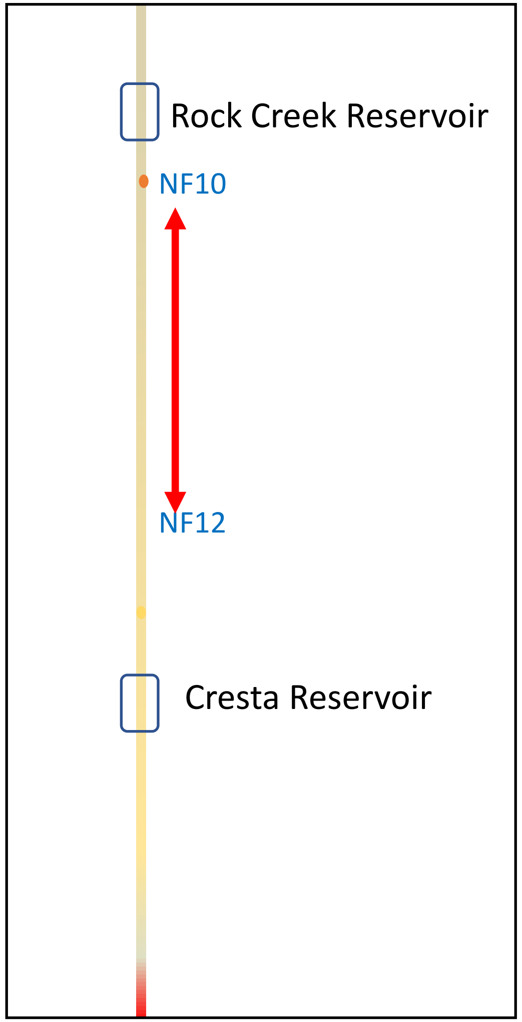


Year: 2016
Flow Regime: WN TP3
AT: Air Temperature

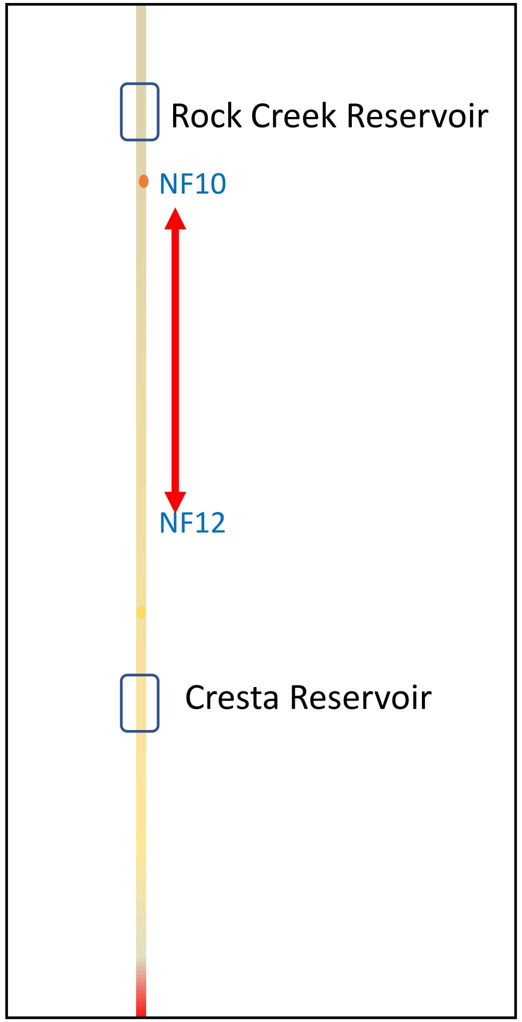


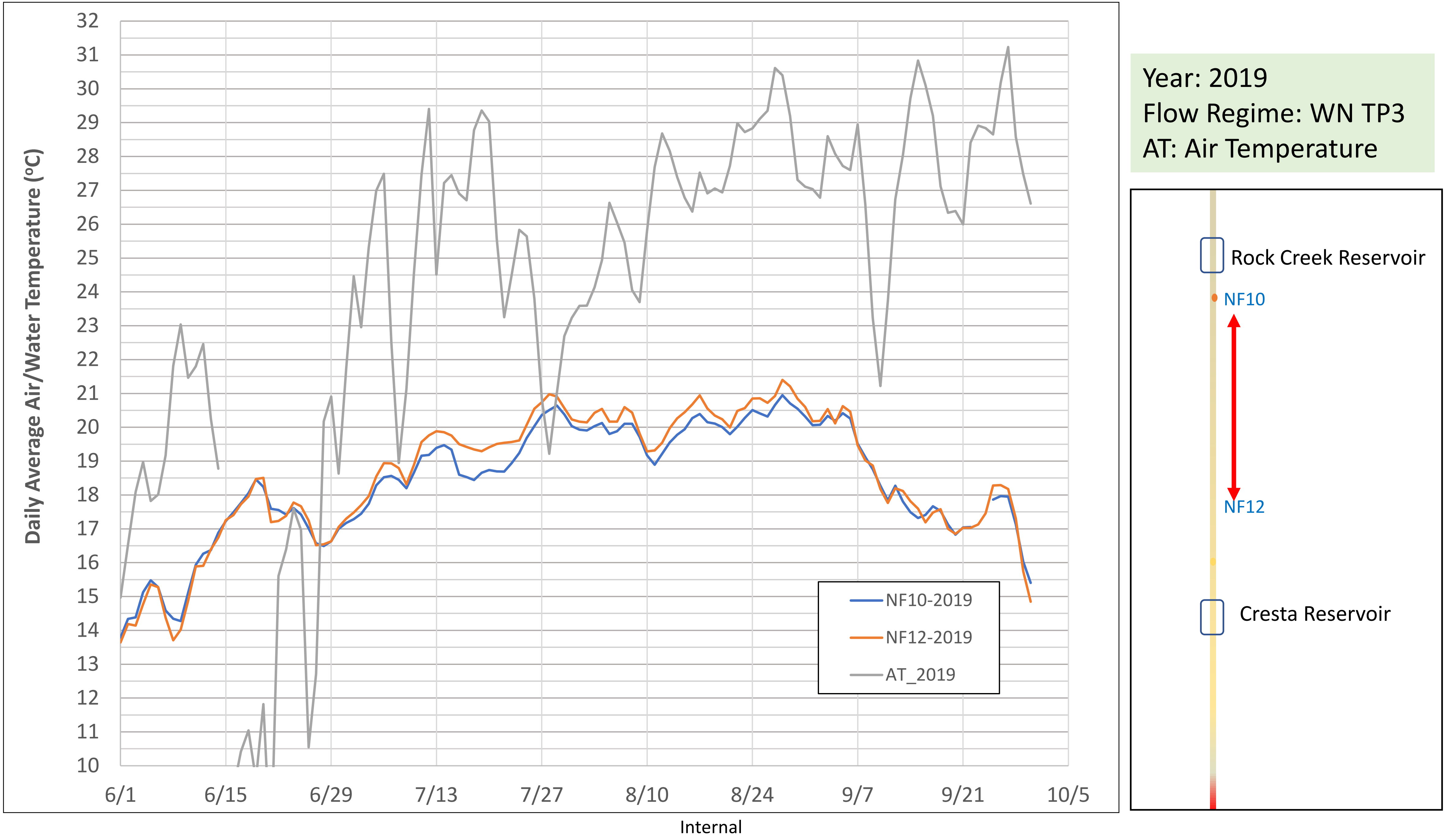


Year: 2017
Flow Regime: WN TP3
AT: Air Temperature



Year: 2018
Flow Regime: WN TP3
AT: Air Temperature





Daily Average Air/Water Temperature (°C)
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
Internal
NF10-2019
NF12-2019
AT_2019
Year: 2019
Flow Regime: WN TP3
AT: Air Temperature
Rock Creek Reservoir
NF10
NF12
Cresta Reservoir